

A detailed topographic map of a hilly region, likely in Italy, showing contour lines, rivers, and various landmarks. The map is rendered in a light, monochromatic style. Key features include the river 'F. Iunorella Sora' at the top, 'Grotte di Ciommo' on the left, and 'Masseria Agresta' in the lower center. Numerous elevation points and place names are scattered across the terrain.

# **PATTERN TO PROCESS**

**METHODOLOGICAL INVESTIGATIONS  
INTO THE FORMATION AND INTERPRETATION OF  
SPATIAL PATTERNS IN ARCHAEOLOGICAL  
LANDSCAPES**

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RIJKSUNIVERSITEIT GRONINGEN

PATTERN TO PROCESS:  
METHODOLOGICAL INVESTIGATIONS INTO THE FORMATION AND  
INTERPRETATION OF SPATIAL PATTERNS IN ARCHAEOLOGICAL  
LANDSCAPES

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**Nederlandse Samenvatting**



What a useful thing a pocket-map is! I remarked.  
That's another thing we've learned from *your* Nation, said Mein Herr, map-making. But we've carried it much further than *you*. What do you consider the *largest* map that would be really useful?  
'About six inches to the mile'.  
Only *six inches!* exclaimed Mein Herr. We very soon got to six *yards* to the mile. Then we tried a *hundred* yards to the mile. And then came the grandest idea of all! We actually made a map of the country, on the scale of *a mile to the mile!*  
Have you used it much? I enquired.  
It has never been spread out, yet, said Mein Herr: the farmers objected: they said it would cover the whole country, and shut out the sunlight! So we now use the country itself, as its own map, and I assure you it does nearly as well.

- Lewis Carroll, *Sylvie and Bruno Concluded*



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## PREFACE

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The volume now before you represents most of my research of the past seven years. It has grown out of two successive research projects and the papers and articles I have written for them since 1994. From 1994 to 1997 I was a Leverhulme research fellow based at the University of Birmingham Field Archaeology Unit (Birmingham, UK) working with Dr Roger White, Simon Buteux, and Dr Vince Gaffney on the Wroxeter Hinterland Project, and from 1997 until the present I have been part of the Regional Pathways to Complexity project at the Groningen Institute of Archaeology, directed by Dr Gert-Jan Burgers and Prof Peter Attema. Parts of this thesis make use of original and compiled data generated in the course of these two projects, and you will therefore find a mixture of work carried out in Britain and Italy being discussed.

The Wroxeter Hinterland and Regional Pathways to Complexity projects are not only very similar in the kinds of questions they confront, they also operate within a similar geographical scale (the 'region') and theoretical context ('landscape archaeology'). They both intend to investigate spatial patterns in the compiled regional archaeological data, and to explain these patterns – and deviations thereof – in terms of underlying historical processes. The title of this thesis, *Pattern to Process*, encapsulates this. The investigation does not start with a *tabula rasa*, however: we bring along our baggage of pre-existing models and interpretations of the past, hoping either to confirm or refute. In the manner in which we go about this task, the uneasy position of the field of Archaeology, split between the Humanities and the Sciences since the New Archaeology of the 1960's, becomes apparent. Archaeological remains can be studied as a means to support and enrich the culture-historical paradigm, or they can be studied as 'archaeological landscapes': on their own merits and with an appropriate methodology. Hence my subtitle: methodological investigations into the formation and interpretation of spatial patterns in archaeological landscapes.

Since much of my work has already been, or will be, published with co-authors as articles in journals and conference proceedings, I decided to submit this thesis 'in articles' (as the expression goes) rather than re-use the material in a single-author monograph. I have tried to organise the material in a logical fashion and have provided introductory and concluding chapters which I hope will help you, reader, find your way. One health warning is in order: if you intend to read this volume from cover to cover, you will inevitably encounter repetition and even contradiction among the chapters that follow. My advice to you is therefore to regard this volume as a buffet rather than a formal dinner.

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This thesis, and the research on which it is based, could not have happened without the support and encouragement of colleagues both here and in England. I would like to express my gratitude to my colleagues at the Birmingham University Field Archaeology Unit, for their hospitality and for helping me and my family cope with life in a strange country. In particular, Vince Gaffney for inviting me to become part of the Wroxeter Hinterland Project team and then arranging for the team to meet the Queen at Buckingham Palace; Roger White for sharing Wroxeter, Shrewsbury, and central Shropshire with me; and Simon Buteux and Sally Exon for helping out under all circumstances. At the Shropshire County Council, Penny Ward was most helpful with proving access to the county records.

Whilst much of the Herculean work of the Wroxeter Hinterland project team has by now reached print in technical papers, journal articles and volumes, and the occasional book, the final synthetic volume is still in preparation. I have very been fortunate in that my employers at the Groningen

Institute of Archaeology have agreed to allow me to finish some of my own contributions to this work. I would like to thank my colleagues in the RPC project for the help, discussions and the shared fieldwork. In particular, I am grateful to Peter Atterna who invited me to apply for one of the research openings in his then brand new project, has been my mentor for the past four years in a very agreeable hands-off style, and is now my promotor; to Marianne Kleibrink and Douwe Yntema whose research at Satricum, Francavilla Marittima, and the Brindisino provided the ultimate *raison d'être* for the RPC project; to Marianne again for convening a series of stimulating staff meetings where current research issues were discussed; and to Gert-Jan Burgers for making me think again about field methods, terminology, and the functional interpretation of ceramic surface scatters. Peter, Gert-Jan and Marianne also commented on draft versions of this thesis, and I am grateful for their helpful comments. Nick Ryan encouraged my interest in using 'executive toys' to improve fieldwork procedures, programmed and tested soft- and hardware during our fieldwork, and together with me described this work in a paper and article. Hendrik Feiken, then an M.A. student at the GIA, provided welcome help in preparing, executing and publishing methodological studies related to our fieldwork on the Pontine coast.

Other archaeologists elsewhere have also helped me in various ways. Most directly, I should thank Bert Voorrips, Susan Loving, and Hans Kamermans for allowing (and indeed encouraging) me to use the ceramic data collected during the Agro Pontino Survey - Bert even supplied me with a digital copy of the complete finds database. Kenneth Kvamme provided helpful leads and insightful comments especially on the GIS studies presented in this thesis; besides him, I should also thank the subscribers to the GISARCH discussion list for their comments and interest. A special mention and thank you should go to Jan Hartmann, a kind teacher who gave me the opportunity to pursue my interest in computer applications and methodology as an M.A. student at the then Institute for Pre- and Protohistory 'Albert Egges van Giffen' of the University of Amsterdam. He put me on the trail which I have been following now for almost 15 years.

Finally, an apology rather than a thank you is due to my wife Monica, who has had to cope with my absences and more than her fair share of the household, especially over the last year or so of work on this thesis.

Groningen, 1<sup>st</sup> May 2002

# NEDERLANDSE SAMENVATTING

Dit proefschrift, getiteld ‘Pattern to Process: methodological investigations into the formation and interpretation of spatial patterns in archaeological landscapes’ (‘Van Patroon to Proces: methodologisch onderzoek naar de vorming en interpretatie van ruimtelijke patronen in archeologische landschappen’), vormt de schriftelijke neerslag van onderzoek dat werd uitgevoerd in het kader van twee verschillende meerjarige projecten in twee ver uiteen liggende delen van Europa. Van 1994 tot 1997 maakte ik deel uit van het Wroxeter Hinterland Project (WHP) dat onder leiding van Dr Vincent Gaffney aan de Birmingham University Field Archaeology Unit (BUFAU) werd uitgevoerd. Dit project had ten doel het ontstaan, de bloei, en het verval van de Romeinse civitas-hoofdstad Viroconium (tegenwoordig Wroxeter, Shropshire) te relateren aan haar inheems-Romeinse achterland, in de late IJzertijd woongebied van de stam der Cornovii. Vervolgens voerde ik van eind 1997 tot begin 2001 aan de Universiteit van Groningen mijn promotieonderzoek uit binnen het project Regional Pathways to Complexity (RPC). Binnen dit project werkte ik onder leiding van Dr Peter Attema (RUG) en Dr Gert-Jan Burgers (VU) samen met drie andere promovendi aan de vergelijking van nederzettingsdynamieken en landgebruik van de late protohistorie tot en met de Romeinse tijd in drie Italische regio’s – het Pontijnse gebied in zuid-Lazio, de Salento Isthmus in Apulië, en de Sibaritide aan de Ionische Golf.

In beide projecten concentreert de problematiek zich rond de verhouding tussen interne dynamieken van de inheemse samenlevingen en de rol van externe kolonistoren. Waar tot voor kort algemeen werd gezien als de drijvende kracht achter maatschappelijke ontwikkelingen als centralisatie en urbanisatie, is sinds de jaren ’80 een kentering op gang gekomen waarbij het inheemse perspectief een gelijkwaardig, zo niet primair, belang krijgt toegedeeld. Omdat dit perspectief niet of nauwelijks door historische bronnen kan worden ondersteund, moeten archeologen gebruik maken van andere instrumenten zoals etnografische vergelijkingen; daarnaast moet het gebrek aan kennis van het inheemse niet-urbane landschap gecompenseerd worden door nieuw veldonderzoek en de studie van inheemse patronen van landgebruik en bewoning. Naast de problematiek van centralisatie, urbanisatie en kolonisatie vormde daarom ook de geografische inslag van het onderzoek een constante in beide projecten, waarbij vooral (het onderzoek naar) de toepassing van geografische informatiesystemen (GIS) voorop stond.

In de vroege jaren ’80, juist toen archeologen alom teleurgesteld raakten in de hoge verwachtingen van de New Archaeology, kwam voor het eerst betaalbare software beschikbaar waarmee geografische informatie – kaarten – aan alfanumerieke gegevensbestanden gekoppeld kon worden: geografische informatiesystemen (GIS). Het nut van dergelijke software werd eerst vooral in de Verenigde Staten onder beheerders van archeologische terreinen herkend, maar begon daarna al gauw ook in Europa en bij universitaire onderzoekers interesse te wekken vanwege haar analytische potentieel. Deze krachtige software bood de mogelijkheid de in de archeologie gebruikelijke, op combinaties van vele geografische factoren gebaseerde, nederzettingsmodellen te formaliseren en op betrekkelijk eenvoudige wijze te genereren en te visualiseren.

Onder andere vanwege het bovenstaande, maar ook omdat veel delen van dit onderzoek in verschillende vorm al eerder gepubliceerd zijn of nog zullen worden, heeft dit proefschrift de, onder Nederlandse archeologen ongebruikelijke, vorm ‘in artikelen’ gekregen. Deze zijn weliswaar gegroepeerd in vier delen – inleiding, methodologische studies, veldwerk, en GIS-toepassingen – maar dit blijft een achteraf opgelegde structuur, en de individuele hoofdstukken kunnen dus het beste als losstaande artikelen

gelezen worden. Om de samenhang tussen de delen en, daarbinnen, tussen de artikelen, te vergroten heb ik aan het geheel een introducerend en een samenvattend hoofdstuk toegevoegd, terwijl aan het veldwerk-deel nog een aparte inleiding vooraf gaat.

## DEEL I: INLEIDING

Dit deel vangt (hoofdstuk 1) aan met een presentatie van het kernprobleem van dit onderzoek – dat patronen in archeologische gegevens *op elke schaal* veroorzaakt kunnen zijn door externe vertekende factoren. Wanneer het, zoals in de landschapsarcheologie, de bedoeling is om archeologische resten en landschap in samenhang te bestuderen moeten dus manieren gevonden worden om dit probleem beheersbaar te maken, en het GIS-instrumentarium speelt hierin een belangrijke rol. Aangezien deze problematiek wordt onderzocht in het kader van de WHP- en RPC projecten worden ook deze kort ingeleid. Tenslotte wordt een overzicht gegeven van de structuur en inhoud van het proefschrift.

Hoofdstuk 2 werkt het kernprobleem nader uit aan de hand van voorbeelden uit de drie Italiaanse regio's van het RPC project. Er wordt begonnen met het geven van een overzicht van de bestaande nederzettingdynamieken zoals dat uit recente literatuur naar voren komt. Hieruit worden de belangrijkste maatschappelijke processen van het 1<sup>e</sup> millennium v. Chr. naar voren gehaald, en de belangrijkste archeologische concepten, theorieën en methoden besproken die in deel IV terug zullen keren. Centralisatie, urbanisatie, en kolonisatie worden als belangrijkste, maar tevens problematische concepten geïntroduceerd; naar aanleiding van een analyse van de theoretische basis voor het maken van interregionale vergelijkingen worden de voor- en nadelen van verschillende benaderingswijzen besproken, waarbij gekozen wordt voor een dichter bij de gegevens staande kwantitatieve benadering dan de tot nu toe gebruikelijke socio-politieke verklaringmodellen; en tenslotte volgt een eerste voorlopige verkenning van kwalitatieve en kwantitatieve vergelijking tussen de drie gebieden.

Aan dit inleidende deel is nog een hoofdstuk (3) toegevoegd waarin de doelstellingen en problematiek van Romanisatie in het Wroxeter Hinterland in meer detail geïntroduceerd worden. Dit hoofdstuk bestaat uit twee artikelen die in 1996-97 in congresbundels gepubliceerd werden. Het eerste, met coauteur Vince Gaffney, plaatst het vinden van een verklaring voor het bestaan van Wroxeter zelf – de vierde urbane nederzetting van Romeins Brittannië in grootte maar ogenschijnlijk zonder het ontwikkelde rurale achterland dat bij zo'n stad hoort – centraal. Doelstelling is om Wroxeter's plaats in de vigerende modellen voor urbanisatie en Romanisatie in provinciaal-Romeinse context te bepalen door middel van zowel een studie van de beschikbare archeologische gegevens als een uitgebreid programma van veldverkenning. Ook wordt het beoogde instrumentarium voor geografische analyse beschreven. Het tweede artikel, met coauteur Roger White, verwerpt op grond van direct bewijs en theoretische argumenten een drietal bestaande verklaringen voor het bestaan van een welvarende inheems-Romeinse stad temidden van een nauwelijks geromaniseerd achterland – dat Wroxeter als stad te ambitieus gepland was en feitelijk nooit een grote bevolking heeft gehad, dat de lokale bevolking vijandig zou staan tegenover de kolonisor, en dat Wroxeter altijd economisch onderontwikkeld is gebleven. Waar de eerste van deze verklaringen door middel van een vlakdekkende geofysische en luchtfotografische studie van de stad direct kon worden weerlegd, worden in dit artikel ook de andere twee verklaringen verworpen op grond van het argument dat het succes van de stad *impliceert* dat ook het achterland rijk moet zijn geweest en dat deze rijkdom naar de stad moet zijn gevloeid. Als alternatieve verklaring voor de schijnbare tegenstelling tussen stad en platteland stellen wij daarom voor dat de rijkdom van de inheemse Cornovii archeologisch onzichtbare vormen (vee, zout) aannam, en dat bovendien onze kennis van nederzetting en landgebruik in de late IJzertijd en Romeinse tijd binnen het gebied vertekend is door een gebrek aan systematisch onderzoek.

## DEEL II: METHODOLOGISCHE STUDIES

Zoals hierboven al werd aangeduid, heeft de interpretatie van grootschalige patronen in archeologische landschappen voorheen altijd plaatsgevonden binnen de kaders die door de voorhanden historische bronnen uit de klassieke oudheid werden geschapen. Wie zich aan die kaders wil onttrekken door zijn interpretaties direct op patronen in de beschikbare archeologische gegevens te baseren, moet daarvoor

eerst geschikte methoden ontwikkelen. Twee soorten methodologische studies werden ondernomen; ten eerste studies die ten doel hadden om greep te krijgen op de kwaliteit van de archeologische gegevens die aan de basis liggen van regionale nederzettingen-geschiedenissen en daarmee ook van vergelijkingen tussen regio's (hoofdstukken 4 en 7). Ten tweede studies die ten doel hadden de bruikbaarheid van het GIS-instrumentarium voor de analyse en interpretatie van patronen in die archeologische gegevens te evalueren (hoofdstukken 5 en 6).

Interpretatie van regionale archeologische bestanden zoals die samengesteld worden door middel van literatuurstudie, eventueel aangevuld met veldwerk, staat of valt met de kwaliteit van de aldus verzamelde gegevens. Met uitzondering van enkele projecten die, onder invloed van de New Archaeology, tegen het eind van de jaren '70 werden ontworpen en in de jaren '80 uitgevoerd, waren die gegevens nooit verzameld met als doel een representatief beeld van het regionale archeologische landschap te verkrijgen. Regionale interpretaties moeten dus expliciet met de mogelijkheid rekening houden dat de gebruikte gegevens niet representatief zijn voor dat landschap. Eenzelfde probleem gold ook de interpretatie van de in diezelfde periode steeds populairder techniek van de archeologische veldverkenning, waarbij steeds intensiever en beter gecontroleerd werk de belangrijke rol van een aantal vertekende factoren bij het verzamelen van veldgegevens naar voren bracht. In hoofdstuk 4 worden methoden uitgewerkt om met deze problematiek om te gaan, zowel pro-actief door procedurele verbeteringen in de planning en uitvoering van lopend veldwerk, als retroactief door uitgebreide 'bronnenkritiek' te plegen op in het verleden gevormde gegevensbestanden.

Hoofdstuk 7 is gewijd aan een beschrijving van de experimenten die in samenwerking met Dr Nick Ryan van de Universiteit van Kent te Canterbury zijn uitgevoerd tijdens veldwerk in de Sibaritide in 2000. Het doel van deze experimenten is om het opnemen en verwerken van informatie tijdens en na archeologisch veldwerk accurater en efficiënter te laten verlopen, door gebruik te maken van programmeerbare, lichtgewicht, en halfautomatische digitale registratieapparatuur. Door de veldadministratie van landschappelijke parameters en de verzamelde archeologische materialen direct in het veld digitaal uit te voeren (dwz zonder 'papier' tussenstap) wordt de efficiëntie vergroot en de kans op fouten verkleind; door tegelijk deze administratie automatisch te voorzien van nauwkeurige digitale plaatsbepalingen door middel van GPS is de kartering van velden en archeologica niet langer afhankelijk van de minder nauwkeurige plaatsbepaling met behulp van vaak verouderd kaartmateriaal. Met de apparatuur werden onder andere routes, veldgrenzen, en de kern en omtrek van archeologische sites vastgelegd. Uit deze experimenten blijkt dat dit soort apparatuur goed toegepast kan worden in zowel intensieve als extensieve archeologische surveys, zij het dat het gebruiksgemak en de fysieke betrouwbaarheid van de systemen nog verbeterd moet worden.

Om te komen tot een evaluatie van de twee hoofdstromingen in de GIS-literatuur van het afgelopen decennium wordt in de hoofdstukken 5 en 6 een uitgebreide analyse gepresenteerd van de theorie, methodologie en methoden die ten grondslag liggen aan zgn. 'voorspellingsmodellen' (voorspellende locatiemodellen, voornamelijk gebaseerd op eigenschappen van het fysieke landschap) en zgn. 'cognitieve' modellen (voornamelijk modellen die betrekking hebben op de mate van zichtbaarheid en bereikbaarheid van delen van het landschap).

Voorspellingsmodellen zijn internationaal voornamelijk ontwikkeld in de context van archeologisch beheer en behoud, maar vormen als locatiemodellen ook sinds lang onderwerp van academisch onderzoek. In dat laatste geval is het doel meestal om bestaande patronen van nederzetting en landgebruik te verklaren door ze te relateren aan aspecten van de natuurlijke omgeving, en hiervoor werd het potentieel van GIS al vroeg herkend, hetgeen in Europa geleid heeft tot een gestaag groeiende stroom van publicaties sinds begin jaren '90. In diezelfde periode echter krijgt ook de postmoderne theorie steeds meer voorstanders binnen de Europese archeologie, zodat de 'ecologisch deterministische' voorspellingsmodellen onder hevige kritiek kwamen te staan, en er 'cognitieve' alternatieven worden voorgesteld. Dit heeft geleid tot een levendig maar chaotisch debat over zowel de theoretische grondslagen als de doelstellingen en methoden van dit soort geografische voorspellingen. Hoofdstuk 5 geeft aan de hand van internationale literatuur een overzicht en evaluatie van alle in dit debat gebruikte argumenten, die overheerst lijken te worden door een reeks dichotomieën voortkomend uit

gepolariseerde theoretische posities. Vervolgens wordt een argument opgebouwd dat niet theoretische zuiverheid maar procedurele transparantie het belangrijkste kenmerk van voorspellingsmodellen dient te zijn; een transparantie die alleen bereikt kan worden door alle in het hoofdstuk gepresenteerde stappen in het modelleringsproces te formaliseren, de kwaliteit van de toegepaste gegevens en methoden te verhogen, en de resulterende modellen ook daadwerkelijk te toetsen. Hiertoe worden specifieke voorstellen gedaan.

Een belangrijke bijdrage van de postmoderne archeologie aan het debat over aard en doel van GIS-toepassingen, hierboven reeds genoemd, is de aandacht voor het landschap zoals dat door de mens werd, en wordt, gepercipieerd en geconcipeerd. In tegenstelling tot de externe, fysieke, kenmerken van het landschap gaat het in deze benadering om de interne, cognitieve kenmerken. In de praktijk heeft zich deze benadering vooral vertaald in archeologische toepassingen die gebruik maken van een tweetal GIS-instrumenten in het bijzonder – de analyse van respectievelijk zichtlijnen en kostenoppervlakken. In hoofdstuk 6 worden vrijwel alle internationaal gepubliceerde toepassingen van deze beide technieken, die overigens nog volop in ontwikkeling zijn, beschreven en geanalyseerd.

### DEEL III: VELDWERK

Onze kennis van de archeologie in alle drie de gebieden was, bij de aanvang van het RPC project, voornamelijk opgebouwd uit Italiaans onderzoek sinds de jaren '60 en Nederlandse projecten vanaf circa 1980. Lacunes in deze kennis vallen dan ook vrij direct te herleiden tot (in de Italiaanse topografische surveys en een deel van het Nederlandse onderzoek) een overwegende belangstelling voor de klassieke cultuur ten nadele van eerdere en latere perioden, gekoppeld aan de veronachtzaming van 'lage' cultuur en het rurale landschap ten faveure van heiligdommen en urbane grafvelden en nederzettingen. Waar het de meer intensieve en systematische Nederlandse surveys betreft was er sprake van een onevenwichtige ruimtelijke spreiding over de onderzoeksgebieden ten nadele van "marginale" gebieden. In het RPC project is in de jaren 1998-2000 op bescheiden wijze een bijdrage geleverd aan het opvullen van deze lacunes in de bestaande gebiedskennis door middel van intensieve en systematische archeologische surveys in alle drie de onderzoeksgebieden. Daarbij is echter steeds ook veel aandacht besteed aan het ontwikkelen van een geschikte methodologie voor het uitvoeren van het veldwerk zelf en voor de analyse van de resulterende gegevens. In dit deel zijn de vier met coauteurs uit het RPC project gepubliceerde verslagen van dit veldwerk opgenomen, voorafgegaan door een inleiding die de overkoepelende doelstellingen en resultaten van dit veldwerk samenvat.

Van de RPC surveys nabij Ninfa aan de voet van de Monti Lepini, en rond het Lago di Fogliano aan de Pontijnse kust (1998-1999), wordt verslag gedaan in de hoofdstukken 9 en 10 van dit proefschrift. Hoewel het oorspronkelijke doel van het veldwerk bij Ninfa de kartering van zogeheten platform-villa's was, viel het onderzoeksgebied nog net binnen één van de kaartbladen van de *Forma Italiae* (Cora, door Paola Vittucci Brandizzi, 1968) en kon dus ook getoetst worden in hoeverre dit oudere Italiaanse gegevensbestand representatief was voor het totale archeologische landschap. Aangetoond werd dat in het gebied naast de door Vittucci gekarteerde, en vrijwel exclusief uit de Romeinse periode daterende, monumentale resten ook veel kleinere en minder opvallende Romeinse sites lagen; bovendien bleek er een door haar in het geheel niet geregistreerd maar intensief gebruikt pre-Romeins (Archaisch en post-Archaisch) landschap aanwezig te zijn. De bewoningsgeschiedenis van deze landschapseenheid (het 'noordelijk colluvium', inclusief de proto-urbane nederzetting Caracupa/Valvisciolo) lijkt hiermee meer overeen te komen met die van het kerngebied van de Latiale samenleving in de Albaanse heuvels, dan met dat van de 'marginale' Pontijnse vlakte waarvoor pas vanaf de mid-Republikeinse periode intensieve bewoning en landgebruik wordt verondersteld. Voor de Romeinse periode beginnen nu, met het herkennen van verschillen in grootte, ligging, en status van de vindplaatsen, in het Ninfa gebied bovendien de contouren van een meer gedetailleerde nederzettingshierarchie op te doemen. Op methodologisch gebied gaf de survey vooral inzicht in de vertekeningen inherent aan de oude topografische manier van onderzoek, en in de noodzaak om in latere surveys methodes te ontwikkelen voor de registratie van *continue* verspreidingen van aardewerk over het landschap (in tegenstelling tot *discrete* verspreidingen, in de vorm van 'sites').



Dit laatste zou inderdaad in latere surveys een belangrijk punt van aandacht worden, waarmee voor het eerst werd geëxperimenteerd tijdens de eerste Fogliano-survey (1998). De uitvoering en registratie van het veldwerk werd gericht op geografische eenheden ('blokken' van circa 1 hectare) in plaats van op archeologische (sites) of landbouwkundige (percelen), en het probleem van de selectieve waarneming werd bestreden door alle oppervlaktevondsten per 'blok' te verzamelen en pas achteraf door een expert te laten beschrijven. Het Fogliano-veldwerkgebied werd gekozen omdat het representatief werd geacht voor het op grond van zowel klassieke als meer recente historische bronnen als 'marginaal' beschouwde kustlandschap van de Pontijnse regio. De resultaten van de survey, gepresenteerd in hoofdstuk 10, wijzen er op dat dit ook inderdaad tot aan de laat-Republikeinse periode het geval is geweest. Resten van waarschijnlijk extensief landgebruik in dit landschap van fossiele strandwallen, valleien en kustlagunes waren incidenteel aanwezig voor de gehele ceramische periode tot en met de IJzertijd, waarna het aantal vindplaatsen begint te groeien in de Archaïsche periode. Voor de post-Archaïsche en mid-Republikeinse periode blijft de intensiteit van het gebruik van dit landschap, vanwege het ontbreken van diagnostische aardewerktypen, vooralsnog onduidelijk, maar er lijkt een duidelijk contrast aanwezig te zijn met de opvallende groei van het aantal rurale villas in de laat-Republikeinse periode (200 – 0 v. Chr.). Aangezien deze groei voornamelijk plaatsvindt in het centrale deel van het gebied, waar zich ter plaatse van het moderne dorpje Borgo Grappa een groter, relatief vlak en aaneengesloten gebied met zandige bodems bevond, kunnen we voor deze periode spreken van de groei van een ruraal dorp – een sociaal-economische ontwikkeling die misschien in verband moet worden gebracht met de productie en bovenregionale handel in vis en visproducten die in deze periode langs de Pontijnse kust op gang kwam. Deze rurale bloei duurde niet langer dan 2 eeuwen, want geen van de vindplaatsen lijkt na de vroege Keizertijd nog in gebruik te zijn geweest; deze neergang wordt in verband gebracht met de algemene trend tot schaalvergroting en extensieve exploitatie die in deze periode zijn intrede doet in het expanderende Romeinse rijk.

Naast het gegeven dat de geschiedenis van nederzetting en landgebruik in beide gebieden zich beter laat begrijpen wanneer we haar analyseren in termen van relatief kleine fysieke landschapseenheden dan wanneer we proberen eenzelfde ontwikkeling te schetsen voor de Pontijnse regio als geheel, bracht de Fogliano survey ook een problematiek aan het licht die eerder al bij de analyse van surveys in het gebied van de Egeïsche zee was herkend door Britse archeologen, namelijk dat van de interpretatie van de vaak zeer lage 'off-site' vondstdichtheden uit verschillende perioden die nagenoeg het gehele Mediterrane landschap kenmerken. In latere surveys is door middel van het herbezoeken van vindplaatsen getracht meer greep te krijgen op de factoren die de kans op het doen van oppervlaktevondsten beïnvloeden, en op grond hiervan meen ik met anderen dat ook een enkele vondst onder bepaalde omstandigheden opgevat moet worden als aanwijzing voor het bestaan van een lokaal ondergronds reservoir (vindplaats). Factoren die het overleven en de zichtbaarheid van aardewerk in de ploegvoor beïnvloeden wisselen bovendien sterk in belang met de productiewijze en ouderdom van het materiaal, reden waarom de kans op het terugvinden van bijvoorbeeld protohistorisch aardewerk veel lager gesteld moet worden dan van het klassieke Romeinse en, zoals we hieronder zullen zien, Hellenistische aardewerk.

Het veldwerk in 1999 uitgevoerd nabij het stadje Ostuni in de Salentijnse Murge had, net als dat van Fogliano, ten doel een voordien niet of nauwelijks onderzocht 'marginaal' deel van het archeologische landschap intensief te karteren. Zoals in hoofdstuk 11 wordt uitgelegd, vormde het kalksteenplateau van de Murge van oudsher de landschappelijke marge van de urbane samenleving die zich vanaf de vroeg-Hellenistische periode in de Salentijnse Isthmus ontwikkelde. Waar het onderzoek zich vanuit de Universiteit van Lecce en de Vrije Universiteit van Amsterdam had geconcentreerd op de centrale plaatsen en hun achterland, bood de Ostuni-survey voor het eerst de kans om de gebruiksgeschiedenis van een deel van zowel de hoge Murge zelf als de overgangszone naar de Adriatische kustvlakte in detail te karteren. Op methodologisch vlak werd de survey, naar aanleiding van de ervaringen met eerder veldwerk, uitgevoerd met een hogere geografische resolutie (eenheden van 0.25 hectare) en een consequenter doorgevoerde registratie van zichtbaarheidsfactoren. Voor de Hellenistische en Romeinse perioden bevestigde de survey enerzijds het marginale karakter van landgebruik, waarbij individuele boerderijen op ongeveer een km afstand van elkaar lagen, anderzijds was het verrassend dat vroeg Hellenistisch aardewerk, bouwmaterialen en –stijlen reeds zo diep in de Murge waren doorgedrongen. De groei van een inheems-Hellenistische urbane samenleving op de Isthmus ging dus gepaard met een

gelijktijdige Hellenisatie, mogelijk zelfs kolonisatie, van zelfs de meest afgelegen gebieden, een aanwijzing dat de totale bevolking bij dit proces betrokken was.

Met betrekking tot de landschapsgeschiedenis van de protohistorie, de klassieke en de archaische perioden in de Salento bevestigde het Ostuni-veldwerk door de nagenoeg volkomen afwezigheid van vondsten uit de late Bronstijd tot en met de 4<sup>e</sup> eeuw dat de samenleving gedurende die periode waarschijnlijk sterk gecentraliseerd leefde in strategisch (kliffen, heuveltoppen) gelegen nederzettingen. De veranderlijkheid van dergelijke protohistorische strategieën werd onverwachts aangetoond door het karteren van zeer algemene voorkomende vondstspredingen van zeer homogeen impasto-aardewerk uit de midden-Bronstijd. Deze worden geïnterpreteerd als de resten van een slechts enkele eeuwen in gebruik geweest zijnd systeem van mobiel landgebruik, ‘shifting cultivation’, waarbij de bevolking in familieverband gedurende korte perioden steeds weer nieuwe of geregenereerde delen van het landschap bewoonde en ontgon, en er dus geen sprake was van permanent bewoonde grotere nederzettingen.

Voor het veldwerk in de Sibaritide (2000) werd ervoor gekozen de survey te richten op het toetsen van de bestaande grootschalige kartering door Lorenzo Quilici uitgevoerd in de jaren '60, en tegelijkertijd een deel van het achterland van de protohistorische nederzetting en cultusplaats op de Timpone della Motta nabij Francavilla Marittima in meer detail te leren kennen. Ook hier was weer een belangrijke methodologische component in het veldwerk, waarover in hoofdstuk 7 uitgebreid verslag gedaan wordt. Uit de kartering door Quilici was, net als andere surveys uitgevoerd in de stijl van de *Forma Italiae*, een intensief bewoond maar vrijwel exclusief klassiek (Hellenistisch-Romeins) landschap naar voren gekomen, waarin bovendien een clustering in (aan hypothetische doorgaande routes gekoppelde) ‘dorpen’ viel waar te nemen. Ons veldwerk was erop gericht de correctheid van dit patroon te toetsen door middel van een veldverkenning van een representatief transect door de voetheuvelzone, waaruit dan eventuele chronologische en ruimtelijke vertekeningen naar voren zouden moeten komen. In dit geval bevestigde het veldwerk het merendeel van Quilici's resultaten: een slechts zeer sporadische aanwezigheid van protohistorisch materiaal wijst erop dat deze zone voorafgaand aan de archaische expansie van de Griekse kolonie Sybaris niet in intensief gebruik was, de vele Hellenistisch/Romeinse vindplaatsen bleken merendeels in de vroeg Hellenistische periode te zijn ontstaan, en te clusteren rond plateau-randen. Anderzijds werd dit kaartbeeld wel genuanceerd door de ontdekking dat de Hellenistische vindplaatsen ook in andere landschappelijke settings wel voorkwamen, en dat de meeste niet aantoonbaar in de Romeinse periode gecontinueerd of uitgebreid werden.

#### DEEL IV: GIS-TOEPASSINGEN

In het vierde deel van dit proefschrift wordt een vijftal toepassingen van GIS gepresenteerd die niet alleen dienen ter beantwoording van specifieke onderzoeksvragen, maar ook ter illustratie van de methodologische studies in deel II. In hoofdstuk 13, bijvoorbeeld, wordt de vorming, vergelijking en interpretatie van gegevensbestanden op regionale schaal (hoofdstuk 2) toegepast op de Pontijnse regio. Daarbij wordt onder andere ingegaan op de gewenste structuur van een regionale relationele archeologische database, op de noodzaak van een eenduidige definitie van archeologische entiteiten (zoals de ‘permanent habitation site’), en op het opvallende gebrek aan standaardisatie van veldwerkmethoden en –publicatie waardoor zelfs vergelijkingen op het meest eenvoudige plan tussen archeologische bestanden mank gaan. In hoofdstuk 14 wordt de door recent en subrecent landgebruik veroorzaakte vertekening in regionale archeologische bestanden (besproken in hoofdstuk 4) gedemonstreerd aan de hand van voorbeelden uit het Wroxeter Hinterland (ingeleid in hoofdstuk 3); en in hoofdstuk 17 wordt ditzelfde thema uitgewerkt in een studie naar de veranderingen in landvorm die vanaf de late jaren '20 van de vorige eeuw door de fascistische en latere landverbeteringen in de Pontijnse vlakte hebben plaatsgevonden, en de invloed daarvan op de resultaten van de veldverkenningen bij Fogliano (waarvan in hoofdstuk 10 verslag gedaan wordt). Vooral uit deze laatste twee hoofdstukken blijkt duidelijk hoe sterk de meeste kleinschalige patronen in regionale archeologische bestanden gecorreleerd zijn aan de combinatie van recent en subrecent landgebruik, en lokale onderzoeksmethoden en –interessen.

In hoofdstuk 15 worden ruimtelijke modellen voortkomend uit de problematiek van centralisatie, urbanisatie en kolonisatie (besproken in hoofdstuk 2) aan de hand van voorbeelden uit de Pontijnse regio en de Sibaritide gepresenteerd – centralisatie en de vorming van territoria in de late Bronstijd, urbaniserende inheemse ‘peer polities’ in de IJzertijd/Archaische periode, en vroege en mid-Republikeinse kolonisatie van de Lepijnse marge. In hoofdstuk 16 wordt aan de hand van voorbeelden uit het Wroxeter Hinterland project de toepassing van zichtlijnen- en kostenoppervlakten analyse (hoofdstuk 6) uitgewerkt. Zichtlijnen worden benut om de potentiële mate van controle over de centrale Severn-vallei vanuit IJzertijd-hillforts en, later, het Romeinse legerkamp te Wroxeter te modelleren en te visualiseren; kostenoppervlakten worden gebruikt om eerst de begaanbaarheid van het gebied ten tijde van de Romeinse invasie te modelleren, en op grond daarvan de ligging van potentiële knooppunten in de lokale infrastructuur.

Resultaten, argumenten, en conclusies uit al het voorgaande worden tenslotte in hoofdstuk 18 nog eens samengevat, waarbij de onderlinge relaties tussen de in het inleidende hoofdstuk uitgezette onderzoeklijnen nog eens benadrukt worden.

## CHAPTER 1

## INTRODUCTION

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 1      AIMS AND BACKGROUND
 

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“The greatest challenge of inter-disciplinary landscape archaeology in the Mediterranean in the coming years will be how to bridge the divide between the ecological approaches of the natural sciences to past landscapes, on the one hand, and the concerns of social archaeologists on the other with the interface between human actions and landscape.”

- Graeme Barker and David Mattingly, in their introduction to the POPULUS series of conference proceedings on the archaeology of Mediterranean landscapes (1999/2000: vii)

## AIMS

In the archaeology of Italy from the Bronze Age to the Roman period, the study of the internal development of indigenous Italic societies and landscapes has remained a relatively underdeveloped area due to the emphasis on explanations relying on external factors (the influence of non-Italic cultures), dominant historical processes (the Greek and Roman colonizations), and a simplistic culture-historical view of society (stages of growth, flowering and decline). Much attention has been lavished on the influence on regional Italic cultures of foreign artefacts and manufacturing techniques during the ‘Mycenean’ and ‘international’ periods, when contacts of trade and exchange ranged throughout the Mediterranean. Similarly, interest in Greek and Roman colonization, mainly based on historical sources, has dominated the study of the role of native culture to the organization of regional Italic societies and landscapes. This one-sided approach has led to the view that the early urbanization of central and southern Italy has been a relatively homogeneous process, in which the role of international impulses and colonization movements has been paramount. Accordingly, the core aim of the Regional Pathways to Complexity (RPC) project has been to demonstrate both the much more complex nature of archaeological reality, and the decisive role played by the perspective offered by regional archaeological landscape study, by comparing the development of indigenous societies in central and southern Italy through the 1<sup>st</sup> millennium BC and into their incorporation into the Roman state, with the emphasis on the processes of centralization, urbanization, and colonization.

## THE REGIONAL PATHWAYS TO COMPLEXITY (RPC) PROJECT

The RPC project started in the summer of 1997, was carried out by staff at the archaeological institutes of the University of Groningen and the Free University of Amsterdam, and ran for an initial period of four years until 2001. Accounts of its aims and context are provided elsewhere (most recently: Attema et al. 1998, Attema et al. (eds) forthcoming), and will not be repeated in detail here. The project as originally proposed for funding under the Netherlands Organization for Scientific Research (NWO) research program ‘Settlement and Landscape in Archaeology’ (Attema 1996) defines the aim of the project as “the analysis of the process of urbanization that took place in large parts of the Mediterranean world in the 1st millennium BC, through a study of long term developments in settlement behavior, land use and technology”.

In the project proposal Attema (1996:13-15) argued that, in the protohistoric and classical archaeology of Italy, the internal dynamics of the indigenous Italic societies and landscapes have remained underemphasized in favor of the influence of dominant external cultures and historical processes and the culture-historical paradigm of the growth and decline of great powers. Attention has been lavished on the presence of foreign artefacts and technologies in Italy in the Mycenaean and 'international' periods, when networks of trade and exchange extended across the Mediterranean. Similarly, archaeological study of indigenous Italian cultures has been overshadowed by a focus on Greek and Roman colonization based in historical sources. This lopsided interest has led to the early urbanization of central and southern Italy being cast as a relatively homogeneous process, in which external impulses and colonization movements were the prime moving factors. In contrast, regional archaeological research conducted from the 1980s by the institutes participating in the RPC project has shown that reality is much more complex; and a project that focuses on the variability of the Italian landscape and the persistence of indigenous regional traditions in land use, technology, and settlement behavior, has the potential to contribute significantly to a well-founded interpretation of early Italian urbanization processes.

Trajectories towards social complexity in protohistoric Italian regions are most clearly expressed in the Italian landscape through the centralization of settlements and through forms of early urbanization. Excavations and surveys have shown that in this process Greek and Roman colonization were potent forces of change. But social complexity was not solely brought about by colonists - some regions already had complex societies at the time that they were colonized, others less so. In addition, the nature and intensity of indigenous contacts with the colonial presence differed, with some regions less directly involved than others. The RPC project studies and compares three areas that show such diverging trajectories. These are the Pontine Region in Central Italy, the Salento Isthmus in Puglia and the Sibaritide in Calabria, all of which have a tradition in Dutch archaeological fieldwork. In these areas the research team of the RPC project compares the modes of interaction between the Italic peoples and Greek and Roman colonialism.

The central question of the project is "how did colonialism affect the Italian regional pathways to social complexity?" Comparative diachronic research of landscape and settlement dynamics is the way in which the project attacks this question over a time span of a millennium from the late Bronze age to the early Roman Empire. A long term perspective (1400 BC - AD 400) is adopted in order to observe this process in its full duration and regional variability. The chosen method of long term comparative study aims to identify connections between early urbanization in the three regions, as well as to gain a fuller understanding of the elements playing a role in this process - landscape, settlement systems, land use, technology, and tradition. Four Ph.D. students are being employed by the project to study each of these elements; the thesis that now lies before you has addressed mainly the element of settlement systems.

#### THE WROXETER HINTERLAND PROJECT (WHP)

The Wroxeter Hinterland project, funded by the Leverhulme Trust and running from 1994 to 1997 at the University of Birmingham Field Archaeology Unit (BUFAU) under the direction of Dr. Vince Gaffney. It is introduced in more detail in chapter 3 of this thesis. Although it is concerned with a much later period, and an area far removed from Italy, the Wroxeter Hinterland project's study of the transformation of the late pre-Roman British tribal society of the Cornovii into a Romano-British Civitas centering on Viroconium Cornoviorum (Wroxeter) focuses on the very same processes studied in the RPC project as well. The juxtaposition of examples and studies from both projects therefore provides a welcome broad canvas against which to place these processes.

#### PATTERNS

The emphasis throughout this thesis on the recording and analysis of pattern is in the intellectual tradition of the New Archaeology (Trigger 1989:310-312). I am disturbed by the current emphasis in both archaeological theorizing and teaching, on the historicist, post-processual approach. The academic

practice of archaeology can only be justified, in my view, if the basic rules of scientific research, publication, and debate continue to be taught and adhered to. As the pendulum swings from the scientific, rule-finding approach of the '60s and '70s to the humanistic, historicist approach of postmodernism in 1980s and 1990s archaeology, the straw man of 'environmental determinism' was set up to decry and distance oneself from.

Regional or landscape studies, whether research- or CRM-oriented, with or without the use of GIS, are generally concerned with discerning and interpreting patterns of archaeological land use and settlement. And undoubtedly the archaeological record is patterned in various ways, but so are other factors influencing our knowledge of that record – erosion and deposition, land use, and research bias, to name the most important. How can we interpret the archaeological record if we cannot separate the effects of these different types of pattern? And if human patterning is only one of a number of factors determining the archaeological patterns found by us, what does that say about the models (predictive or otherwise) that we produce? We can relate slope, distance to water, and other environmental variables to the occurrence of certain site groups, but the correlation may run via the effects of erosion and the differential visibility of archaeological materials on the surface, rather than directly.

Different types of patterning occur at different spatial and temporal scales. This thesis is about the detection, description, and explanation of such patterns. Since we must first understand how the ways in which we study the past affect our understanding of it, much of this thesis is devoted to methodology - how do we collect and record data, how do we analyze its structure, and how do we attach explanations to such structures? The goal of this work is to find ways of studying the past which can either avoid recording biases, or which allow formal corrections for such biases to be made. Methodological themes investigated in this thesis include: the design and execution of archaeological surveys (field walking); methods of analysis of both regional 'site' databases and local 'non-site' survey data using Geographical Information Systems; and methods of dealing with the tension between description, explanation, and extrapolation in archaeological location / allocation studies.

#### LANDSCAPE ARCHAEOLOGY AND THE ROLE OF GIS

The case studies involving field work and GIS analysis are all based on the theoretical premises of landscape archaeology – that human actions may occur, and leave an essentially continuous 'blanket' of traces, anywhere in the landscape, that the resulting surface record is a palimpsest of such traces through time, and that patterns in this record may be explained in part by the in turn limiting and enabling qualities of the landscape. These principles are extended into the realm of spatial extrapolation and cultural resource management using the theory of spatial sampling (which says that properties of a properly selected sample have a specific likelihood of also being properties of the parent population).

Archaeological input for GIS analysis comes in two forms. Firstly, traditional archaeological records often collected and enhanced in the form of a 'topographic' or desktop survey; and secondly, field walking surveys. The former are site-oriented without exception, and are based on archive research and a limited amount of field work; the latter come in several forms (urban, rural) and intensities but share the same theoretical basis.

Most analytical GIS use is based on the analysis of spatial or statistical patterns, hence on the quantitative aspects of the archaeological data. Before we can use either data type as GIS layers, a stage of source criticism (see Chapter 4 on bias modeling) must be applied. Next, methods for recording and describing the data must be standardized to some extent in order to allow comparison between surveys, and here again the premises of landscape archaeology influence the approaches chosen (chapter 13).

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 2 STRUCTURE OF THIS THESIS
 

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As once Gaul, the body of this thesis is divided into three parts – methodological studies, field work, and case studies. Most of the individual chapters have been conceived as separate articles, indeed some have already been published or are currently in publication, so each study carries its own introduction and conclusion, its own set of bibliographic references and, where appropriate, acknowledgements. Whilst I have tried to avoid duplication of text and figures as much as possible, and have liberally cross-referenced between the chapters, I have given precedence to the need to present the chapters in the form of self-contained units. In order to clarify to the reader how all the parts of this loose structure interconnect and serve to reinforce each other, it is presented in some detail below, and an attempt at its graphical representation has been made in figure 1.

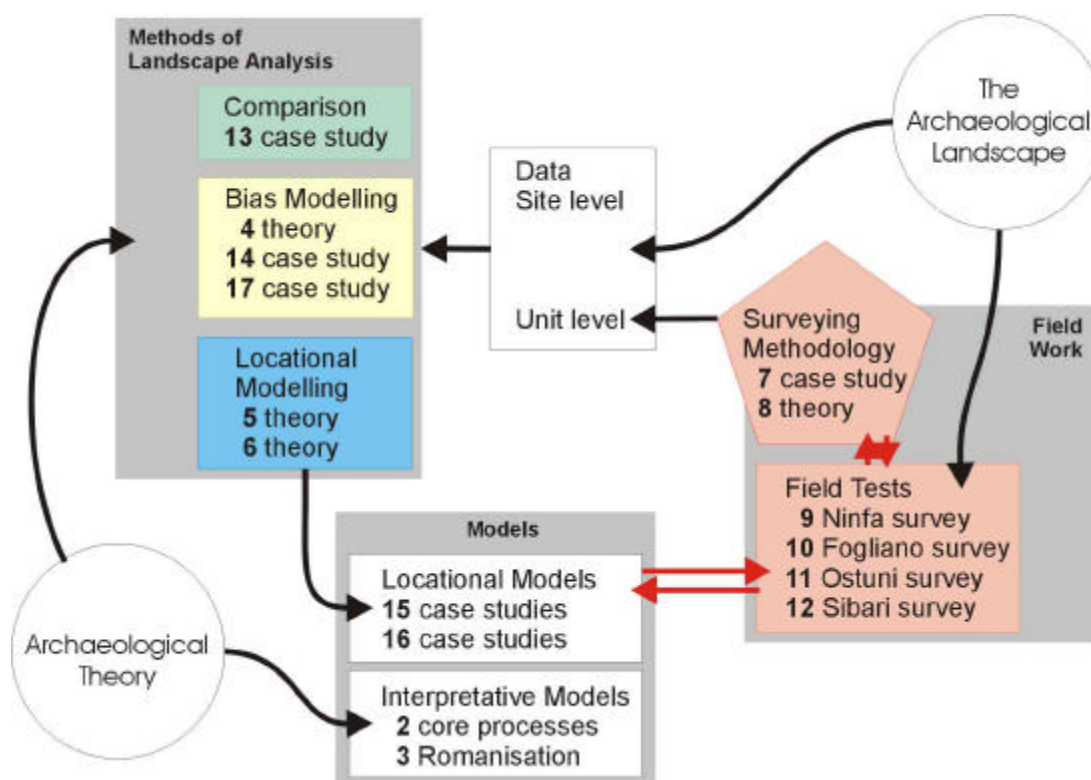


Figure 1 - Structure of this thesis. Middle range theory and models derived from archaeological theory are used to explain patterns in the data being derived from the archaeological landscape; field work is carried out in order to test and improve the models and develop an appropriate methodology.

The next two chapters in this introductory part of the thesis are intended to provide the broad archaeological and theoretical context to the research reported in the main body of the thesis. The central concepts and definitions employed by the RPC project are reviewed in chapter 2, which also defines and describes broad stages and variations in the processes of centralization, urbanization and colonization in the first millennium BC in Italy. It provides brief qualitative, quantitative, and spatial descriptions of these processes, and discusses differences and similarities of the three regions. Since the emphasis throughout this thesis is on the detection and explanation of spatial patterning on different scales, the potential for spatial analysis of archaeological data is discussed at two scales – that of the individual survey and that of the region – and the use of GIS in the modeling of archaeological landscapes is introduced here because it imposes certain restrictions on the types of analysis that can be handled. The introduction to the

thesis is completed with a chapter on the process of romanization in the Wroxeter Hinterland, reproduced from White & Van Leusen 1997 (chapter 3).

Following the body of the work, a final chapter (18) considers how the conclusions reached in these studies affect our view of the settlement dynamics and interregional differences in the study areas, and what recommendations can be made for future research and development in the field of landscape archaeology, GIS, and the management of archaeological resources.

## 2.1 METHODOLOGICAL STUDIES

My methodological bent is evident in the four chapters that make up this part of the thesis. The methodological studies conducted for this thesis are all concerned with the use of GIS for landscape archaeological research, either by understanding existing data sets in terms of their formation (chapter 4), by reviewing maturing research areas such as predictive modeling (chapter 5) and cognitive landscape analysis (chapter 6), or by examining its role in driving the evolution of field recording techniques (chapter 7).

### BIAS MODELLING

The first (chapter 4) is about methods for recording so-called bias factors, i.e. factors that distort our picture of the archaeological record, and methods for correcting these distortions. It is based on an article published in 1996 (Van Leusen 1996a), which established my aims and general approaches to this subject in the context of the Wroxeter Hinterland Project. The chapter is about recent post-depositional and research biases in the kind of data that form the basis for archaeological landscape reconstruction and settlement history – site-based data collated from desktop study and older surveys, and land parcel-based data coming from modern surveys. Recent post-depositional biases are nearly exclusively related to human changes to the landscape and its use; research biases are those biases that have occurred in the past, and still occur, during the construction of the archaeological record; I specifically exclude biases occurring during the site formation process. My main point is that recent post-depositional and research biases can not just obscure, but also create patterns in the archaeological record. This has two consequences: firstly, if significant biases in the data we work with are not dealt with, then our reconstructions based on those data will be significantly flawed; secondly, comparison of the archaeological records of the three RPC Project study regions is predicated on the assumption that such records are, or can be made, comparable. Two case studies (chapters 14 and 17) demonstrate my approach in practice at two geographical scales, one concentrating on the role of ‘discovery’ biases in the regional site database used for the WHP; the other on the effect of subrecent large-scale landscape changes on survey results in the Pontine Region.

### PREDICTIVE MODELLING

My second chapter on method (chapter 5) consists of a paper on the methodology of predictive modeling of archaeological site distributions, which is based on the extrapolation of geographical patterns and correlations in order to describe and predict typical locations where specific types of archaeological remains may be expected to occur. The chapter grew out of my earlier review of Dutch approaches to archaeological predictive modeling (Van Leusen 1996b), but many aspects were further developed in subsequent irregular meetings and discussions in the period 1998-2000 with members of the ‘bath-house’ group: Harry Fokkens, Hans Kamermans, Jos Deeben, Daan Hallewas, Jan Kolen, Ronald Wiemer, Eelco Rensink, Philip Verhagen and Milco Wansleebe. Philip, Milco and I co-authored and presented a previous incarnation of this paper at the 4th international conference ‘Archäologie und Computer’ (Vienna 1999, published as Verhagen et al. 2000), and the group as a whole recently submitted a successful proposal for an in-depth study of the role of predictive modeling in archaeological resource management to the Dutch Foundation for Scientific Research (NWO, Kamermans 2001). The chapter presented here, however, substantially reflects my own personal research and opinions with regard to predictive modeling. In it, I argue that many improvements are necessary to the current predictive modeling methodology as practiced by Dutch and international modelers, before the method can be



labeled either reliable or useful; and several likely avenues for future research and development are outlined.

## COGNITIVE MODELLING

The third chapter (chapter 6) is concerned with visibility and accessibility modeling, two geographical analysis techniques only recently made feasible and popular among archaeologists by the spread of GIS. Both techniques are being used in attempts to model the social / cognitive, rather than the physical / economic, landscapes of the past. The text of this chapter is substantially enlarged and updated from an article I published earlier (Van Leusen 1999), and critically reviews the majority of accessible archaeological studies based on viewshed and cost surface analysis over the decade 1990-2000. The two techniques are discussed together because of certain similarities in methodology and underlying theoretical principles, which express an emphasis on the human experience of being and moving in the landscape; not surprisingly, they have been at the center of processual – postprocessual debate almost from the beginning. This chapter should be read in conjunction with the case studies presented in chapters 15 and 16, which investigate aspects of ‘dominance’, territory, and accessibility arising from current archaeological thinking about the role of Late Iron Age hillforts and markets in the Wroxeter hinterland, of early Roman colonies on the Lepine Margin, and of protohistoric settlements in the Sibaritide.

## FIELDWORK METHODS

The fourth chapter on methodology (chapter 7) deals with the very practical question of how to conduct a field walking survey with a minimum of effort and error, and discusses experiments conducted during the SIBA2000 campaign with the use of self-locating digital handheld computers. This text has been presented by my co-author, Dr Nick Ryan, at the annual conference of CAA (Visby, Sweden, 2001), and will be published in the CAA proceedings for 2002 (Ryan & Van Leusen, forthcoming). The article describes ongoing development of the FieldNote system at the Department of Computer Science, University of Kent at Canterbury, UK. A new version of this portable system for self-location, mapping, and note-taking during archaeological fieldwork, was field tested in October 2000 during a systematic survey in the Sibaritide (Calabria, Italy; see chapter 12). In these tests, the system was used for wide-area mapping tasks for the first time, and proved to be very useful in mapping field boundaries, highland transhumance routes, and archaeological sites to a specified accuracy and in the absence of detailed up-to-date topographic maps. It also proved useful in navigation and in re-locating archaeological sites mapped in the 1960's. The article presents the results of these field tests and discusses their significance for future survey design and methodology, emphasizing the trade-off between speed of operation and accuracy. Lines for further development of the system, including improvements to both interface and functionality are set out as well.

### 2.2 FIELD WALKING CAMPAIGNS

In this part are collected the preliminary reports of the four field surveys which I conducted between 1998 and 2000 with other members of the RPC project in all three Italian study regions. The reports themselves have already been published or are in press, and are preceded here by a chapter (8) reviewing the aims, approaches, and results of the RPC field work. The Lepine Margin: Ninfa 1998 (chapter 9, Van Leusen 1998) was published in *Assemblage*, on-line journal of the graduate students of the Archaeological Institute at the University of Sheffield; The Pontine Margin: Fogliano 1998-9 (chapter 10, Attema *et al.* 2001) is published in *Palaeohistoria*, the annual journal of the Groningen Institute of Archaeology; The Salento Margin: Ostuni 1999 (chapter 11, Attema *et al.* forthcoming) will be published in *Studi di Antichità*; and the preliminary report on the Sibaritide 2000 survey appearing here as chapter 12 has been submitted for publication in *Palaeohistoria* as well.

It may be asked why field work was included at all in a synthetic project such as the RPC project. There are two reasons for this. Prior to the start of my research, I was unfamiliar with the archaeology and the landscapes of central and southern Italy. The fieldwork has been essential in providing first-hand

experience of the landscape, its scale and characteristic features, the climate, and myriad circumstances which currently preserve or destroy, hide or present archaeological remains. The second and more formal reason is that in providing methodological control over poorly understood regional data sets, the fieldwork represented an essential phase of ‘source criticism’ without which any synthetic work would have to appear of doubtful value.

### 2.3 CASE STUDIES

The case studies in this part of the thesis explore and demonstrate several of the issues raised in the methodological studies presented in chapters 2, 4, and 6, and most have already been referenced there.

#### BIAS MODELS

The case studies in chapters 14 and 17 explore the extent of modern land use and research biases in regional archaeological records (cf. chapter 4) at two different spatial scales. Chapter 17 presents an investigation of changes in land form associated with the land improvement scheme to which the Pontine plain was subjected in the late 1920’s and early 1930’s, and their influence on the results of the Fogliano survey (cf. chapter 10). This was the subject of an elective study under my supervision by graduate student Hendrik Feiken during 1999-2000, subsequently presented as a joint paper to the CAA 2000 conference and published in its proceedings as Feiken & Van Leusen 2001. Chapter 14 explores the correlation between land qualities, land use and land cover on the one hand, and the formation of the regional archaeological site record of the Wroxeter Hinterland on the other (see chapter 3 for an introduction). It is found that, whereas most large-scale patterns in this record are strongly correlated to the opportunities for discovery afforded by the combination of land use / land cover (LULC) and research methods in the 2<sup>nd</sup> half of the 20<sup>th</sup> century, a historical LULC reconstruction suggests that Wroxeter’s territory has been extremely stable in the *longe durée* – indicating that the subrecent pattern of land use in the region might be similar to that of the late Roman period.

#### COGNITIVE AND LOCATIONAL MODELS

The case studies presented in chapters 15 and 16 demonstrate issues currently at the heart of the debate on GIS predictive modeling (chapter 5), namely the modeling of ‘cognitive’ aspects of the landscape as opposed to the usual physico-economic modeling. Cases taken from both the RPC project area (chapter 15) and the Wroxeter Hinterland (chapter 16), and ranging in time from the Bronze Age to the Roman period, are used to explore the concepts of dominance and accessibility through the GIS techniques of viewshed analysis and cost surface analysis (chapter 6). These concepts are closely related to those of centralization, urbanization, and Romanization presented in chapter 2.

#### INTRA-REGIONAL COMPARISON

The discussion of the theoretical basis of, and potential approaches to, interregional comparison of settlement and land use histories in chapter 2 further explored in a case study concentrating on the Pontine region (chapter 13). Two aspects of such comparison are explored in depth: the creation of a GIS-enabled regional archaeological database, and the quantitative comparison of data sets collected within the same, adjacent, and more widely separated landscape units. An attempt is made to assess the extent to which the comparison of field survey results can throw light on the three core processes studied by the RPC project - centralization, urbanization, and colonization – in southern Italy.

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## CHAPTER 2

# PATTERNS AND PROCESSES

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### 1 INTRODUCTION

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The archaeological themes investigated in this thesis are to a large extent those of the individual projects I have been part of since 1994. The nature of changes in settlement and land use patterns spanning the Iron Age / Roman transition in an outlying part of Britain has been the subject of the Wroxeter Hinterland project; the comparison, from the late Bronze Age to the Roman Empire, of long-term processes of centralization, urbanization, and colonization in the three Italian regions of the Pontino, the Salento Isthmus, and the Sibaritide has been the aim of the Regional Pathways to Complexity project.

Such aims require the careful definition and detailed description of the core concepts and processes involved, of the available general explanatory frameworks for socio-political change, and a justification of the chosen methodology to approach this aim. The interpretation of the available archaeological and historical evidence in terms of processes of centralization, urbanization, and colonization (Hellenization, Romanization) taking place in ancient Italian societies must rely heavily on appropriate middle range theory – the theory concerning the cultural transformations and formation processes giving rise to the archaeological record. Our methods of collecting and interpreting the raw data themselves must be studied in order to assess the tendency of the methodology employed both by us and by previous researchers to produce spurious patterns in those data; we cannot avoid taking this step if we want to feel secure in our interpretations.

The current chapter is therefore devoted to a review of the concepts, theories, and methods employed later on in the case studies. A crucial part of the theoretical discussion also concerns the basis for interregional comparison. What makes us think that the historical trajectories of the three study regions can be compared at all? If we feel they can profitably be compared, what yardsticks are we going to use?

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### 2 REGIONAL SETTLEMENT DYNAMICS

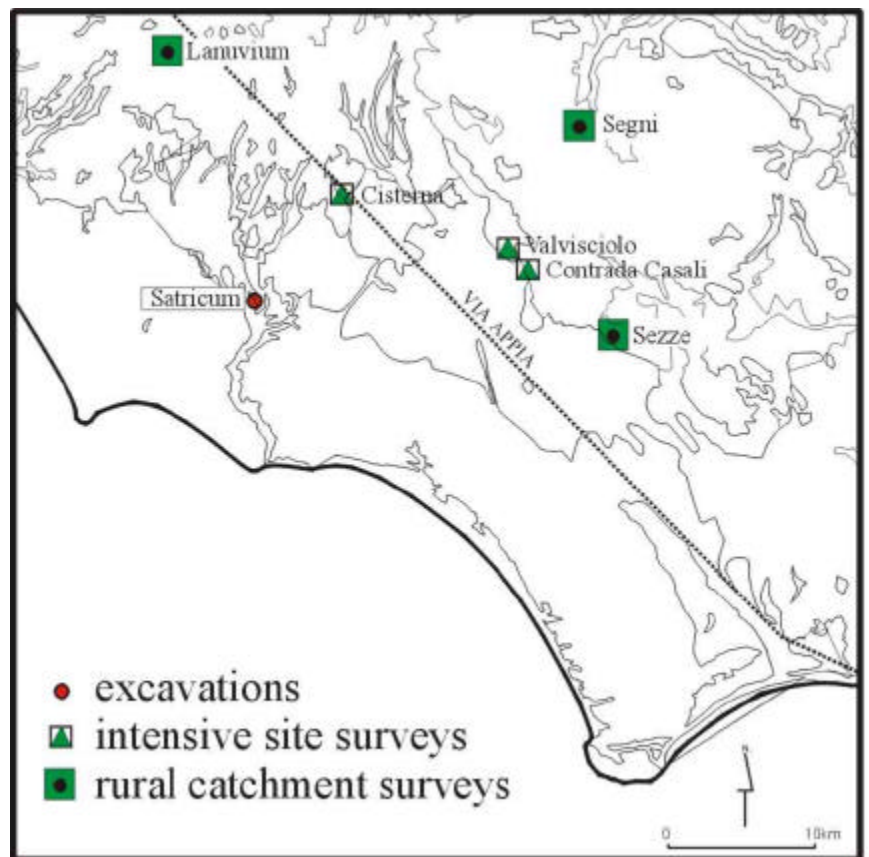
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A review of the current consensus among Anglophone researchers regarding the settlement dynamics of the three study regions provides the basis for a discussion of the core concepts and terms being used to describe and understand the presumptive societal processes operating in 1<sup>st</sup> Millennium BC. We begin with a brief chronological review of the main settlement dynamics in the three study areas. In a second section, the interrelating concepts and processes central to the RPC project are reviewed; this is followed by a consideration of the continued significance of the traditional concepts of ‘Hellenization’ and ‘Romanization’.

## 2.1 SETTLEMENT DYNAMICS OF THE STUDY AREAS

### THE PONTINE REGION

The study area of the Pontine Region Project is located about 60 km south of Rome and comprises part of the volcanic landscape of the Alban Hills, the limestone range of the Monti Lepini and the coastal plain of the Agro Pontino bordering on the Tyrrhenian sea. Surveys in this area focus on the 1<sup>st</sup> millennium BC (Latian protohistory and Roman Republican period), though the Bronze Age and the Imperial period are considered as well. In the first five years of the project (1987-1993) research mainly focused on the pre-Roman landscape. In addition to extensive transect surveys and environmental research, three protohistoric settlement areas were intensively surveyed. In a follow-up program (1994-1997) the impact of early Roman colonization on the protohistoric landscape was investigated in three sample areas. The final publication for this is in preparation. The research of the PRP was carried out in close collaboration with the Latian Pottery Research Group and the Satricum excavation team, both at the GIA.



*Figure 1 – The Pontine Region, with indication of the main surveys and excavations which had been undertaken by the Groningen Institute of Archaeology before the start of the RPC project.*

The Tyrrhenian coast of central Italy is generally believed to be the area where the earliest urbanization within Italy took place. Settlements begin to nucleate during the final Bronze Age and early Iron Age, with differentiation in grave goods indicating the growth of social hierarchies (Peroni 1994: 221-5). At this early stage, the settlements are ‘proto-urban’ in the sense that many will later develop into urban settlements and the cores of early states. Attema (1993:217) suggests that Satricum and Caracupa in the Pontine region began their existence in the early Iron Age as gathering places with cultic and territorial marker functions for transhumant groups claiming rights in the winter pastures of the Pontine plain, and

only later developed into settlements<sup>1</sup>. In this scenario, urbanization in south Lazio only began in the 8<sup>th</sup> century BC and culminated with the large Archaic centers of the 6<sup>th</sup> century. Urbanization and large scale trade in agricultural products developing in the Archaic period are preceded by an approximately three-fold population growth during the Orientalizing period (7<sup>th</sup> century BC), allowing Etruscan settlements to be classified into a hierarchy of types (Perkins 1999:104-6).

The term ‘colonialism’ may under some circumstances be interpreted as indicating a conscious movement, a policy. The early (5<sup>th</sup> and 4<sup>th</sup> century) colonies in southern Latium may have been part of such a strategic movement on the part of the early Roman state, aiming to secure the disputed borderlands of Latium Vetus, and was certainly represented by later writers (esp. Livy) as such. The strategic value of a colony was expressed with admirable clarity by Machiavelli in *The Prince* (translation Bondanelli 1984:10)

*“The other and better solution [to securing new territory] is to send colonies into one or two places that will act as supports for your own state (...) Colonies do not cost much, and with little or no expense a prince can send and maintain them; and in doing so he hurts only those whose fields and houses have been taken and given to the new inhabitants, who are only a small part of that state; and those that he hurts, being dispersed and poor, can never be a threat to him, and all others remain on the one hand unharmed (and because of this, they should remain silent), and on the other afraid of making a mistake, for fear that what happened to those who were dispossessed might happen to them.”*

But Livy may have been telescoping events that took place almost two centuries apart, and we should not discount the possibility that the reality of the earliest Romanization of Latium Vetus was much more haphazard and unplanned, and contingent on historical circumstances than he suggests. In contrast, Roman colonies established in the later 4<sup>th</sup> century BC appear to have been more systematic and “urban” ventures. According to Attema (1993:13) they expressed a territorial organization totally different from the Archaic patterns of settlement and land use, involving such structural innovations as the putting into place of a system of rural villas for olive culture on the Lepine footslopes, centuriation of agricultural land near Terracina, and drainage and road-building (the Via Appia through the Pontine marshes). Olive culture requires a large investment in establishing plantations, but perhaps the villas could exploit an existing (less intensive) agricultural system by the Archaic and post-Archaic Latial peoples<sup>2</sup>. These colonial towns must each have had rights over parts of the Lepine upland and the Pontine plain, up to the Via Appia or even beyond, possibly even including fishing and fowling rights in the coastal environment. But, since recent intensive surveys in marginal landscape units within the Pontine region indicate that a large measure of settlement continuity may have been present between the Archaic and Republican periods (see chapters 9 and 10), the impact of 4<sup>th</sup> century colonization may have been restricted to selected ‘core’ parts of the region. Especially strategic locations on the Lepine margin.

In this scenario, two temporal gaps remain to be accounted for. Firstly, what happened in between the historical establishment of the colonies around 500 BC and their first archaeological appearance around the middle of the 4<sup>th</sup> century BC? And secondly, why was the apparent establishment of systematic olive culture in the Lepine margins delayed for more than a century after the 4<sup>th</sup> century colonization? There is no archaeological evidence for the presence of Roman colonists in this region in the Archaic or post-Archaic periods. It appears that the early process of colonization by Rome was either largely unplanned and long drawn-out, or it ran into unexpected difficulties and was discontinued. However, recent field surveys indicate that a densely settled Archaic (and, less clearly, post-Archaic) landscape existed in at least

<sup>1</sup> In view of the new radiocarbon dates and improved understanding of site formation processes at these sites, this process must be dated some 50 – 100 years earlier.

<sup>2</sup> Pollen evidence indicates that olive culture on a substantive scale began in the 3<sup>rd</sup> century BC in this region (Haagsma, in Attema 1993).

two 'marginal' parts of the Pontine region, with no evidence for the displacement of this indigenous population by Romans in the later 3<sup>rd</sup> century BC (chapters 9 and 10).

Judging from the urban architectural remains at *Setia* (Sezze) and the late 4<sup>th</sup> century infill of its immediate rural surroundings (*ager*), Roman colonization here took place as much as two centuries earlier than in the coastal landscape near the Fogliano lagoon. Clearly, if there was a planned or sustained Roman policy of agricultural colonization in the 4<sup>th</sup> century BC, it extended only over limited and specific areas. If aerial photographic indications for a 4<sup>th</sup> century centuriation of the central part of the Pontine graben between Sezze and Terracina, predating the construction of the Via Appia about 326 BC, are correct (Cancellieri 1990), then the area colonized would have mostly consisted of previously marginal land – the *macchia* of pre-Roman *Setia*. Agricultural production in the Pontine region became less important to the expanding Roman empire after 200 BC anyway, and there are indications that the coastal area may at that time have specialized in fish farming for the market at Rome (Attema et al. 2001).

Later instances of colonization by Rome took place at a much greater pace and left abrupt changes in the archaeological record; it is generally believed that, once the expanding Roman Republic had acquired sufficient experience from its earlier attempts at colonization, it was capable of planning and executing a rapid colonization policy 'package'. But even then, local circumstances would influence the speed and success of the process. In the case of Wroxeter, after a very brief military phase in the middle of the 1<sup>st</sup> century AD, local elites were co-opted into the political and administrative structures of the Roman state such that the processes of centralization, urbanization and romanization were essentially complete within the next 25 years (chapter 3).

#### THE SALENTO ISTHMUS

Research in the Salento Isthmus (in the heel of Italy) was started in 1981 by Prof. Dr. Joh. Boersma and Dr. D.G. Yntema of the AIVU, in close collaboration with the Scuola di Specializzazione in Archeologia Classica e Medievale of the University of Lecce. Its aim was to elucidate the development of regional settlement patterns in the Brindisi region in the context of the integration of native society into the Roman world. AIVU surveys have covered a total area of some 90 square km, incorporating various environmental zones. Between 1981 and 1983 surveys were concentrated on an area of circa 63 square km around the town of Oria, the roots of which go back to well within the Bronze Age. In 1989 and 1990 another team conducted a field survey in an 18 square km large transect between the Adriatic and the ancient fortified site of Valesio. The AIVU has been engaged in a complete survey and partial excavation of its walled area since 1984; this being the first systematic urban survey in the area.

In 1991 the Brindisino research was extended to include the Taranto plain, and renamed the Salento Isthmus Project, under the direction of Drs. Gert-Jan Burgers and subsidized by NWO. Four complex settlement areas and their surroundings were incorporated into the regional survey project - Muro Tenente, Muro Maurizio, Li Castelli di San Pancrazio, and Cellino San Marco. Through intensive total coverage surveys of these more or less urban settlements their chronology, extent, lay-out, occupational density and nature was studied. From 1993 onwards the AIVU has been engaged in large scale excavations at Muro Tenente.



Figure 2 – The Salento Isthmus, with indication of the main survey and excavation projects which had been undertaken by the Archaeological Institute of the Free University of Amsterdam before the start of the project. For legend, see figure 1.

In the Late Bronze Age (14<sup>th</sup>-12<sup>th</sup> centuries BC) of the Salento peninsula, a preference for coastal locations is suggested by the presence of large enclosed promontory settlements such as the one at Masseria Risieddi (see chapter 11). These settlements are thought to be located here for easy participation in overseas communication networks (D'Andria 1991:403). On the basis of the lack of finds in surveys conducted by the AIVU, and the predominantly coastal location of the known sites of the FBA and Early Iron Age (11<sup>th</sup>-9<sup>th</sup> centuries BC), Burgers concludes that the pattern of a relatively empty inland Salento landscape continued (1998:173), although some inland sites are known from this period (Oria and Monte Saletè).

The question of continuity or discontinuity in settlement dynamics at the end of the Late Bronze Age and the beginning of the FBA has been a subject of intense debate. Some have emphasized a continuous process of increasing complexity (notably Peroni 1979), while others insist on radical cultural disruption and a subsequent invasion of tribal elements from Illyria, typified by violent destruction, abandonment or restructuring of Late Bronze Age settlements (De Juliis 1988: 9-19). Still others recognize a relative continuity in interregional networks, emphasizing instead the collapse of overseas exchange with the Mycenaean world which could have been the cause of a decreasing complexity of society in general (Yntema 1990:38-39, Yntema 1993:154). Coastal communities at this time 'were probably autarchic, while the inland may have been exploited for extensive pastoralism, if at all' (Burgers 1998:174 and note 95).

In the Iron Age (9<sup>th</sup> and 8<sup>th</sup> centuries BC), native communities were 'engaged ... in settlement expansion, territorial reorganization, demographic growth, increasing rural use of the interior of Salento, and overseas contacts' in order to 'enhance internal power positions' (Burgers 1998:296). Demographic growth and influx from the Balkan area are thought to have driven a strong development of the village system and a gradual occupation of all available agricultural land in southern Puglia (D'Andria 1998:108). This crystallization of a settlement system developing since the 9<sup>th</sup> century BC was interrupted on the western side of the Isthmus at the start of the 7<sup>th</sup> century by the establishment of the colony of Taras which carved out its chora. The origins of the early Hellenistic fortified sites in the Brindisi region and the larger Salento peninsula could still be traced by Burgers (1998:293-6) to the Iron Age, because 'the earliest diagnostic artefacts found are Iron Age matt-painted ceramics'. The founding of these settlements is thought to be an expression of a larger gradual process of landscape reorganization, accelerating from the late 8<sup>th</sup> century BC to include the interior of the peninsula and other outlying regions such as the area around Ostuni (chapter 11). By the 6<sup>th</sup> century BC a two-level hierarchy (or, following Semeraro



1997, 'hieratic system') had come into existence, with three large towns (Oria, Cavallino, and Ugento) surrounded by a larger number of small villages.

Urban features, such as the growth in size of single dominant settlements, social and economic hierarchies, and the construction of monumental buildings, were all appearing in southern Italy between the 6<sup>th</sup> and the early 4<sup>th</sup> century BC, a process of urbanization which accelerated in the early Hellenistic period (later 4<sup>th</sup> and 3<sup>rd</sup> centuries; Lomas 1993, Burgers 1998:293). A settlement system emerged that was dominated by a series of fortified towns. In the later Hellenistic period this system disintegrated as the region became increasingly involved in supra-regional conflicts. Integration of the Salento into the expanding Roman state started with the defeat of the Tarentine/Messapian allies in the first half of the 3<sup>rd</sup> century BC, and was spearheaded by the colony of *Brundisium* (founded 245 BC). 3<sup>rd</sup> Century wars, and especially the 2<sup>nd</sup> Punic war, resulted in massive disruption of the old native/Greek culture, but recent research indicates that it was not everywhere replaced by an exploitative large-scale colonial economy – instead, differences can be attested within the region (Burgers 1998:30-31). For the native elites of the Salento Isthmus, close association with the Roman state and way of life became the means to further oneself. Towns away from the central axis of the Via Appia decline, while Brundisium becomes the focus of Roman and native surplus production. The increased market orientation in the production of olive oil and wine caused rationalization and concentration of farm labor both locally and, regionally, near the Via Appia (Burgers 1998:303-7).

#### THE SIBARITIDE

The Sibaritide, consisting of a coastal flat and its surrounding hills, has been the subject of research by the GIA since 1990. The main object of study has been a system of Bronze Age hilltop sites, one of which, near the town of Francavilla Marittima, consists of a low hill called 'Timpone Motta' with a sanctuary on top and settlements of huts and houses on three lower 'plateaus'. It also includes the general catchment of this hill and connected areas such as the adjacent Iron Age Macchiabate necropolis, part of which was excavated in the 1960s by Paola Zancani-Montuoro. Following a 20 year gap, the project was revived by M. Kleibrink with test campaigns in 1990/91 in order to research the problem of native Enotrian versus Greek settlement and colonization activities - particularly the relationship with the nearby Greek colony of Sybaris. This new research brought to light a number of huts from the Middle Bronze Age and early Iron Age, as well as a 8<sup>th</sup> - 7<sup>th</sup> century cult activity area and a 6<sup>th</sup> century 'colonial' village on the lower slopes of the Timpone Motta (Maaskant Kleibrink 1993; for recent publications containing further references, see Kleibrink 2000 and Kleibrink & Sangineto 1999).

The recent mapping and discussion of pre- and protohistoric settlement in northern Calabria by Peroni and Trucco (1994) has served to modify the old 'textbook' view of a largely pastoral society in the Apennine period (Puglisi 1959)<sup>3</sup>. One set of more elevated settlements, situated on calcareous outcrops and connected most likely with specialized transhumant pastoralism since they lie along routes still used today to reach the higher mountain ranges, is now thought to have been "under the control" of another set of larger, lower-lying settlements<sup>4</sup>. Following Barker (1985), Peroni points to the spread of dry farming in the Middle Bronze Age period in the higher valleys as the causative factor for the development of this latter set. Because many of its settlements are situated on old fluvio-marine terraces, consisting of conglomerate and/or sand, Peroni could plausibly argue that settled Middle Bronze Age society preferred well

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<sup>3</sup> Peroni proposed the following chronology for the Bronze Age and early Iron Age: Middle Bronze Age 1600 – 1300 (300 years), Recent Bronze Age 1300 – 1150 (150 years), Final Bronze Age 1150 – 900 (250 years), and Early Iron Age 900 – 700 (200 years).

<sup>4</sup> This is an unfortunate turn of phrase in my view, which is also used by other authors. A more neutral expression would be: "are part of the same system as".

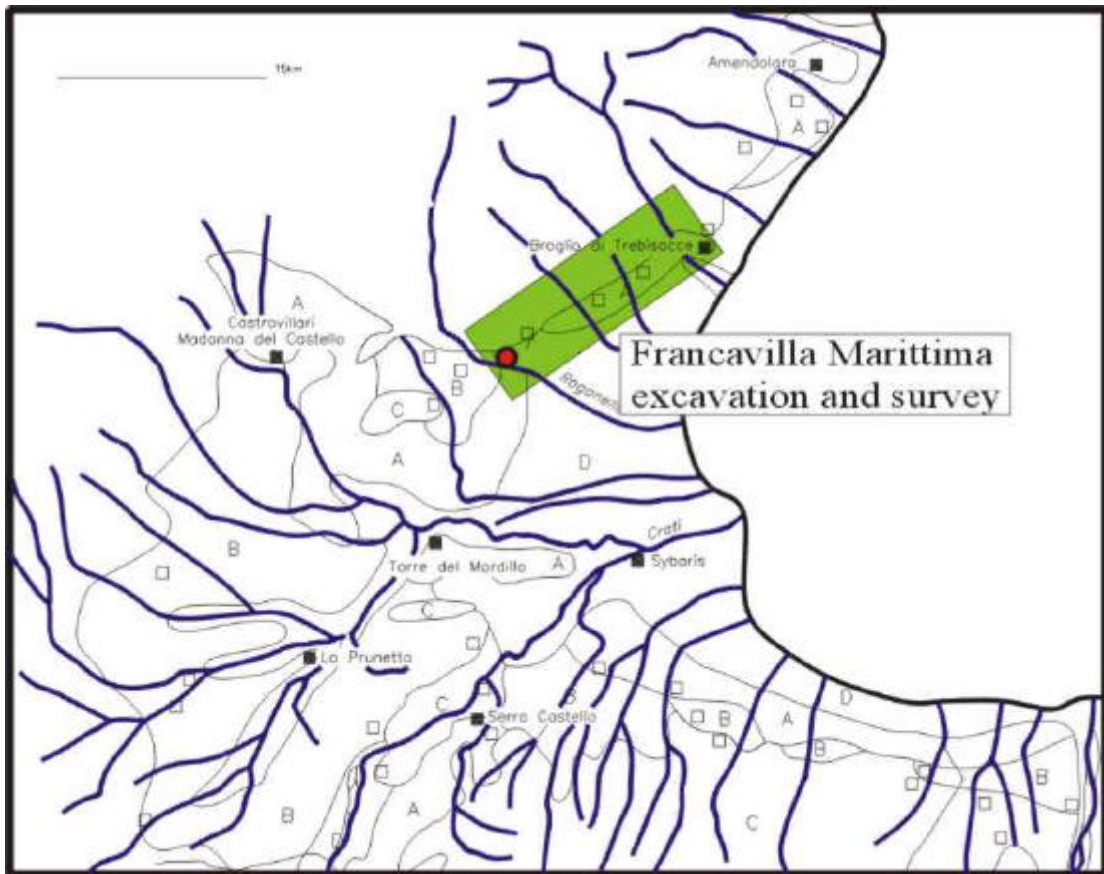


Figure 3 – The Sibaritide, with indication of the main survey and excavation projects which had been undertaken by the Groningen Institute of Archaeology before the start of the project. For legend, see figure 1.

defensible hills and terraces on which to practice dry farming of cereals and vegetables (Peroni & Trucco 1994:37). In the excavations at Broglio di Trebisacce Peroni saw signs of increasing demographic pressure in the course of the protohistoric period. The presence, in the Broglio excavations, of Mycenaean wares dating to the 15<sup>th</sup> – 12<sup>th</sup> centuries BC has been seen as an indication that Greek potters were present in the Sibaritide at that time, which would argue for an early hierarchization of indigenous society, in which elites maintain long-distance contacts and channel tribal surpluses into the acquisition of prestige goods. In the Late Bronze Age, Torre Mordillo became a major settlement with a defensive wall (*agger*) encircling the highest plateau (Arancio *et al.* 1994), Late Bronze Age layers at Torre Mordillo, Broglio and Francavilla Marittima contain Italo-Grey ware of different fabric qualities indicating local ceramic production, and evidence for wider use and cultivation of the olive tree (Peroni & Trucco 1994:45). This evidence for Late Bronze Age exchange of objects and technology indicates that overseas contacts with the Aegean must have been frequent (Peroni 1994:24) and presumably profitable for both sides. The Late Bronze Age in the central Mediterranean is therefore seen as ‘a clear case of expansion of people, technology, ideas and products’ (Kleibrink forthcoming par. 3.2), with autonomous settlements occupying all viable river-delimited territories in the Sibaritide, and powerful leaders controlling the means of production and redistribution (*idem*, par. 3.6/7).

As in the Salento, overseas and possibly supra-regional contacts broke down during the FBA, but the settlement system continued to crystallize. The occurrence of pairs of defensible hilltop sites of unequal size and agricultural potential has been interpreted by Peroni in terms of a defensive strategy, with the smaller and higher of the pair having little agricultural potential and a role in defending the lower settlement and its agricultural riches in which a large section of the population would have lived. One example of such a pair, brought to light by surveys, is the following:

1. *Monte San Nicola*, a site overlooking both the Raganello valley and the Sibari plain, at about 500 m asl. Potsherds were found here on a plateau of circa 1 ha; the encircling terraces lower down are much larger and together form an area fit for cultivation of circa 25 ha (Peroni & Trucco 1994, no 31).
2. *Monte Spirito Santo*, a site situated about 1 km northwest of Monte San Nicola at an elevation of circa 510 m asl; it is located on a much smaller plateau and without a view over the plain. The site is connected with the steep slopes of the Raganello near Cività and on its southern end with similar steep terraces of the Eiano (Peroni & Trucco 1994, no 30).

By the beginning of the Late Iron Age, the two most important settlements in the Sibaritide appear to have been located at Torre Mordillo and at Francavilla Marittima, and it is thought that these were respectively the economic and cultic centers of the region.

Large sections of the coastal landscape may have been of marginal significance to the indigenous tribal societies, so that the establishment in the late 8<sup>th</sup> century BC of a Greek trading emporium which later evolved into a colony need not be seen in terms of conflicting interests at all. The earliest indications of classical ‘colonial’ influence in the Sibaritide are the Aegean style temples built on the Timpone della Motta presumably with the active help of early Greek traders (Kleibrink, in Attema et al. 1998:127), but it is only in the mid-7<sup>th</sup> century that Greek colonists would finally claim the sanctuary as theirs by rebuilding it in a fully Greek style. From about 640 BC, Greek and colonial pottery became the dominant gift both at the cult center on the Timpone della Motta of Francavilla Marittima and in grave inventories of the nearby Macchiabate necropolis. It is noteworthy that the first indications for the rural spreading of Greek pottery out into the Sibaritide foothills date to the 6<sup>th</sup> and 5<sup>th</sup> centuries BC, making it likely that the chora of Sybaris did not yet extend beyond the coastal plain around 600 BC (see chapter 12). If Kleibrink is correct in dating the latest rich burials at Macchiabate to the first decades of the 6<sup>th</sup> century, then we may suppose that the local elite by that time found it opportune to relocate themselves to Sybaris – a sign that the nearest indigenous polities of the foothills were rapidly being absorbed by the colony by then.

Historical sources claim that Sybaris, in its (6<sup>th</sup> century) heyday, ruled over four tribes and 25 towns (Strabo VI, 1, 13). Certainly it was instrumental in founding a further colony as far away as Metapontion, and dominating others as far away as Laos on the opposite coast of the Calabrian peninsula. By the middle of the 6<sup>th</sup> century BC the town shows an enormous expansion from Stombi to the outer walls, and regular plan buildings must have appeared as at Amendolara and elsewhere. Pottery production became standardized. For example, there is no difference between the local soft ware productions at Sibari, Amendolara and Francavilla (Attema et al. 1997/98) and, whilst the 7<sup>th</sup> century BC matt-painted tradition at Francavilla still showed a peculiar and original development, the 6<sup>th</sup> century BC brings standardization in both architecture and pottery. By then, over one century of acculturation between natives and Greeks must have created a new social structure in which Sybaris (and later Thurioi) became the regional urban administrative and economic center for an expanding rural hinterland of villages and isolated farms with associated rural sanctuaries and cemeteries. While the settlement history of the plain must remain largely unknown because of later substantial alluviation, surveys indicate that farmsteads began to appear in the foothills, some 15 km away from the urban center itself, sometime in the 6<sup>th</sup> or 5<sup>th</sup> century. Clear evidence for settlement expansion in the foothills becomes available only with late 4<sup>th</sup> century Hellenistic fine wares; by the 3<sup>rd</sup> century, isolated Hellenistic farms even occur far into the highlands at elevations up to 1000 m asl.

It would appear that the inhabitants of the Timpone della Motta managed to adapt to the presence of the powerful Greek colony without losing their social structure. The site was only finally abandoned in the 5<sup>th</sup> century BC, possibly because it lost its function as an extra-urban sanctuary when Sybaris was destroyed by the Crotonides in 510 BC. Since its pan-Hellenic successor colony Thurioi was not established until 443 BC, and surveys have barely been able to identify any material from this period, something of a ‘dark age’ lurks between the late 6<sup>th</sup> century BC and the onset of the Hellenistic rural expansion phase in the late 4<sup>th</sup> century BC.

As around Poseidonia, and unlike the Metapontino where the process happened already in the 6<sup>th</sup> century, a major increase in settlement density appears to occur in the Sibaritide only in the late 4<sup>th</sup> century

BC. De Neef (1998:105, 110) suggests that this may in part be related to the marshy nature of both plains, the large scale drainage of which would only have been possible in the 4<sup>th</sup> century, but it seems equally likely that the rural colonization of the chora of Sybaris had already begun in the 6<sup>th</sup> century but was interrupted by the conflict with Croton before it had time to reach the archaeologically visible foothill zone. Large-scale drainage of the plain in the 4<sup>th</sup> century, directed from Thurioi, could still be invoked as an early phase in the Hellenistic colonization process, leading to a late 4<sup>th</sup> century rural expansion into the foothills and explaining the preponderance of Greek material culture from that period and area (see also chapter 12).

Historians report that, during the 4<sup>th</sup> century BC, there was constant warfare with the Lucanians and Bruttians, and Thurioi became a voluntary Roman dependency. Like the Salento, it then became involved in the 3<sup>rd</sup> century struggles of the Romans against Pyrrhus and Hannibal and their Italian allies. After the 2<sup>nd</sup> Punic war the Romans attempted to revive the town by replanting it as the colony of Copiai in 194 BC, but according to the ancient historians it was not successful and quickly dwindled to insignificance (Appianus, *BCiv.* 5.56). Even less is known of a second Roman colony at *Interamnium*, depicted on the Peutinger Map and identified with the modern town of Castrovillari on the upper Coscile<sup>5</sup>.

## 2.2 CORE CONCEPTS AND TERMS

It is obvious that the three processes of Centralization, Urbanization and Colonization cannot be seen as wholly independent of each other. Centralization and urbanization are two ways in which early societies can become more complex; colonization comes into play at a later stage when societal structures become organized at a wider (interregional) scale, and bring other forms of urbanism. However, the terms centralization, urbanization, and colonization have been used to encompass such a wide and ill-defined range of processes, that they can not provide a reliable basis for comparing regional histories. For example, Burgers (RPC in prep.) regards pre-Roman urbanization as part of a supra-regional process of social differentiation involving most of the Mediterranean basin and affecting all of the landscape including 'marginal' areas. Perhaps wisely, therefore, Attema (1993:17) did not even attempt to provide a formal definition of urbanization in his discussion of the settlement history of the Pontine region.

Neither, in my opinion, can 'urbanization' or 'colonization' be regarded as neutral concepts. Urbanization and urbanism play a central role in the expansion of the Greek colonial and, later, Roman politics in Italy, because the town was the focus of the classical conceptual landscape (Laurence 1994:139). Both the later Greek colonists in Magna Graecia and the expanding Roman state were possessed of a mindset in which the town was the center of life – and colonization would, ipso facto, have meant urbanization. To accept the classical definition of urbanism is therefore tantamount to accepting a teleological view of history, in which the historical urban forms of classical Greek and Roman society represent the ideal or standard by which archaeological reality is measured. Such a view ignores the potentially different evolution of indigenous settlement systems. Similar objections may be raised with regard to the use of the term 'colonization', which is colored not just by its origins in and treatment by the ancient historians but also by 19<sup>th</sup> century western colonialism seeking justification of its 'civilizing' activities elsewhere, and assumes that there is a fundamental inequality between the external colonizing party and the indigenous 'receiving' party. To describe the 1000 years of history of settlement and land use in the study regions in these terms is therefore to invite a 'classicist' bias.

These issues have recently become part of a wider 'revisionist' trend regarding the role of the Greeks and Romans in initiating and dominating 'civilizing' processes in early historic central and southern Italy. For instance, regarding the relation between colonization and urbanization, opinions expressed in the recent literature range from McIntosh's (1991) "urbanization was a development initiated by the colonizing Greeks" to Van Dommelen's (1997, 1998) "indigenous urbanization was, in some instances, influenced by colonists". However, most importantly, we should not expect any of the three processes to lead to

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<sup>5</sup> In my view, this identification is incorrect; see my argument in chapter 12, note 9.

uniform results irrespective of the time, place, and local history of the study area. Attema, Burgers, Kleibrink and Yntema (1998:131), in their presentation of case studies introducing the RPC project, noted:

*'[how] important the indigenous perspective is in the study of centralization, early urbanization and colonization processes in Central and Southern Italy, and how regional cultures and landscapes underwent these processes at different points in time, in different ways, with different intensities and with different results. It is clear that the natural environment, technological level, subsistence and ideological strategies of the local populations and the degree of early external contacts and colonization movements were all important influences on internal regional developments.'*

## CENTRALISATION

The concept of centralization is applicable to societies from the tribal stage onwards, and thus plays a role in both the protohistoric and the early historic periods. 'Centralization' in the context of such early societies may be defined as the process by which societal functions, and the power and control derived from them, become geographically concentrated at a small number of locations and, socially, in a small number of individuals. Since it is such an all-encompassing concept, archaeological evidence for centralization may be derived in almost any context, from evidence for social differentiation in cemeteries to evidence for the spatial concentration of settlement across a wide region. The latter type of evidence provides a direct link with the concept of urbanization, which may be viewed as a particular type of centralization. For example, to account for the lack of identifiable settlements in the Early and Middle Bronze Ages of both Greece and southern Italy, a system of shifting cultivation has been proposed for these periods; whereas the Late Bronze Age (Bronzo Recente, Bronzo Finale) saw the population move to live together in villages, each with its field system and associated manuring spread.

The development of centralized settlement during the later Bronze Age and early Iron Age (but beginning already in the Middle Bronze Age in some areas) cannot be explained by simple 'external' monocausal factors such as overseas contacts with a higher (Mycenean, Phoenician, Greek) civilization resulting in a core-periphery transfer. Not only would this by itself have been unlikely to cause such a fundamental shift in the organization of prehistoric societies, but dating evidence as well indicates that developments in Italy were not lagging (sufficiently) behind those in the eastern Mediterranean to allow for this kind of causation. Another factor which has been advanced to explain the development of centralized settlement is that of 'defensibility'. In my view the significance of this should not be overstated; although it is true that Late Bronze Age centralized settlements occur in relatively defensible positions (e.g., 'capes' and hilltops), such locations also have other desirable qualities such as exposure to cooling breezes and large viewsheds. It is to be considered unlikely *a priori* that a society could experience (or survive) such a long period (3 to 5 centuries) of insecurity as to base its settlement structure on it.

One can imagine a competitive 'big man' or chiefdom society in which defense is needed from the ritualized raiding familiar from the Irish sagas... but in such a case the settlements should be interpreted in terms of strength – as strongholds expressing the wealth of a tribal unit and prowess of its leaders – rather than in terms of defense against attacks. In such a perspective, what could be the reason for Late Bronze Age settlements in the Salento peninsula to be located on the edge of the Murge rather than within it, as in the Early Iron Age? It is possible that the competitive structure based on pastoral wealth, which required territories composed of coastal as well as upland components, was gradually replaced by one in which agricultural wealth played a larger role. This could have been expressed in a progressive 'carving up' of the Murge upland zone into agro-territories centered on hilltop settlements; an idea supported by the more or less regular distances of circa 12 km separating Early Iron Age settlements in the Murge and other south Italian upland areas, as recently mapped by D'Andria (N.D., fig. 9; see also my chapter 11, fig 1).

A completely different type of argument about centralization stresses the effects of research and discovery biases, and suggests that the currently known settlements represent only the most obtrusive remains of a much more extensive and complex settlement system. Prospection and research has tended to focus on relatively easily discovered sites with substantial structural remains, even if these are of a later date, while equally large sites lacking such features and lying outside areas of interest remain undiscovered unless a systematic survey happens to hit on them (as with the several hectares of clearly visible Middle Bronze Age impasto discovered during the Ostuni99 survey, chapter 11). If it is accepted that this effect plays an important role, then our whole frame of reference changes to one where we try to understand why the rank-size hierarchy of protohistoric settlement developed in the way it did.

## URBANISATION

Definitions of the concept of ‘urbanization’ (the process) in the archaeological and human geographic literature abound. Many of these make no clear distinction with the related concept of ‘urbanism’ (the state). Since we are here concerned solely with the diachronic process of town formation (*Formazione delle città*), we will use with minor modification the definition given by McIntosh (1991:208): urbanization is ‘a process of regional transformation by which a rural landscape of undifferentiated villages and hamlets with homogeneous populations transforms into a settlement network in which an agricultural hinterland supports a few population agglomerations to which specialists are attracted.’

Note that this definition gives both quantitative (the number and size of agglomerations) and qualitative (the presence of specialists) characteristics by which to recognize the process of urbanization; in my discussion of methodology I will specify how these – and additional – characteristics are employed to model the dynamics of the settlement history in the three study regions. The process of urbanization is characterized by the growth of large(*r*) population centers, economic specialization, markets, and services; the state of urbanism is characterized by the physical presence of a town, of its symbols (towers, walls, temples), and of an urban hierarchy (plebs, skilled workers, and political/religious elites). The question of whether something is a town must be therefore be decided by the application of physical and social functional criteria (such as economic specialization, hierarchization, spatial differentiation, central market and religious function). The term ‘proto-urban’ has been widely used to designate nucleated settlements during the early stages of the urbanization process, when it may be expected that a candidate archaeological site does not meet all the criteria set out above. The related term ‘semi-urban’ has also been used to describe settlements that do not (clearly) meet a sufficient number of these criteria. Since such pre-urban settlements may exhibit a whole range of divergent forms (McIntosh 1991), no single set of characteristics can be given to define this concept with.

The use of the term ‘proto-urban’ carries two potential dangers. Firstly, with hindsight it is tempting to see processes of centralization and urbanization in proto- and early historic Italy as inevitable. There is thus a potential teleological element to the use of the term ‘proto-urban’, suggesting that urbanization is a natural progressive development for any society and that settlements that are not completely urban are in some sense ‘not there yet’ or even ‘failed’. We should instead use the term to indicate that no *clear* urban character could be established. Secondly, the term can be used to ‘demote’ native settlements which do not display the characteristics of Roman or Hellenistic urban forms (Lomas 1996:142); it is therefore important to guard against in-built Greek or Roman biases in the definition of what constitutes ‘urban’.

Of course urbanization is a form of centralization (both physical and social), and hence carries implications for the level of organization of a society. Since in true towns social organization is no longer exclusively based on kinship, early urbanization can only take place when societies are moving from a segmented, tribal structure to a hierarchical, early state (McIntosh 1991). Pre-Greek urbanization in the south, and pre-Roman urbanization in central Italy, would therefore indicate an indigenous development toward early states in a manner at least partly independent of external forces. A priori it is unlikely, for example, that (proto-) urban development in the Iron Age and the Archaic of south Lazio was restricted to Rome itself, although it may well have been limited to those coastal areas which had sufficient external contacts to generate wealth from trade.

## COLONISATION

A widely used definition of colonialism by Prochaska (1990, quoted in Van Dommelen 1997:306) sees “the presence of one or more groups of foreign people in a region at some distance from their place of origin (the ‘colonizers’) and the existence of asymmetrical socio-economic relationships of domination or exploitation between the colonizing groups and the inhabitants of the colonized region” as its two fundamental characteristics. Note that the characteristic of asymmetry is here linked to a dominant role for the colonizers. Both the presence of ethnic foreigners and the asymmetry of economic relationships are very difficult to prove as long as all arguments are based on the material culture of the colonizer rather than that of the native population. The dominant role of the colonizer, at least in the early stages of the process, appears to be more of an assumption than an argument based in fact.

In contrast, the term ‘colonization’ has been used to describe a number of disparate processes occurring in different archaeological and historical contexts. When we speak of Greek and Roman ‘colonization’ of parts of central and southern Italy, we lump together processes ranging from the undirected ‘internal’ cultivation of previously uncultivated land to the plantation of colonists whose activities form an integral part of the economic and military strategies of the state. The historical process of colonization, by Greeks, Phoenicians, and Romans, has traditionally been a focus of interest and study within Mediterranean archaeology. Since it began to be studied at a time (the mid-19<sup>th</sup> century) when western powers were colonizing many other parts of the world, it was naturally seen from the colonizers’ perspective as a benign, civilizing process. For the same reason, the terms ‘colonialism’ and ‘colonization’ are often used with the implicit connotation of asymmetric power relations between the colonizer and colonized, with the connotation that the ‘native’ can only act within a space determined by the colonial power (Rowlands 1998:329); but there is no reason to assume such asymmetry in many actual instances of Greek and Roman colonization. Guzzo (1982), for example, argues that the Greek colonies of southern Italy were established in coastal areas that were only marginally exploited by the indigenous populations, whose settlement system had developed in the hilly hinterland. In the first years, contact with nearby indigenous people would have been crucial for the development of the incipient colony, while increased trade with and through the colony would cause the focus of the indigenous settlement pattern to shift gradually toward the colony in later decades and centuries<sup>6</sup>.

Even if the asymmetric character of the colonial situation is without doubt, the indigenous party may perceive it as providing opportunities rather than posing restrictions. In an article on aspects of romanization in the hinterland of the Roman *civitas* capital at Wroxeter (Shropshire) for example, Roger White and I proposed a detailed model for the relatively smooth changeover from the decentralized pre-Roman Iron Age tribal society of the Cornovii to the urbanized Roman *civitas* (Van Leusen & White 1997; chapter 3). In this instance, the colonizer opened up political and economic possibilities previously inaccessible to a land-locked indigenous Cornovian society.

It appears likely that no single definition of either *colonialism* or *colonization* can be applicable across the three study regions and the five centuries between 800 and 300 BC, and the nature of both must therefore be defined separately for each instance. Within the context of the RPC project the goal has not been to define Greek and Roman colonization as such, but rather to gauge the influence of these processes on native development in the three Italian study regions. Were the Greek and Roman colonies and urban developments dominant forces in this development (creating center-periphery relations), or did they create equal polities integrated within indigenous society (creating peer polity interaction)? Herring, in his study of socio-political change in the south Italian Iron Age and Classical period (1991), argues for the existence of the latter up to, at least, the 6<sup>th</sup> century BC, while Whitehouse and Wilkins address the former in their review of the archaeological evidence for Greek - native relations in south-east Italy (1989). In general, it is easy to overemphasize the colonizers’ perspective, because of the near exclusive role of late classical authors in providing historical sources about the colonization process. Similarly, the highly identifiable remains of classical cult may have led De Polignac (1994, 1995) to put too much stress on the

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<sup>6</sup> However, it has been pointed out (eg, by Carter 1993) that much of the archaeological proof for this kind of development is very sensitive to the dating and interpretation of archaeological remains.

use of ‘cult politics’ in claiming and securing colonial territory – more detailed investigation as at Francavilla Marittima (Kleibrink 1997:69) has highlighted weaknesses in his argument.

If the strategies of ancient colonizers were, at times, less coherent than previously imaged, then comparisons with early modern instances may be instructive. Attema (1999) suggests that a fruitful comparison may be made between some instances of early Greek and Roman colonization, and the 18<sup>th</sup> century colonization of Australia, where the presence of ‘debatable land’ – that is, land on which no clear ownership claims rested – allowed colonization by the English not because those lands were unused but because the natives’ and colonizers concepts of ownership differed too widely. A similar scenario may be invoked to model early (7<sup>th</sup> century BC) Greek colonization in southern Italy; there, the colonies and their initial agricultural base were established in a part of the landscape – alluvial deposits in the coastal plain – considered of marginal importance by the indigenous populations whose societies focused on the low hills and plateaus surrounding the plain (see chapter 12).

Another instructive comparison may be made with the early 16<sup>th</sup> and 17<sup>th</sup> century colonization of the North American east coast by Europeans, where colonists depended upon trade with the indigenous tribes for their survival. Native tribes had some decided advantages when it comes to living off the land:

*“England’s attempts to establish colonies on the mainland in the sixteenth century failed completely. In the early seventeenth century, the English succeeded only because neighbouring Indians assisted the newcomers. The English colonies prospered by learning to grow such unfamiliar crops as corn and tobacco and by developing extensive trading relations with Native Americans. ... To achieve their first goal – feeding themselves – they had to adopt agricultural techniques suited both to the new crops and to an alien environment. Their second goal – maintaining lucrative trade networks – required them to deal regularly on a more or less equal basis with people who seemed very different from them and who were far more familiar with America than they were.” (Norton et al. 1991:2)*

Obviously the historic instances of colonization by the Greek city states and by Rome did not take place in an environment that was very different from what the colonizers were used to at home, nor were communications with the homeland as difficult and time consuming, but one may still wonder (on the one hand) how much help the colonists needed before they could fend for themselves, and (on the other) how the relative freedom from the mother country might have afforded the colonists room for experimentation with the organization of society (Rowlands 1998:330).

In other instances the process of colonization proceeded along very different lines. For example, the Romans arrived in the Salento only after their military defeat of the Tarentines and their associates, while in Lazio they progressively dominated a pre-existing urban structure and established new colonies in strategic areas; a spontaneous process of urbanization during the Iron Age and Archaic became directed urbanization under the Romans.

Whereas traditionally ‘colonization’ has been a concept inextricably linked to the superior and civilizing role of Greeks and Romans in the indigenous societies of Italy, research over the last decades has made clear that the earliest phases of Greek and Roman presence in indigenous landscapes were characterized by unobtrusive and small contingents of trader/settlers (Burgers 1999, Yntema 1999). There is no reason to assume any kind of conflict existed between Greeks and natives of the Salento and Sibaritide at this stage, and no reason to assume that their role in society became preponderant until the late 7<sup>th</sup> century. But the Greeks arrived in a society which had already established a settlement system centering on large defended villages in the foothills by the Late Bronze Age, and the Romans took over a landscape already



substantially settled by the native Archaic Latial tribes. If ‘colonization’ is taken to signify the bringing into productive use of a previously wild landscape, these natives were the ones who colonized Italy, and who had established certainly by the late Iron Age a system of ‘proto-urban’ top-ranking settlements in places considered as marginal as the Salentine Murge.

The traditional view as, for example, formulated by Piero Guzzo and François de Polignac, denies this native (‘Oenotrian’) dynamic of settlement and land use. In Guzzo’s view the Greek colonies, all founded in coastal plains, led the Oenotrians to live in villages on the hilltops around, not the other way around (Guzzo 1983:14-151). In De Polignac’s view the Greeks founded sanctuaries along the border of their colonial territories to offer indigenous societies an opportunity to display wealth and influence, thereby civilizing them (De Polignac 1984). Any ‘native’ progression to urbanized life and organized cult in this view only emerged under Greek domination and coaching. The archaeological evidence, however, indicates that the indigenous society came under the domination of Sybaris only much later when, in the 6<sup>th</sup> century BC, the historically attested ‘imperium’ of Sybaris became fact (e.g., Greco 1996:236).

The driving force behind both the native and the Greek colonization of the coastal plains of southern Italy could well have been the same - demographic increase caused by the growing importance of agricultural and arboricultural land uses since the Late Bronze Age and the restoration of supra-regional contacts in the Early Iron Age, both of which led to a flowering of native elite-led redistributive societies organized as chiefdoms (De Neef 1998:101-105; cf. Crielaard 1999).

The odious (because supremacist) terms of ‘hellenization’ and ‘romanization’ can, as we have seen, be avoided in all this by the use of a neutral term such as ‘acculturation’. While this begs the question of what, precisely, was the relative contribution of both sides to this process, it has the advantage of lacking an in-built pro-Greek or pro-Roman bias in the interpretation of the archaeological evidence.

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### 3      TOWARDS INTERREGIONAL COMPARISON

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The aim of the RPC project is to compare the settlement dynamics of the Pontine region, the Salento Isthmus, and the Sibaritide from late protohistory until the early Roman empire. I intend to approach this goal via a circuitous route, first discussing the theoretical basis for making such comparisons, then deriving a methodology from that, and lastly pointing forward to the case studies implementing them (chapter 13).

#### 3.1      WHY, HOW AND WHAT TO COMPARE ?

Before we begin our attempt to compare the settlement dynamics of the study regions, we need to establish a theoretical and methodological basis for such a comparison, answering the questions of why we think these regions can be compared at all; and, if they are comparable, of how to compare them. Implicit in both these questions is the definition of *comparanda*, that is, which are the things we will be comparing?

A starting point for answering the question of why the study regions *should* be comparable may be found in similarities and differences in their respective physical landscapes. To begin with what all the regions have in common, they all consist of coastal plains with a mountainous hinterland and transitional foothill zones; each of them is a self-contained physical geographical unit of sorts. In a general sense the regions are also similar because they are relatively close to each other – a well-known maxim in Geography says that ‘everything is related to everything else but, all things being equal, closer things are more strongly related to each other’. As to the *differences* between the regions, all three are situated on different coasts of

the Italian peninsula, although the Salento and Sibaritide are very much closer together and the Pontine region is both very near Rome, and beyond the farthest point reached by Greek colonists. Unlike the relatively open geography of the Pontine region and the Salento Isthmus, the physical geography of the Sibaritide (an isolated alluvial plain surrounded by foothills) may be compared to that of the plain of Poseidonia (Paestum; De Neef 1998:101-105), neither of the latter two has any evidence for substantial human activity in the plain until the 7<sup>th</sup> century BC.

One can also compare the regions by looking specifically at the cultural processes taking place in each of them, and this is the approach taken within the context of the RPC project. During the 1<sup>st</sup> millennium BC all three regions witnessed processes of settlement nucleation and urbanization (*Formazione delle città*), and were subjected to one or more colonizing movements emanating from outside the region itself. On the other hand, the Pontine region came under the early influence of Rome, and both were part of the same Latin culture, whereas the early colonizers in the south were Greeks bringing a much more foreign culture. Why did the Greek colonization of the Salento take a different route to that of the Sibaritide? Were processes of centralization (urbanization) running similar courses in each region before they were altered/truncated by outside factors? Culturally, the Sibaritide was also much more isolated from neighboring areas than the Latial tribes in the Pontine region, and this might have affected the rate and direction of cultural evolution within these two regions.

#### COMPARANDA

In reply to the question of what to compare and how, I take the phrase ‘*dynamic* settlement models’ to imply the modeling of processes rather than states; this is a strong definition, akin to that of simulation. A less strict definition, more descriptive of current practice, is one whereby static models are placed within a dynamic narrative.

It should be noted here that interregional comparison entails the explanation of *differences* between regions, not the explanation of societal change itself. Thus, Bintliff’s (1997:17-33) models for regional development provide explanations for what has been the outcome of the *comparison* between regions of Greece. Can we indeed explain why things went differently in the longue duree / conjuncture of the three study regions, without being forced to explain the fact of the occurrence of the processes themselves as well? Perhaps what we should be explaining is the phenomena in terms of the underlying processes, e.g. the hypothesis of craft specialization can explain certain archaeologically visible phenomena in terms of an underlying process of centralization of society.

As the operation of the core processes in our study regions cannot be attested directly by archaeological proof, centralization and urbanization might as well be seen in the way biological evolution was seen in the past, i.e. as stages in a progressive development of societies (for example, Guidi writes about the general *evolution* of chiefdoms into early states in the Alban hills in the central Tyrrhenian area from 1200 to 700 BC)? From a pragmatic point of view, processes encompassing all three study regions may be argued to be outside the scope of this study, and need not be explained here either. This then leaves us free to concentrate on the comparison, between the regions, of archaeological expressions of these underlying processes.

#### ISSUE OF SCALE

The potential for any type of question, including geographical analysis, of archaeological data is dependent on the scale at which that data was collected. At the regional scale, unless extensive surveying has taken place, the bulk of the record will consist of point-like observations relating mostly (in Italy) to easily observable structural remains of the Classical period. By their very nature such data present a mainly classical Roman and Hellenistic landscape of towns, roads, necropoli, and villas, overlying a protohistoric landscape of hillforts and *tombe principesche*. Such data are exemplified by the early volumes in the *Forma Italia* series of publications; later volumes are much more detailed and include mapping of non-visible zones (Cambi & Terrenato 1994:152).

### 3.2 EXPLANATORY MODELS OF SOCIO-POLITICAL CHANGE

A combination of demographic growth and technological change may be assumed to be the ultimate driving factor behind many of the processes of change in early Italy, but as we shall see explanatory models of socio-political change tend to concentrate on more proximate factors. Among these, quantitative/geographical models have gone out of favor since the 1970s, and have since been replaced by sociological models closer to the humanistic outlook of most archaeologists. However I would like to reiterate that, at sufficiently coarse geographical and temporal resolutions, physical parameters such as geographical boundaries and the availability of natural resources may provide sufficient explanation for the historical outcome of the processes we study (cf. Diamond 1998). Thus, biogeographical similarities explain why crops, animals, and lifestyles could be communicated across the Mediterranean basin with relative ease. Matthews (1999), in a volume dedicated to a discussion of models of late prehistoric and Romano-British rural settlement in North West England, provides some useful pointers to non-archaeological models, in particular to anthropological models of population density and forms of organization (Kosse 1990, Bekker-Nielsen 1989) and Christaller's geographical models of settlement hierarchy (Collis 1986). He argues that such models have unjustly gone out of favor with the demise of New Archaeology.

While archaeological explanations of socio-political change in classical Italy were originally driven by a classicist perspective, the current literature, dominated by Italian prehistorians and Anglophones, is almost exclusively expressive of the 'revisionist' trend that emerged in the 1970s. The 'new archaeology' is seen by many (e.g., Trigger 1989:294-303) as the force that finally put native populations on a par with the conquering military and administrative population, and authors such as Herring, Whitehouse and Wilkins, and Burgers, accordingly reject the traditional 'literary' Hellenophile approach. Recently indications are mounting that the pendulum has reached its maximum: Jones (1997), in his review of the historiography of Roman Imperialism, describes the rise of revisionism and its recent slowing down as ambiguities in the archaeological record are recognized (see also Rowlands 1998:328).

In the archaeological literature about the structure of protohistoric and early historic societies of southern Italy (and generally of Europe), two types of explanatory models were advanced in the mid-1980s to replace the earlier 'advance of classical civilization' model. The Peer Polity Interaction model, introduced by Renfrew and Cherry (1986), sees change brought about by the interaction and competition between a large number of independent and initially approximately equally matched polities; the Core-Periphery model advanced at almost the same time by Rowlands (Rowlands et al. 1987), describes change as driven by unequal interacting parts of single systems. In the two sections below, the specific application of these two explanatory models to the south Italian evidence is given; however, it is not my intention here to argue for or against either – rather, these models act as the backdrop against which testable hypotheses about the patterning of the archaeological record in our three study regions may be developed. The value of explanatory models, as is particularly clear from the discussion of the Core-Periphery model by Whitehouse and Wilkins, is in how well they are able to predict the occurrence of certain archaeological evidence; my purpose here is to derive specific testable hypotheses about the spatial scale and distribution of archaeological features. The tests themselves are then conducted by transforming these hypotheses into a form conducive to GIS analysis.

#### PEER POLITY INTERACTION

Herring (1991:35-6, 42-9), discussing peer polity interaction in the south Italian Iron Age and Classical period, aimed 'to show how communications (on all levels) between the different communities could have been a major dynamic to socio-political change'. He argues that the Greek colonies were themselves tribal societies and therefore peer polities to the native tribes, and attempts to fit the available archaeological evidence into Renfrew's (six) characteristics of peer polity interaction. Herring concludes that the peer polity model 'works well between the late 8<sup>th</sup> century to sometime in the 6<sup>th</sup> century', while later on one can see two systems of peer polity interaction (one indigenous, one colonial Greek) existing in southern Italy at the same time. The change-over being brought about by 'exogenous change'. Herring struggles to avoid lapsing into the old hellenization idea when arguing that in the later period, while

new ideas and products came from Greece through the Greek colonists to the natives, this was an exchange between equals rather than one between a dominant and a subservient partner.

Peer polity models for the organization of pre- and protohistoric societies have enjoyed a growing popularity with students of Bronze Age and Iron Age hillforts, especially those working with GIS, because the underlying assumption of equality between hillforts belonging to the same system allows the application of a number of spatial analytical techniques. Hillforts formed the top of the settlement hierarchy in the tribal societies of the Bronze Age and early Iron Age in large parts of Europe, but very little is known about the living systems they were part of. Since many of them were only investigated from a topographic point of view, and dates are in many cases only available where diagnostic surface finds could be made, assumptions must be made about their contemporaneity in order to be able to treat them as the foci of interacting peer polities. The polities themselves might best be viewed as tribal subdivisions or 'cantons' with a population ranging from a few hundred to a few thousand, as in the case of the tribal area of the Cornovii in north-western Britain (Van Leusen & White 1997).

#### CORE – PERIPHERY INTERACTION

Since the original volume edited by Rowlands and others, the core-periphery model has been applied to many comparative studies by prehistorians (see, for example, the volume edited by Champion 1995). Whitehouse and Wilkins (1991) employ its theoretical framework to study the south Italian archaeological evidence, discussing in turn the archaeological evidence, the Greek cities, the relationship between Greek and natives, and changes in the native communities. These authors conclude (1991:123) "We have tried to demonstrate that an analysis of the development in south-east Italy in terms of a center-periphery model can give important insights into the precise forms of social and economic relations through which the native communities were brought into contact with the Greeks, and we have highlighted the specific importance of prestige goods for the transformation of native economies and social organization." However, as noted in a review by Yntema (1996), there is an in-built assumption that the native hinterland must perforce be the periphery to the Greek coastal colonial centers; the reverse is not being investigated. Whitehouse and Wilkins (op. cit.: 107-115) tabulate the expected differences in evidence between the rival hypotheses of Greek control and co-existence, but their discussion of the artefactual evidence is marred by ignoring the strong biases that are present. They come down clearly in favor of the co-existence model, and explain the occurrence of predominantly 'Greek' sanctuaries in the native area by reference to a prestige-goods system, in which the sanctuaries functioned as emporia for the trading of native products (wool) for Greek prestige objects.

When discussing direct Greek control of Italian territory in the Archaic period, Whitehouse and Wilkins want to emphasize the small amount of land held directly by the colonies – only 15 by 15 km in the case of Metapontion, and perhaps four times as much for Taras. However, this just about uses up all of the available coastal plain and raises the interesting question of just what might have been the role these plains could have played in the native economies – a question that is also relevant to the Sibaritide in the Archaic period! The native settlements outside this area were perhaps 'allowed to continue to flourish', but if so they would have to do it on a different economic basis from that of the colonies themselves...

#### MODEL AND REALITY

Both Peer Polity and Core-Periphery explanatory models for dynamic interaction predict specific regional and supra-regional patterns of archaeological correlates, but only for idealized homogeneous spaces and societies. It is therefore doubtful that they can be tested through landscape archaeological fieldwork. Similarly, static regional locational models such as gravity or central place models apply only to certain types of interaction within hierarchical settlement patterns. For example, a successful application of central place models is possible only in the study of *retail* distribution within physiographically homogeneous regions such as river valleys (Crumley 1979:152). Such models are not applicable to dynamic and open societies, which have a heterarchical organization.

### 3.3 DETECTING MACRO-ARCHAEOLOGICAL QUANTITATIVE PATTERNS

Human action is structured in space and time; hence the archaeological record is patterned in space and time. Unfortunately the processes by which the archaeological record is preserved, recovered and described (constructed) are themselves also non-random; hence the result is a second set of patterns superimposed on those within the archaeological record itself. The general theoretical approach followed in this thesis is that of the French Annales school as applied in archaeology (Bintliff 1991, Knapp 1992); this is most suited to deal with the nature (mostly undiagnostic surface material) and temporal scale of the material studied (from about 1400 BC to about AD 300). The case studies involving field work and GIS analysis are all based on the theoretical premises of landscape archaeology – that human actions may occur, and leave an essentially continuous ‘blanket’ of traces, anywhere in the landscape, that the resulting surface record is a palimpsest of such traces through time, and that patterns in this record may be explained in part by the in turn limiting and enabling qualities of the landscape. These principles are extended into the realm of spatial extrapolation and cultural resource management using the theory of spatial sampling (which says that properties of a properly selected sample have a specific likelihood of also being properties of the parent population).

A model for interregional quantitative pattern analysis is provided by Bintliff’s (1997) comparison of diachronic site counts from surveys in Greece. He shows that more intensive surveys yield larger numbers of Geometric and Archaic sites. It is therefore possible that part of the geographical shift in the period of demographic take-off is due to the fact that areas where, at best, only extensive surveys took place will show a sudden increase in site numbers for the period in which the first easily recognizable material is present – that is, the classical/Hellenistic period. By the same reasoning, inasmuch as the more intensive surveys have concentrated on the heartland of classical Greece, these areas will show the clearest evidence of protohistoric settlement activity. Bintliff’s hypothesis of shifting demographic take-off and conclusion (1997:14) that, ‘by and large, the “evidence on the ground” is broadly comparable to political history’ is therefore, I feel, not well supported by the evidence he adduces and must be strengthened by a more detailed study of potential biases. From his very brief statement of method (1997:2) it is not clear how successful he was in ‘unbiasing’ his data.

#### SAMPLING IN ARCHAEOLOGICAL SURVEYS

Approaches to pattern detection in archaeological data are contingent on the methods used to collect those data. The study of questions relating to how to collect sample data in order to allow generalizations about a sampled population *with a specific degree of certainty* is the domain of sampling theory. Once data have been collected, other approaches are needed to determine whether patterns may be present. A very popular approach, especially with the advent of GIS, has been to measure the correlation between the sample data and explanatory variables, but this has generally been tied up with the discrete, site/non-site approach to the archaeological record (for a further discussion of these methods, see chapter 4). Geostatistics and signal processing theory are two alternative approaches to consider when studying continuous survey data.

The type of sample taken during archaeological surveys depends on the type and scale of patterning one expects in the archaeological record, but is restricted by available time and funding. Thus catchment studies may sample nearly all of the immediate surroundings of some central place or village in order to establish the existence of a microregional pattern, or they may sample a small part of a physiographic region such as a watershed basin in order to establish regional patterns of settlement and land use.

#### SOPHISTICATION IN SPATIAL ANALYSIS

One of the most popular approaches in archaeological pattern detection and explanation since the 1960s has been to demonstrate a correlation between two or more variables - for example, the presence of farm sites and the agricultural productivity of the soil. The bulk of GIS work in the 1990 has concerned exactly such work. Unfortunately, the analysis of spatial (geographical) data has always been complicated by the fact that real-world spatial variables exhibit a large amount of autocorrelation (near things are more

similar), and variables are also spatially correlated. A measure of spatial correlation between two variables has been developed from the formula for autocorrelation. This issue is dealt with in more detail in chapter 5.

Geostatistics are a body of theory and methods designed for the analysis of spatially correlated, geographical variables. Despite the reservations expressed by Barceló and Pallarés (in their discussion of the theory and method of social space, 1998: 65) that geostatistical methods do not perfectly fit archaeological purposes because social action and, with it, social space is discrete rather than continuous, I believe that the construction of geopedological units on the basis of point measurements (corings) and areal observations (geomorphological units) is sufficiently similar to the construction of meaningful archaeological entities (e.g., site catchment areas and urban manuring zones) on the basis of excavations and surveys to warrant a further exploration of the potential of geostatistics including such spatial extrapolation techniques such as Kriging. Any underlying assumptions (e.g., the normal distribution of the variables) should of course be born in mind when applying geostatistical methods to archaeological data.

#### BIAS MODELING

The theory behind bias modeling is that the factors and processes causing bias can be measured and modeled, thus taken into account when analyzing and interpreting survey data. This line of research is the subject of chapter 5 of this thesis.

#### SIGNAL PROCESSING

Recording archaeological surface material as one or more gridded surfaces of counts, weights, or densities of object or material types results in a data type – gridded continuous variables – that is, as we have seen, conducive to storage and processing in a GIS. However, it also suggests that principles and techniques from the field of signal and image processing may be applicable as well. If, as many authors argue, we should no longer employ the concept of ‘site’ at the heart of our survey designs, field procedures, and analysis, we must identify an alternative concept.

If, as is argued by most landscape archaeologists, we can regard the surface archaeological record as an essentially continuous variable, though varying in density, then perhaps we can escape from some of the confines and confusions of established archaeological terminology (‘site’, off-site, non-site, etc) by temporarily adopting the vocabulary and some of the techniques of a related field – that of signal processing. In order to do this effectively, I would like to argue first that we should view the surface record not as one single signal or variable, but as a potentially large number of overlapping signals, each representing the land use intensity of a particular period. This is in agreement with the generally accepted view of the surface record as a palimpsest of past uses. Each of these signals in itself may be continuous. Rather than predefining the nature of these signals, for example as representing archaeological activity types (‘subsistence farming’ would be one example), we can adopt more pragmatic methods that allow us to analyze the signals without establishing their nature first.

If the surface record can be viewed as a series of overlapping signals of varying frequency and amplitude, then we may be able to use frequency filtering techniques such as Fourier analysis in our attempt to define and separate these signals. And we may be able to employ non-archaeological definitions of what constitutes a signal (and therefore of what constitutes noise) to aid in the quantitative processing of data generated by surface survey. These two possibilities are discussed below. A number of fairly strong assumptions about the type of patterning present in the archaeological record underlie the following discussion, and I will refer to these where-ever necessary.

#### *Frequency filtering*

Although the surface record is an essentially two-dimensional data set, assumptions of isotropy (see section 3.1) allow us to consider a one-dimensional ‘slice’ through this surface first. The total density of the record is the signal, and it is made up out of a number of patterned human activities. We postulate that these are distributed regularly in space (frequency) and in density (amplitude); for example, an

area settled by small farmers in the Roman Republican period will, other things being equal, be represented in survey data by a regularly spaced occurrence of ceramic scatters of some typical density. Each of these scatters in turn has a typically bell-shaped density distribution. If a data set consists of a number of signals of differing frequency and/or amplitude, standard signal processing techniques can be used to separate these signals.

Fourier analysis of discrete two-dimensional data is a well-known technique in image processing, discussed for example in the handbook by Lillesand & Kiefer (1994:563-566). The data are mathematically described by a combination of sine and cosine functions transformed into two arrays containing the real and imaginary components of its frequency space, which can then be masked so as to remove unwanted frequencies or select frequencies of interest<sup>7</sup>. Its uses within archaeology have so far been limited mainly to noise removal or reduction in aerial and satellite imaging, and its potential for the analysis of archaeological survey data has, as far as I have been able to establish, not been investigated. In theory, GIS software containing tools for Fourier analysis can be used to split up the results of a survey into a series of maps, each representing a different frequency<sup>8</sup>. The criteria for this splitting can be purely empirical, that is, based on signal strength only, or they can be derived from field measurements of observed frequencies such as those of plough furrows and ridge-and furrow, or they can be derived theoretically. For example, if an archaeological landscape is hypothesized to consist of modular units centered on a single family farmstead, the theoretical diameter of the modules (e.g., 400 m) may be used as the frequency of interest. In a further step, a frequency or set of frequencies may be subtracted from the original data, leaving only the residuals for further modeling and analysis.

### *Signal vs. Noise*

Much of the debate has centered on the question of ‘signal vs. noise’ or, in archaeological terms, site vs. off-site. Although it is now generally agreed that *all* surface finds can contribute to our knowledge of the archaeology of an area (and in that sense there is *no* noise<sup>9</sup>), the use of statistical noise levels can help to distinguish meaningful variation from meaningless variation in the surface record. For example, a ‘site’ might be defined as any area that has a significantly higher surface sherd density than its surroundings (e.g., Gallant 1986), with ‘significant’ indicating that a certain level of random variation will be present in the data and should not lead to the definition of a site. Similarly, the definition of what constitutes a ‘manuring spread’ will have to include some way of dealing with statistical noise levels (Wilkinson 1982). The concept of statistical variance must be introduced here, because it provides a means of specifying the *probability* that data constitute ‘noise’ rather than a ‘signal’.

These issues can best be illustrated by examining Bintliff’s recent reanalysis of the results of the 1980s survey campaigns conducted by him and Snodgrass around the Greek city of Thespieae (Boeotia), in combination with the results of the RPC project’s recent surveys (Bintliff & Howard 1999). The Boeotia project team is now looking for low-density patterns that may have been hidden by the general late Archaic/early Hellenistic ‘blanket’ of ceramics resulting from intensive manuring practices during the demographic heyday of the city. Among their early results are the discovery of a prehistoric landscape consisting of Early/Middle Bronze Age small short-lived farmsteads, and the realization that localized areas of low ceramic density, if combined with finds of certain pottery types, indicated the presence of cemeteries; of especial interest here is their use of numeric correction procedures to re-assess the presence of Greek and Roman sites in the light of *expected* ‘off-site’ finds densities in the *chora* of Thespieae. The approach taken by Bintliff and Howard is to use GIS to model the distribution of identifiable off-site material (the manuring scatter emanating from Thespieae itself, and the scatters surrounding rural farm sites) using a cost surface based on terrain slope and distance to historically known trackways. They then subtract the ‘expected’ manuring finds density from the recorded finds density in order to interpret the

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<sup>7</sup> Low frequencies are in the centre and high frequencies near the edges of these arrays.

<sup>8</sup> GRASS 4.1 uses the fast forward and inverse Fourier transforms.

<sup>9</sup> A position taken, for example, by Kuna (2000:42).

residuals. However, the recorded finds densities result from material collected during uncontrolled gridded site surveys (i.e., neither the type nor the number of finds collected is necessarily representative of the area surveyed) and it is therefore unclear that the residuals reflect actual variation in the density of archaeological materials on the surface. Furthermore, Bintliff and Howard's assumption (1999:60) that manuring will, over time, result in a smooth blanket of ceramics seems untenable; rather, there will be peaks and troughs (noise) that are the accidental by-product of the historical manuring process. The expected pattern of manuring may also be different from the one modeled by Bintliff and Howard, leading to a different pattern of residuals; for example, might there be an inverse relation between soil fertility and manuring practice? For such methods to become generally accepted, we must develop better ways of calculating expected off-site densities and their residuals, perhaps using standard deviations and confidence levels rather than absolute densities. And our trust in the correctness of the residuals and 'noise' levels should be expressed by establishing formal statistical levels of confidence.

If we compare this to the RPC project approach to low finds density, two comments may be made. Firstly, the re-survey in 1999 of parts of the 1998 Fogliano survey area has demonstrated that very low finds densities cannot be disregarded as 'noise' or 'off-site' – they may well be related to low visibility conditions and that revisits/excavations have the potential to substantiate the 'one sherd can indicate a site' idea. Low finds densities therefore have to be problematized. On the other hand, it should be recognized that even intensive 'general' surveys cannot hope to collect representative samples of low density, low visibility categories such as the prehistoric impasto in the Sibaritide 2000 survey (chapter 12); this will need a targeted re-survey. Finally, the recording of low densities can also be an artefact of the classification process; some periods can only be recognized if diagnostic forms or decorations are present. If these are rare or absent, finds will be classified into broad undiagnostic categories, or even as 'indeterminate'.

Secondly, our interpretation of the protohistoric off-site ceramic 'carpet' during the Ostuni survey is different from Bintliff's interpretation of the carpet of classical material around Thespieae. The protohistoric (Middle Bronze Age) impasto carpet of OST99 is explained by assuming a relatively short period (150 years) of shifting cultivation which transformed a large percentage of the area into a 'site'; in contrast, the Classical period carpet around Thespieae is explained as the result of a relatively brief period of manuring from the town.

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#### 4 DISCUSSION

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The brief review of current archaeological opinion regarding the settlement and land use history of the three Italian regions, presented in section 2.1 above, immediately tempts us to make comparisons and define similarities and differences. However, the question arises of whether these similarities and differences are properties of the regional archaeological records themselves, or of the explanatory frameworks being used. Since this allegation has been made repeatedly of the traditional classicist Greek- and Roman-centered narrative, it is incumbent on the current generation of researchers to demonstrate that they have not just replaced this with a 'native-centered' explanatory framework. The following should therefore be regarded as a preliminary comparison only:

- In both central and southern Italy, a nucleation of permanent settlement out of a previous (presumed) system of pastoralism and shifting cultivation becomes archaeologically apparent by the Late Bronze Age. Whilst the same set of causative factors has been adduced to explain this phenomenon in both areas, I have argued above that this may be caused by our use of 'catch-all' explanations when we have a poor understanding of the true causes.
- Both the Greeks in the Late Iron Age Salento and Sibaritide, and the Romans in Archaic southern Latium, encountered a developed indigenous tribal society which had already colonized all but the most marginal landscape units and who lived in a range of settlements from isolated farms to 'proto-



urban' settlements. In both cases the process of acculturation took some 150 years before the native culture was fully submerged into the new supra-regional material culture of the Hellenistic and Roman Republican periods.

It would be better if we could make comparison of quantitative aspects of the regional archaeological records, and here the example of Alcock's (1993) and Bintliff's (1997) work on Classical to Roman Greece provides a valuable point of departure. However, as noted in section 3.3 above, this approach must be refined in order to allay doubts about their methodological justification. The greatest potential for resolving these doubts lies in limiting the geographical scope of our comparison to an infra- or even micro-regional level; this potential is further explored in chapter 13.

In the end, one must agree with Bintliff's (2000:214) opinion that

*Field survey is an incomplete guide to regional settlement systems, but it is an illusion to suppose that excavation or historical source control is a firmer basis – these approaches are probably even more inadequate for regional settlement reconstruction than large-scale intensive survey. In combination however I believe that these three approaches can create Piggott's 'cumulative credibility'; many of the more intractable problems of settlement and population reconstruction and interpretation may be assisted considerably through a dialectic in the field involving information from all three sources of regional information.*

This sentiment is supported by Millet's (2000) convincing argument that surface (surveyed) and stratified (excavated) assemblages are complementary in content, and therefore have a complementary role in archaeological explanation.

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## CHAPTER 3

# INTRODUCTION TO THE WROXETER HINTERLAND PROJECT

This chapter consists of two previously published articles which, together, provide the backdrop against which the case studies on land use / land cover bias (chapter 14) and visibility and friction (chapter 16) should be read.

The first article, 'Extending GIS Methods for Regional Archaeology: the Wroxeter Hinterland Project', co-written with Vincent Gaffney, was originally presented to the 1995 Meeting of CAA (in Leiden, The Netherlands), and was published the following year in its proceedings (Kamermans and Fennema 1996). The article introduces the project itself, its main research goal of explaining the anomalous existence of Wroxeter itself through a study of both the town and its hinterland, the models for urbanisation and Romanisation that were to be tested with the project data, and especially to detail the geographical approaches that were to be developed and applied for this study.

The second article, 'Aspects of Romanization in the Wroxeter Hinterland', co-written with Roger White, was originally presented at the 6<sup>th</sup> annual Theoretical Roman Archaeology Conference (TRAC, Sheffield 1996) and appeared in its proceedings the following year (Meadows et al. 1997). It provides a preliminary analysis of the evidence and arguments explaining the paradoxical existence of a large and thriving Romano-British town in the middle of a rural landscape almost devoid of any evidence for indigenous wealth, centralisation, or significant acculturation to Roman lifeways. Wroxeter is the only large Roman town in Britain which does not appear to have a substantially Romanised hinterland. Previous hypothetical explanations for this phenomenon have included a hostile stance of the local population, an over-ambitious civilian foundation of Wroxeter, and /or its economic underdevelopment. The second idea could be laid to rest given the results from the aerial photographic and geophysical study of the town itself (Van Leusen 1999b, Gaffney & Gaffney 2000); we argue here that the first and third idea can now be discounted as well because the archaeologically attested success of the town *implies* that the hinterland must have been wealthy. We conclude that the paradox is mainly due to the near invisibility of the forms of wealth which the native Cornovians would have commanded and to the lack of a systematic study of late pre-Roman Iron Age and Roman patterns of settlement and land use in the Wroxeter hinterland.

The congruence in both the core processes being studied (centralisation, urbanisation, and Romanisation), the general theoretical stance (landscape archaeology), and the emphasis on the use of methods of geographical analysis, suggests that a comparison of the results of the WHP and RPC projects may be fruitful.

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## Extending GIS Methods for Regional Archaeology: the Wroxeter Hinterland Project

### 1 Background

In September 1994 a 3 year research project to study the Roman town of Wroxeter and its hinterland was started at the University of Birmingham Field Archaeology Unit (BUFAU). The project is funded jointly by the University and the Leverhulme Trust, and aims to take forward many aspects of regional archaeological research in Britain, including the application of GIS and remote sensing in both the design and analytical stages, the close involvement of the local community, and the study of urban-rural relations. This paper, the first in a series that will describe the progress of the Wroxeter Hinterland Project, sets out our intentions and preliminary results, concentrating on innovative uses of GIS.

#### 1.1 THE RESEARCH AREA

Wroxeter, located between the modern towns of Shrewsbury and Telford (county Shropshire; see fig. 1), was the Roman Civitas capital (named *Viroconium Cornoviorum*) of the Cornovii, an Iron Age tribe that is thought to have lacked a centralised structure before the arrival of the Romans in the mid-first century AD (fig. 2). Yet, at 64 hectares, Wroxeter has the fourth largest walled area in Britain and preliminary geophysics results have already shown it to be much more densely settled than was thought previously. How could such a large and, given the splendour of its public buildings, rich town develop and prosper in a region that was both economically and politically peripheral? What was its economic and social basis? These are questions that can only be answered by a study of the towns' hinterland, the area that must have contained some of the pre-Roman tribal elite, and must have formed the main economic basis for day-to-day life in the town. This hinterland must have extended at least as far as the nearest major natural boundaries and the next nearest minor towns - an area of some 30 by 40 km.

#### 1.2 THE ARCHAEOLOGICAL EVIDENCE

A compilation of existing archaeological records has resulted in a database of some 1600 pre-Norman Conquest (AD 1066) 'sites', the bulk of which belongs to the Iron Age and Roman periods. Very little targeted surface

archaeological research has been done in the area, the records consisting mainly of reports of chance finds and of crop or soil marks discovered by aerial archaeology (Whimster 1989). Site distributions may be heavily influenced by differential preservation and visibility effects, and reporter bias.

### 2 Use of GIS in the Project

The Wroxeter Hinterland Project is designed to study the settlement history and the various processes of Romanisation in the study area from the Later Pre-Roman Iron Age down to the sub-Roman period. The design incorporates GIS at a number of levels:

- as a data management tool, to hold data sets originating at multiple sources (from County records to satellite imagery) as a georeferenced map 'stack';
- as an image processing and mapping tool, to process and interpret non-invasive prospecting data ranging from surface geophysical surveys to airborne remote sensing;
- as a modelling tool for describing both the archaeological landscapes in the study area and our imperfect knowledge of those landscapes;
- as a spatial analysis tool, to study the contributions made to archaeological knowledge by a variety of non-invasive prospecting methods.

#### 2.1 DATA MANAGEMENT

To keep on top of the data collected and generated by the project, GIS is used to collect, hold, and analyse all available archaeological records, vertical and oblique aerial coverages, a variety of geophysical and remote sensing data sets, and a number of maps representing environmental variables. This use of GIS is non-controversial and is now beginning to be accepted as the standard for regional archaeological research.

#### 2.2 IMAGE PROCESSING

The WHP will have remotely sensed data covering the whole (Landsat TM) or part (airborne TM and CASI) of the study area, vertical and oblique air photographic data covering large parts of the study area, and surface

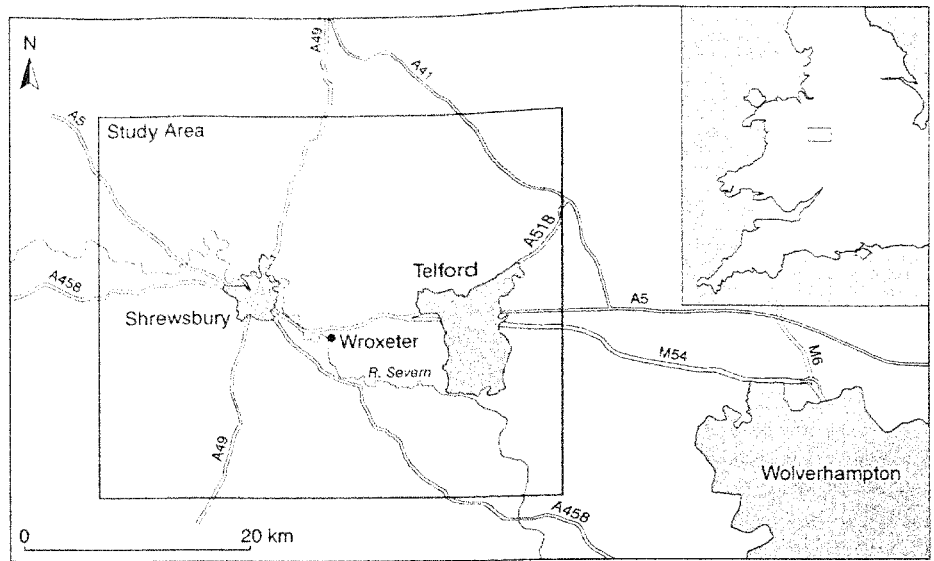


Figure 1. Location of the Wroxeter Hinterland Project research area.



Figure 2. Map showing approximate pre-Roman tribal territories in Britain (after Millett 1990: fig. 16).

geophysics data covering sample areas. Whereas the data for the hinterland will be used as a control on existing records, special high resolution imagery will be acquired for the town of Wroxeter itself in order to produce high quality mapping. Existing maps of the town (fig. 3) have been produced almost exclusively on the basis of air photographic evidence, and have not had the benefit of modern photogrammetric techniques for accurate mapping.

Evidence taken from vertical and oblique APs, from ground-based geophysical measurements and aerial remote sensing, and from excavations can now be collated, using GIS technology, to produce a georeferenced graphical database of Wroxeter and its direct environs (stretching approximately 500 meters outside the town defences). Processing this imagery with the GIS in preparation for mapping will involve algorithms ranging from stereo-DTM generation to orthorectifying transformations and enhancements in the spatial and frequency domain. The processed imagery will then be ready to be digitally mapped off screen.

By interpreting and mapping the archaeological features present in the resulting georeferenced and enhanced image database in both a topological, a functional, as well as a chronological sense, digital vector maps can be produced that represent the spatial structure, the functional structure, and the chronological development of the site. These might form the basis for a Digital Interactive Atlas of Viroconium, allowing users to query any of the Project data layers and to display the results.

### 2.3 MODELLING

The authors, having written earlier about the pitfalls of current GIS applications (Gaffney/Van Leusen 1995; Van Leusen 1996), intend to develop innovative GIS solutions to the problems of modelling archaeological landscapes, both in the environmental and in the cognitive vein. We feel that GIS models should derive most of their use from either confirming or refuting theoretical constructs, and previous applications were lacking in that respect. Even more importantly, any model that is based on real archaeological data should explicitly deal with the biases that are inherent in such data, and we intend to use GIS to model such biases.

#### 2.3.1 *Linking Archaeological Theory and GIS*

GIS modelling will be applied to our main research question, which concerns the impact of Romanisation on the late Iron Age tribal society of the Cornovii. Taking current models of this process by Millett (1990) as our starting point, we intend to extend GIS methodology into the largely uncharted territory of non-environmental data.

The problem of urban-rural relationships in archaeological research is a general theme within many periods and areas of study. Such analyses have a specific resonance within Roman studies where urbanisation, twinned with Romanisation, has long been a suitable topic for research. The reasons for this are not hard to discern, especially in those provinces — including Britannia — where there is an apparent lack of urban traditions or where pre-Roman trends towards urbanisation were weak, and the development of towns and cities is interpreted as only one variable in the process of Romanisation. The study of Wroxeter and its hinterland is just one example of this research theme in action, but it can also be neatly grouped with the recently growing number of regional or 'landscape' studies in archaeology.

There is a complex web of interactions between any urban centre and its (normally directly adjacent) rural hinterland. This complexity extends into the functional, geographical, and chronological domains: which activity grew up when and where, and why? Even modern towns are notoriously difficult to study as living organisms, and a dead town such as Wroxeter, for which evidence of any sort is patchy at best, would seem to present insurmountable problems. However, we should measure our efforts not against an ideal, but rather against current archaeological practice. Hypotheses about the origins of Roman towns in general should be tested against the evidence generated by the project, and refined.

Millett (1990; see tables 1, 2) has presented such hypotheses. In particular, his models of early Roman impact on native society and of settlement dynamics during the later Empire should be amenable to testing. In order to avoid a lapse into brute force implementations of environmental models, we will attempt to extract culturally significant and spatially referenced information from the existing archaeological records and compare this with the more traditional economic indicators.

We have argued elsewhere that patterning in 'cultural' data should be as amenable to GIS analysis as is economic patterning (Gaffney/Van Leusen 1995: 370-371). For example, we can conceive of Romanisation as the combination of a wide variety of spatially variable cultural markers distributed across the landscape. On this basis we should be able to use architectural, morphological and artefactual data to construct maps depicting the spatial dispersal of status and degree of Romanisation across the landscape. These can then be compared with maps derived on a purely economic/environmental basis, and the differences between them should provide us with pointers to the social processes at work in the town/hinterland relationship. Inversely, we will construct models of status distribution based on archaeological theory, and test these against existing and newly acquired data.



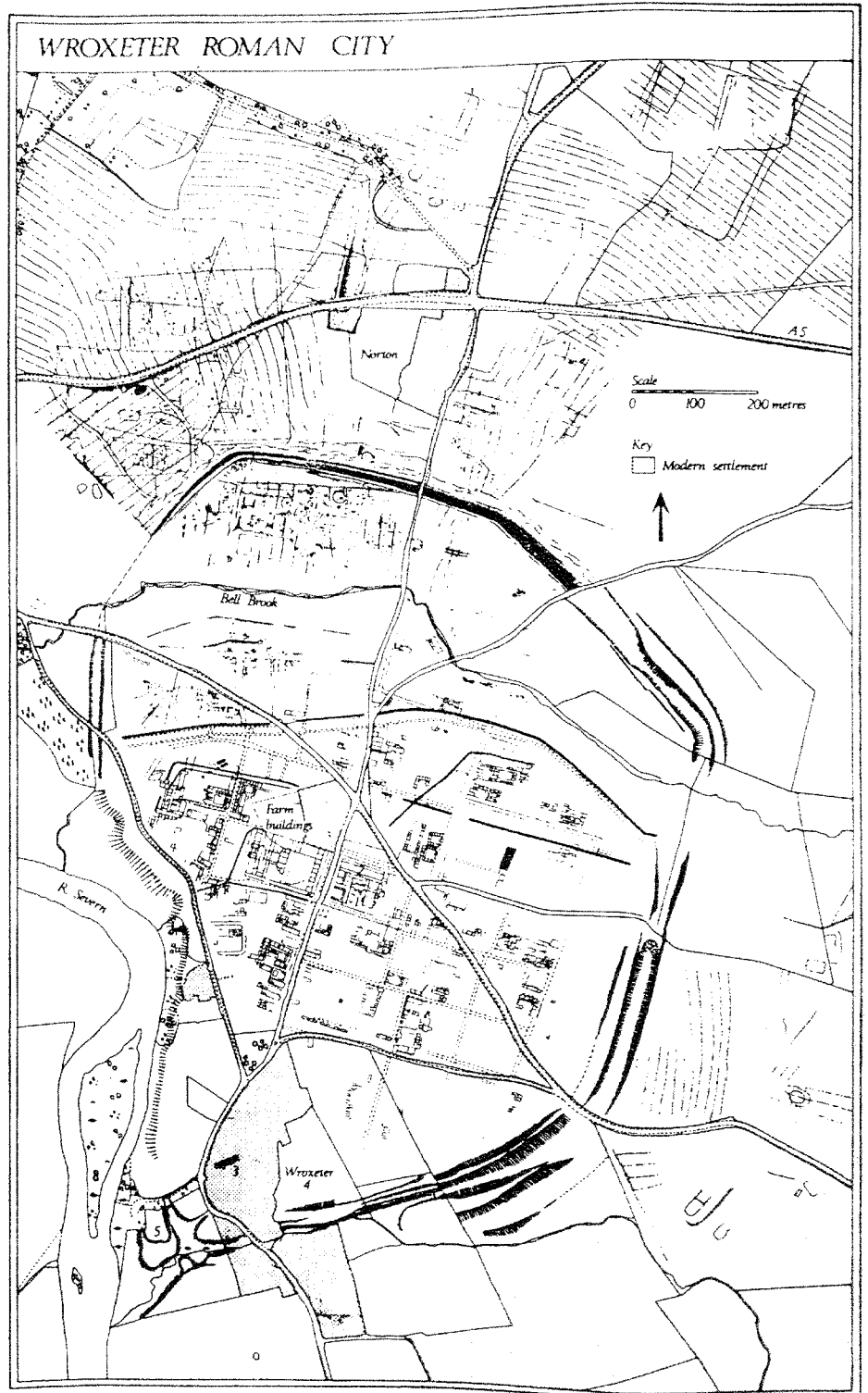


Figure 3. Topographic and archaeological features at Wroxeter, as mapped from air photographic evidence by D. Wilson (after Barker 1990: Fig. 3).

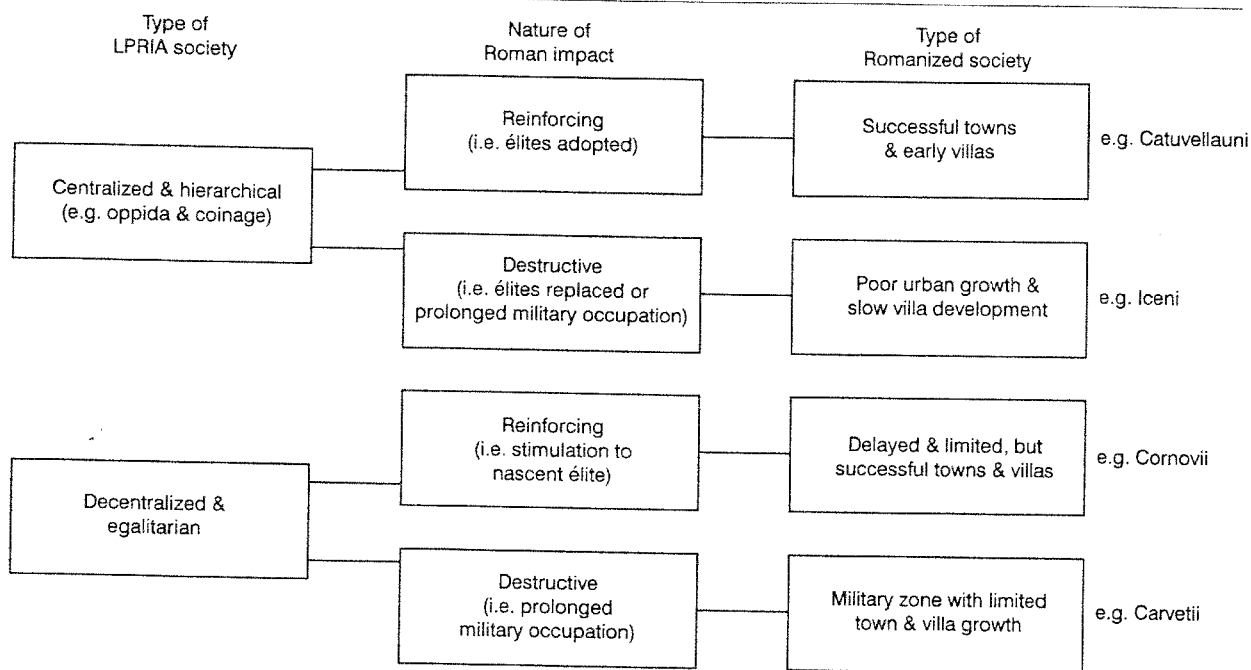


Table 1. Simplified model of Roman impact on native societies (after Millett 1990: Table 4.3).

The seeming lack of highly romanised buildings ('villas') in the hinterland and the contrast with the relative opulence of the urban area is a case in point. It seems reasonable to assume that the Roman urban elite was essentially a continuation of the existing Iron Age elite. However, where are the original settlements associated with such groups? Emerging evidence for LIA activity within the town area indicates that the primary conduit for social display and development even then was via the urban centre. What conditions both prompted and allowed such a development? The lack of similar change in the countryside is intriguing given that we must assume that agricultural productivity supported urban advancement. Will these contrasts permit us to isolate the pre-existing social relations that allowed one part of the community to invest in the town, apparently at the cost of other groups or, alternatively, are we seeing a 'resistance' to Roman culture by some indigenous groups? Or are we just being wrongfooted by the limited visibility of 'villa' structures in the current Shropshire landscape?

2.3.2 *Bias modelling*

Since both theoretically derived and data-driven models in archaeology are ultimately based on our knowledge of the archaeological record, keeping control over the quality of our basic data is of prime importance in the Wroxeter Hinterland Project. This control is achieved in two ways:

- by assessing and then compensating for biases in the text based and mapped data; and
- by providing independent mechanisms of control with which to test the validity and power of the models we develop.

The sources for our archaeological data — national and county records, previous studies and surveys — are of wildly varying quality. The archaeological record is 'filtered' by formation processes, visibility and reporting biases, and past and current recording practices. For example, enclosures identified from aerial photographs (largely undated but generally ascribed to the Iron Age on morphological grounds), give us high-quality mapped data, but at the same time we may be sure that differential visibility and recording are biasing the distribution of these data to such an extent that they cannot be used prima facie to build or test models on. By modelling the biasing factors (differential soil responses, geological processes, land use both past and present, accessibility) and using them to compensate for the bias, we hope to arrive at a more credible distribution map for these and other data.

To further assess the quality of our mapped archaeological data (acquired from both existing records and our own field work) we have instituted a programme of fieldwalking based around 3 transects centred on Wroxeter and cutting

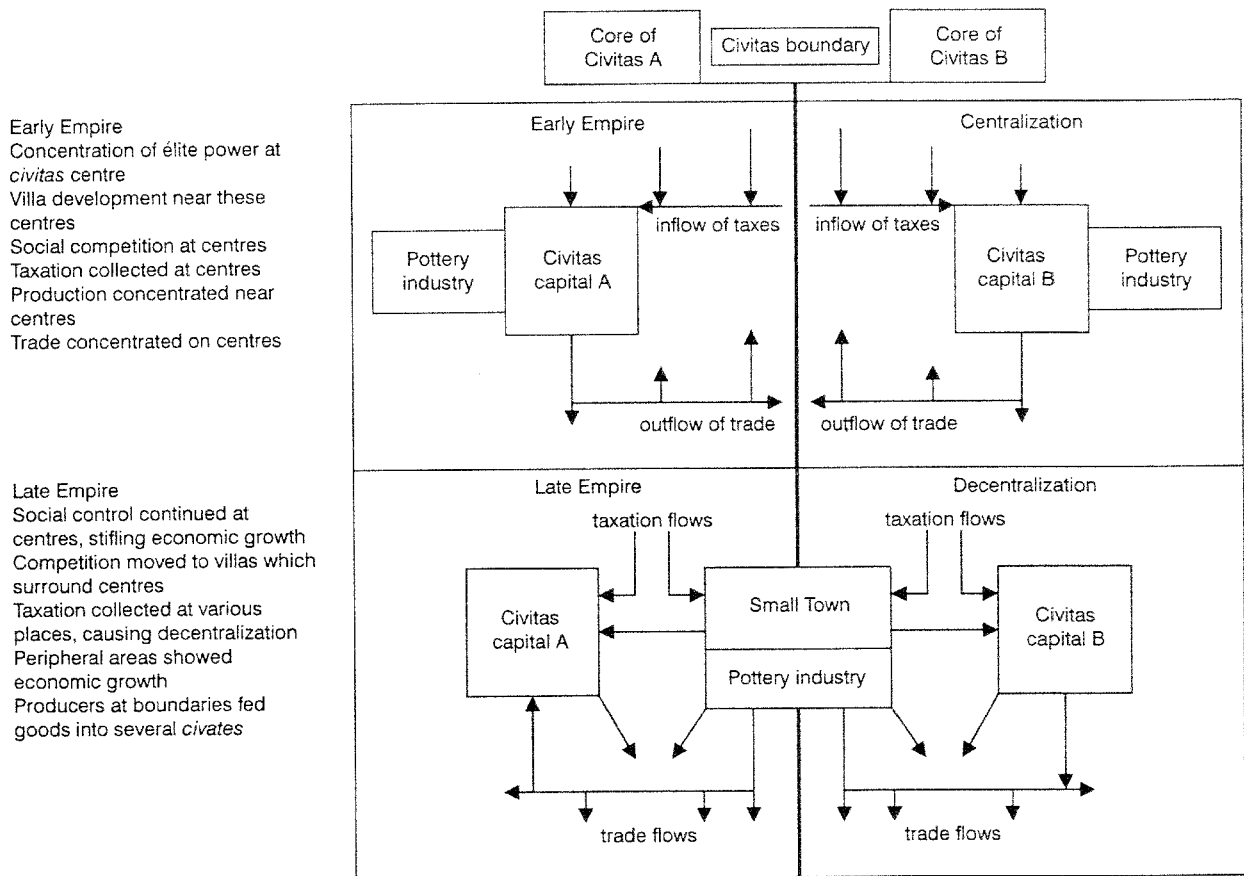


Table 2. Simplified model of the influence of taxation on settlement centralisation (after Millett 1990: Table 6.3).

across the study area's dominant topographic features (fig. 4). The choice of transect and orientation was dictated by the need to study the variation of activity (as opposed to simply settlement) with distance from the urban centre (Gaffney *et al.* 1985). Using a continuous grid retrieval system based on the UK national grid it will be possible to sample circa 10% of the transects' area. This should allow the team to study distance dependant site and non-site activity within the transects.

Equally, the mapped environmental data which is normally used in regional GIS models and which is largely based on the availability of printed map sheets of variables such as soil types, geology, hydrology and land use, suffers from a number of flaws including ignoring small-scale variation in the landscape, and employing cartographic conventions such as choroplethe mapping to represent data that vary continuously across the landscape. These biases we hope to compensate for by returning to the original field observations on which the maps were based, and constructing higher-quality maps from these.

### 2.3.3 Project management

GIS models will also be used to steer project development, for instance in determining our programme of test excavations of enclosures — the major archaeological feature in the area, about which little is known for certain. Several hundred enclosures exist in the project area, over one hundred of which have been classified on morphological grounds by Whimster (1989). We expect these features to reflect some of the upheaval caused by the advent of the Romans and the growth and eventual decline of Wroxeter, and will use GIS to study their distribution and to target specific enclosures for excavation.

### 2.4 SPATIAL ANALYSIS

One of the aims of the Wroxeter Hinterland Project is to provide a laboratory for research into non-invasive prospecting methods. In general, not much is known about the precise relations between non-invasive prospecting data, such as magnetometry, and the underlying archaeology, or

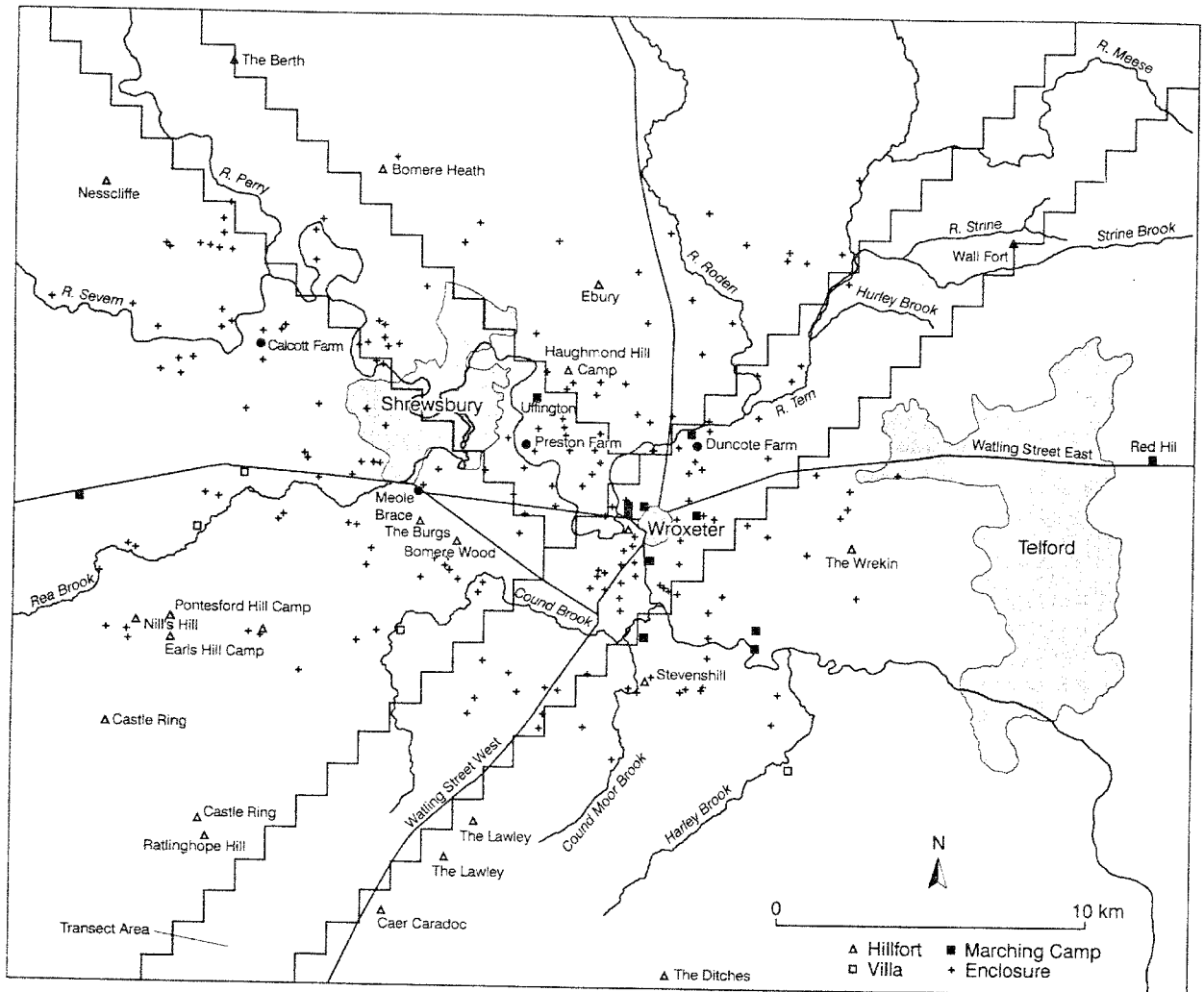


Figure 4. Field work and remote sensing transects for the Wroxeter Hinterland Project are used to collect control data across the main geological axis of the terrain (NE-SW) and along the Severn Valley (NW from Wroxeter).

about the relative contributions to archaeological knowledge of the plethora of non-invasive techniques that are currently available (David 1995). We intend to explore these questions in collaboration with Dr Kenneth Kvamme (currently at Boston University), by conducting extensive testing and multivariate analysis of techniques ranging from ground based resistivity, gradiometer, GPR and seismic to airborne photography, multispectral scanning, and thermal imaging. We expect multivariate analysis of properly georeferenced data to tell us how various techniques are correlated to each other, and how much information they contribute to the final picture. This should allow us to make

some practical decisions as to which technique will be the most efficient in the given circumstances.

### 3 Regional Archaeology and the Local Community

It is an unfortunate fact that, in Britain at least, it has become increasingly difficult to allow the close involvement of the local community in major archaeological research projects. Places for field work are generally taken by students that need the experience, and requirements of efficiency and planning have made it increasingly difficult to use volunteers for any but the most circumscribed

work. The Wroxeter Hinterland Project is changing that by stressing the importance of involving the local community, not only in field work, but also in finds and computer processing and generally assisting the research team. Since all its field work is funded by charities, it is remarkable that, one year into the project, we have over 200 volunteers working for us as field workers, map digitisers, office staff, geophysics teams, and even as a pilot. These people are mostly untrained but are very keen to learn, and it is possible to work with them throughout the year — not just when term time has ended.

We try to keep these volunteers up-to-date by issuing a bimonthly newsletter and by organising regular meetings and open days at which volunteers mix with project staff and each other. The success of this strategy leads us to think of extending volunteer involvement to conduct a full scale Parish Survey of the area, a huge task which would be impossible to contemplate with just two project staff available.

#### 4 Concluding remarks

The Wroxeter Hinterland Project is an ambitious undertaking and is unusual in a number of ways. It is attempting to study one of the more arcane, and hotly debated, social processes — Romanisation — using technological and

theoretical approaches in a manner never previously attempted. The project incorporates a complex group of data sources within a single 'critical' database, some of which have never been used in an archaeological context before, whilst others have rarely been integrated in such a comprehensive manner. Finally, the project, despite its highly technical and academic base, is being carried out with the explicit aim of encouraging public participation and aims to involve local communities at every level.

There is obvious risk in such an innovative approach, and we cannot expect to be fully successful on all counts, but preliminary results have been extremely promising and we hope to be able to confirm this at the 1996 CAA conference.

#### 5 Envoy

The project team maintain World Wide Web pages at <http://www.bham.ac.uk/BUFAU/Projects/WH/> which provide an up-to-date review of activities and a means of directly contacting the authors.

#### Acknowledgements

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## 15. Aspects of Romanization in the Wroxeter Hinterland

by R. H. White & P. M. van Leusen

### *Wroxeter's Paradox*

The common perception of Wroxeter is that it occupied an anomalous position as the fourth largest Roman town in Britain set within a landscape apparently practically devoid of any of the normal accoutrements of Romanized rural society (figure 1). This creates a paradox in that, in all other Roman towns, there seems to be a direct relationship between the size of a town and the degree of Romanization in its hinterland. Ray Laurence has recently highlighted this perception in his study of Pompeii, concluding that "we cannot divide the city from the countryside, nor the countryside from the city. They are both part of the Roman conceptual landscape." (1994:139). If this is so, then Wroxeter, apparently uniquely among Roman towns, seems to be a successful town within an unsuccessfully Romanized area. Archaeologists have developed a number of theories to deal with this apparent paradox. Some have envisaged a hostile rural population resistant to the idea of urban life (Richmond 1963); others have implied or asserted that the success of the town was more apparent than real, allowing them to invoke the *deus ex machina* of an over-ambitious Imperial foundation (Webster 1993); while others have stressed the apparent economic isolation of the territory prior to the conquest and the supposed relative economic underdevelopment of the town, despite its large size (Stanford 1991:95-8).

The Wroxeter Hinterland Project, a three year GIS-based research project specifically designed to test models relating to the Romanization of the heartland of Cornovian territory, is beginning to highlight that these theories have been based on low quality data, since so little systematic work has been done in the region. For example, comparison of the database of aerial photographs of the town centre to the recent geophysical surveys carried out within the town, under the aegis of the Wroxeter Hinterland Project, indicate that settlement was more dense than the photographic evidence would suggest (figure 2). Wroxeter was clearly much more successful than most archaeologists have suspected heretofore. Thus, without a systematically assembled and verified database of sites, analysis of the density and nature of the settlement in and around Wroxeter can only be partial, and at worst misleading.

The aim of this paper is to suggest that Wroxeter, like other Roman towns, was completely integrated with its landscape and, furthermore, concludes that the very success of Wroxeter indicates that previous estimations of the wealth of its hinterland have been grossly under-estimated.

### *Reconstructing the Iron Age Background*

In order to gauge the effect that the imposition of *Viroconium* had on the environment, it is essential



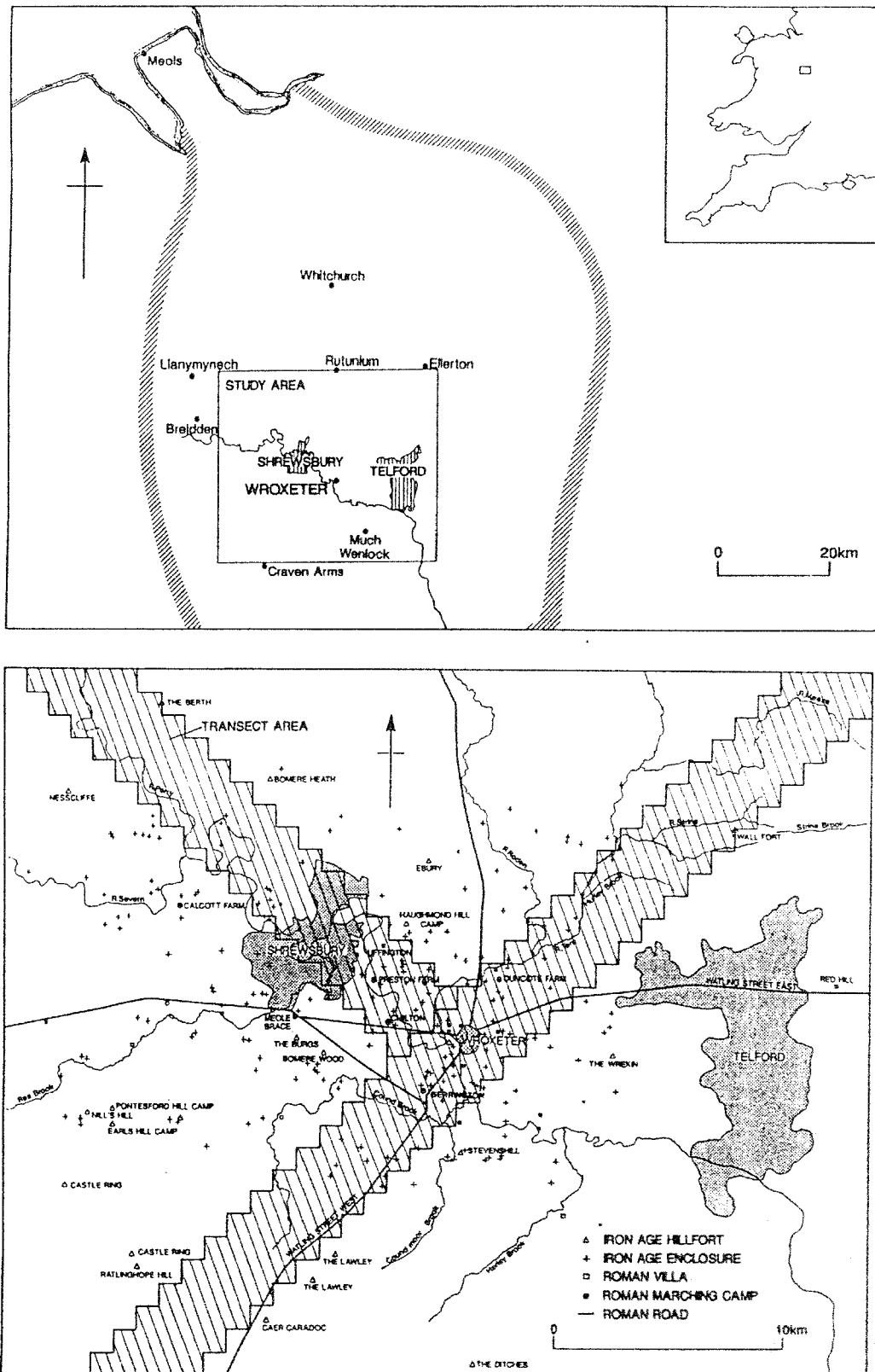


Figure 1. Location map of the Wroxeter Hinterland Project study area and key to the place-names mentioned in the text.



first to attempt a reconstruction of the existing prehistoric landscape. The Iron Age settlement pattern consisted of two main elements: hillforts and enclosures. The evidence from the Bromfield enclosure suggests that unenclosed settlement sites also existed, but these have only been detected through excavation (Stanford 1995:101–3). There are nineteen known hillforts within the study area and six of these have provided evidence for Iron Age and/or Roman occupation. They vary considerably in size, complexity and situation, suggesting that there was no single strategy for the exploitation of the territory. The hillforts at Baschurch and Wall Camp, for example, lie within marshland which must have determined an economic strategy based on exploitation of wildlife and, possibly, of livestock. In contrast, the economies of the Breidden and the Wrekin, with their easier access to arable resources, were presumably based on a mixed strategy of cereal production and livestock exploitation (Musson 1991:186–7; Stanford 1991:48–50). The profusion of hillforts within Cornovian territory generally has been interpreted as evidence that the Cornovii were cantonalised, with no overt progress towards centralisation before the Roman conquest (Davies 1996:694). The relationship of these hillforts with the enclosures, if in fact there was any, is still obscure.

Hundreds of enclosures have been identified through aerial archaeology within the Wroxeter hinterland. A recent analysis subdivided the enclosures on morphological grounds into three basic shapes: curvilinear, hybrid and rectilinear, with bi- and multi-vallate examples of each. In the same study, it is suggested that rectilinear enclosures cluster around Wroxeter and other Roman military sites and thus represent sites of the Roman period (Whimster 1989:35–47). This might lead one to conclude that curvilinear enclosures were Iron Age but excavation does not appear to support this; multi-period occupation has been detected on many sites of all morphologies. This would appear to rule out chronology as a determinant of morphology. What then does the shape of enclosures mean? Clearly, single interpretations are not likely to be adequate and an assessment of social, cultural and economic factors should be taken into consideration.

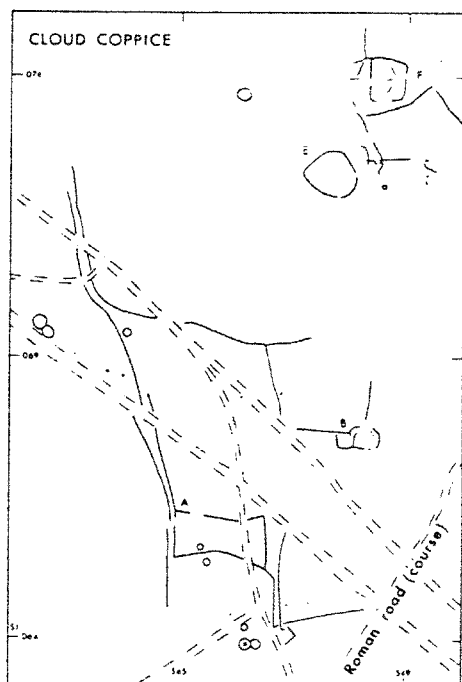


Figure 3. The Cross Houses-Berrington archaeological landscape, among others in the Wroxeter Hinterland, shows evidence of pre-Roman organisation, with the Roman road network cutting across a field system dated to the Iron Age (after Whimster 1989, figure 38).

On current excavated evidence, it would seem that multi-phase occupation is common on enclosed sites which would indicate that the landscape was probably heavily organised and settled before the conquest. Further evidence for this may be detected in the ancient landscape preserved at Cross Houses-Berrington which apparently shows a wide droveway with attached fields and enclosures (Whimster 1989:62–3; Watson & Musson 1993:49). This landscape is clearly cut by the Roman road leading from Wroxeter to Craven Arms, proving it to be of pre-Roman origin (figure 3). The relationship of the fields to an extensive Bronze Age cemetery in the same area is unclear, but it is likely that the cemetery is earlier (Gwilym Hughes pers. comm.). If this is so, it would indicate a move towards an organised landscape in this area during the Iron Age or perhaps the later Bronze Age, at a date consistent with similar processes in other areas of lowland Britain (Cunliffe 1991:531–6). Hints of further areas with a pre-Roman organised landscape have also been suggested around Wroxeter itself, which may indicate a developing centralisation of settlement there in the pre-Roman period (see below; Bassett 1990).

Thus, the evidence points towards a much more developed and stable landscape than is usually perceived for this area. Models of pre-Roman Cornovian society tend to suggest that it was generally impoverished and under-developed (Webster 1991; Stanford 1991). This perception no doubt arose from the lack of systematic archaeological work in the region and closer analysis of the evidence suggests a different interpretation. It is generally accepted that the Cornovii inhabited territory roughly equivalent to modern-day Shropshire and Cheshire, with the exact borders probably coinciding with the natural boundaries of rivers, such as the Mersey and Teme, or with watersheds, such as that between the Severn and Trent. In the Welsh foothills, the border is less certain, but given the large number of hillforts, it may well have been relatively unstable. This is a large cohesive block of territory, and one that is rich in both agricultural and mineral resources. Besides salt, which was exploited in the 'wich' towns of Cheshire and exported widely throughout the north-west and Wales (Morris 1985), mineral resources included lead and copper. (Although there is no positive evidence of these metals being exploited in the Iron Age, it seems unlikely that mines such as the copper mine at Llanymynech remained unexploited, sitting as it does within the ramparts of the hillfort.) In terms of agricultural resources, Shropshire and Cheshire are even today noted as being rich in pasture and, given the evidence for the establishment of co-axial field systems around Wroxeter and elsewhere, there is no reason why such lands could not have been exploited in the Iron Age and Roman periods.

The distributional pattern of known enclosures shows significant clusters within the river valleys, often with a low frequency of settlement in the surrounding areas. This might suggest that lowland settlement was confined to the valleys while large tracts of heavier soils remained unexploited. However, a recent intensive aerial survey of the Mersey, Dee and Weaver valleys in north Cheshire points to insensitive crop responses rather than a genuine dearth of settlement (Collens 1996); detailed analysis of the region around Wroxeter indicates that crop- and parch-marks can appear on a variety of soils, including stagnogleys, depending upon local conditions and topography (Whimster 1989:12–9). The blank areas may, therefore, be no more than areas which are resistant to showing crop-marks except in the most abnormal conditions. If the clay lands were in fact exploited, then the population and wealth of the Cornovii must have been considerably greater than evidence of their material possessions alone would imply. Given that the Cornovii had access to substantial natural resources, why is there so little apparent participation in typical late pre-Roman Iron Age trends such as increased trade with the continent, the centralisation of settlement, and the use of coinage?

*Continental trade:* It seems clear that the only direct access the Cornovii had to external markets was at Meols on the northern tip of the Wirral. The port was almost entirely washed away in the 19th century, but it is clear from isolated finds of billon coins of the *Coriosolites* that there was a strong Irish Sea trade there (Warhurst & Chitty 1977), although this may have been severely disrupted after the destruction of the *Venetii* and the re-direction of Roman trade to the south-east (Cunliffe 1991:434–42).

*Centralisation:* while there is no real evidence for general centralised lowland settlement, there are hints, albeit slight, that there was a trading point at Wroxeter suggesting the development of a central place (White 1993). The suggestion rests on a number of points:

1. The name *Viroconium* itself (the place of *Viricio*), suggests there was a settlement there before the Romans arrived.
2. Excavations beneath the *macellum* detected substantial ditches possibly relating to an enclosure (Webster 1988: figure 6.12\*).
3. Wroxeter's position as a natural trading point, in respect of both the river and trackways (Pannett 1989; Bassett 1990)
4. Dobunnic coins and a sherd of Arretine ware from within the area of the later town and other Iron Age metalwork from its immediate hinterland (White 1993).

In the wider context, the laying out of extensive field systems and the possible concentration of resources under the control of individuals may point to the first stages of the development of a centralised society.

*Use of coinage:* there is no evidence for any indigenous use of coin by the Cornovii but coins of the *Coriosolites* and of the *Dobunni* from Meols and Wroxeter respectively suggest that coins were used for trading purposes.

From the evidence above, it seems clear that the Cornovii had the resources to become a centralised society similar to the more developed late pre-Roman Iron Age societies seen further to the south and east, but this process had only just begun when the Romans arrived. The transition towards a centralised economy could have been impeded by the assumed confederate structure of the tribal society, but such a structure is unproven, the assumption being based only on the large number of hillforts in the area, many of which are undated. Other explanations may be more viable. In theory, centralisation could have taken place through the control of key resources, such as salt, copper and agricultural products by a number of individual petty chieftains. These chieftains could then have used their greater power to extend their territories and influence. Trade would have played an increasingly important role in this development since resources concentrated in such a way would have had to be marketed. Such trends would, however, be constrained by the poor access the Cornovii had to adequate trading facilities since their territory was substantially land-locked. The only port, at Meols, lay exposed at the very tip of the territory. Trade would have been possible along the Severn at least up to the area of Wroxeter, but imported trade goods brought along this route would have been under the control of the Dobunni who may well not have been inclined to allow many of the prestige imported goods out of their own territory. Substantial trade to the west is highly unlikely given the difficulties of access of that region, while to the east, there is little evidence of an established trade into the Midlands. The difficulty of moving goods into and out of the tribal territory may, therefore, be the principal reason why so little material wealth has been discovered in the area. The picture that is established is of a largely self-sufficient society which had little access to the outside world despite its hypothesised wealth. If this is the case then the wealth and surpluses created by Cornovian society must have been disposed of in other ways, such as conspicuous consumption at ritual feasts or through the construction of the numerous hillforts and enclosures known in the area.

### *The Foundation and Impact of Wroxeter*

Like any town, the civic population of Wroxeter, which may have been in the region of 5,000 – 8,000 at its high point, had to be fed, demanding that its immediate suburbs be devoted to market gardens such as those identified through excavation at Duncote farm (Ellis *et al* 1994:67–8). These would need high-quality soils and a field morphology of relatively small, perhaps gridded, fields. Less productive or seasonally flooded land might be given over to seasonal activities, such as tile-making or potting (Houghton 1961). Further out from the immediate area of the town, farms might be practising a more mixed agriculture in areas of poor quality soils, or for those on good quality land, such as the freely-draining alluvium, arable farming might predominate. Those wishing to take advantage of the town's market would have had to settle close to the roads or river *Sabrina* (Severn) so that produce could be easily transported. These farms would also have been able to participate in the redistribution of produce from Wroxeter to outlying trading settlements, such as Meole Brace, and to the possible markets or *mansio* sites at *Rutunium*, Red Hill (*Uxacona*) and Craven Arms.

### *Roman Settlement Pattern as Understood to Date.*

Three non-urban settlement forms are known around Wroxeter: enclosures, villas, and unenclosed roadside settlements.

As noted previously, the dating of enclosures in the Wroxeter hinterland is a particular problem since relatively few have been excavated. There is no apparent correlation between the morphology

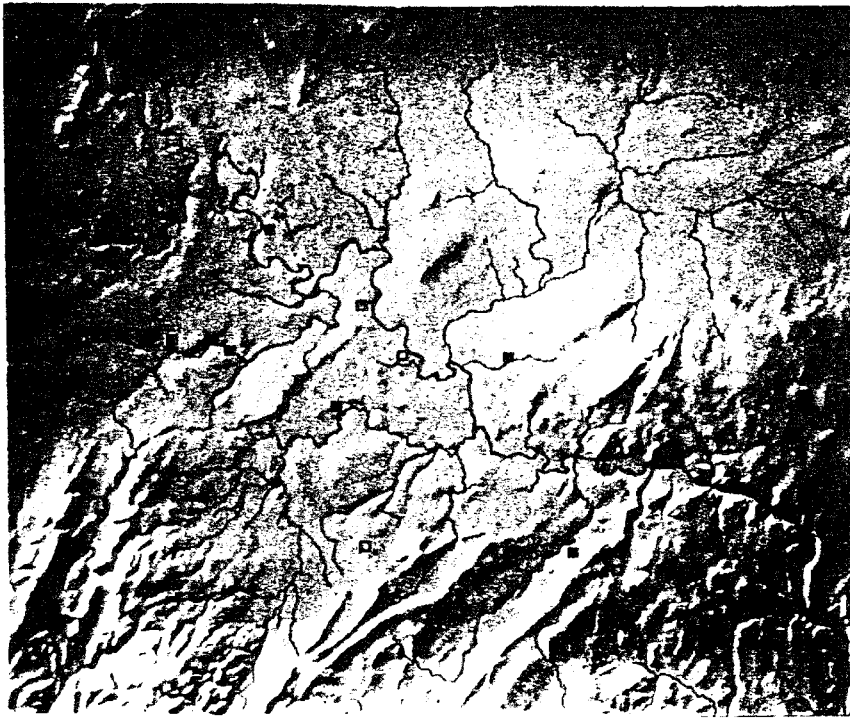


Figure 4. Distribution of villas in the Wroxeter Hinterland. Closed symbols: confirmed villa sites. Open symbols: unconfirmed villa sites.

of the enclosures and their date, and many that have been excavated show prehistoric as well as Roman occupation. This strongly suggests that there was no great dislocation of settlement after the conquest.

Villas appear to be notably absent from the archaeological record, but this may be more illusory than real. A significant cluster of three villas has been found spaced at approximately two mile intervals along the Rea Valley, south-west of Shrewsbury, while further work is showing that other examples may well exist in the Cound valley at Pitchford (Stanchester) and Conover. Two others are known in the Much Wenlock area at Yarchester and possibly at Much Wenlock itself. Isolated sites are also known south of Craven Arms at Acton Scott and Linley and it has been suggested that others lay at Rushbury and at Berwick, north of Shrewsbury. Further, there is an instance of an enclosure site which has also produced cropmark evidence for a contemporary or later villa (Ashford Carbonnel); while excavation on an enclosure at Chilton Farm, Atcham has produced evidence for a substantial Roman building. Interestingly, only one possible villa site is known in the immediate vicinity of Wroxeter (Hugh Hannaford pers comm). What is known of the distribution of the villas suggests they were focused along the courses of the tributaries of the Severn and the Roman road network, not clustered around the town (figure 4). This would suggest that villas were being established within the existing territorial organisation, strengthening further the hypothesis that there was little dislocation of settlement after the conquest. Where excavations have been carried out, the villas seem quite impoverished with few portable goods, although they are well furnished with mosaics (Yarchester) and substantial buildings (Whitley, Yarchester, Acton Scott), suggesting that they are fully Romanized establishments (Webster 1991:97–103). There is little evidence for great wealth and it is possible that these establishments were run by bailiffs for absentee landlords.

Only three unenclosed settlement sites are known, all of them apparently beginning within the Roman period. The first, on Heath Road, Whitchurch, is more properly understood as suburban ribbon development associated with the town of *Mediolanum* (Whitchurch) rather than as an independent settlement. Another, at Meole Brace, was an unenclosed roadside settlement which has been interpreted as a secondary market for the re-distribution of goods from Wroxeter (Ellis *et al* 1994:52–5) while the third settlement is an unverified site at Ellerton on the Shropshire/Staffordshire border. These sites presumably show the penetration of a full market economy into the rural hinterland but the extent of their influence beyond the road system may well have been negligible.

### *Moving Towards a Synthesis*

There is no doubt that the conquest of Cornovian territory in the late 40s AD had a profound impact on tribal society. There are some signs of resistance (White & Webster 1994) but the conquest may have been largely peaceful and swift, suggesting a degree of co-operation from the tribe, probably including the elite. In the initial stages some land, such as the settlement of *Viricio*, will have been seized by the military authorities for their numerous forts and fortresses (Webster 1988; Welfare & Swan 1995) and it may be that the displaced hillfort populations would have settled around the more permanent of these establishments, as Webster has suggested (1991:47–8). It is certainly true that there was a huge increase in the import of manufactured goods of all kinds into the area which, although largely for the benefit of the troops, would also have been used by the indigenous population.

With the establishment of *Viroconium*, there was an undoubted boost to the level of Romanization, reflected in the construction of impressive public buildings in the centre of extensive defences

enclosing sixty-four hectares. Recent geophysical surveys have indicated that within the town, there was a dense pattern of buildings and streets indicative of fully developed urban life (Gaffney *et al.* forthcoming; van Leusen forthcoming). Considerable quantities of imported and locally-produced goods recovered from excavations within the urban core are unequivocal about the scale of Romanization witnessed at Wroxeter. This strongly suggests that the tribal elite took on the trappings of Romanization with enthusiasm, as did substantial elements of the population. This being so, it is reasonable to conclude that the surrounding *territorium* which supported the town should have been densely settled and tied in with the Romanized economy. Current interpretations suggest, however, that rural development was stunted. Hypothetically, it should be possible to detect the degree of acculturation around Wroxeter by studying artefacts associated with the settlement sites in the hinterland. For example, the density of some material should correlate with the intensity of agricultural activity in the area.

The Wroxeter Hinterland Project is specifically designed to test such hypotheses through GIS analysis of existing, as well as newly-created, databases, and a number of specific hypotheses have been put forward for investigation in the initial analysis:

1. Settlement around Wroxeter will be distance-related since the inhabitants of the hinterland would have an interest in marketing their produce either at Wroxeter or at their nearest market. This relation would be modified to some extent by factors such as the position of the settlements, the nature of their produce, and their ease of access to the town. Any models of this kind must therefore take into account transport via the roads and river systems.
2. Cornovian settlement sites may well be materially impoverished since the Iron Age pattern suggests a degree of resistance to the acquisition of traded goods. This was presumably overcome to some extent during the Roman period as the sheer quantity of material available saturated the markets, as the trading settlements such as those at Meole Brace and outside Whitchurch indicate. It should be possible to establish the existence of resistance by determining whether those sites with ease of access to the primary or secondary markets did or did not avail themselves of the opportunities to acquire material possessions. This could perhaps be reflected through high status materials such as samian ware or mortaria in rural settlements.
3. Although settlement in the Wroxeter hinterland may have been extensive, the visibility of any one particular site through surface collection and excavation will be dependent on the agricultural regime practiced there. If, as seems likely for the heavier glacial soils, agriculture was predominantly pastoral, manuring spreads will not have been incorporated into the landscape to the extent that may be expected elsewhere. Certainly, the excavated bone remains at Wroxeter indicate an important industry in the processing of cattle carcasses and its subsidiary industries. On the poorer soils, there may have been a reliance on sheep ranching to produce wool and other by-products. Both trades were important in Shropshire in the medieval and post-medieval periods. Nonetheless, there must still have been extensive areas of arable land around Wroxeter as carbonised cereals, including high quality bread wheats, oats and rye, have been located in excavation. Such areas should be detectable through artefact scatters produced by the normal manuring processes. Mapping manuring scatters, identified through sherd size and abrasion, against specific soils should clarify whether prime arable land was being used for pasture or not. It should also be possible to examine known enclosures in such areas for droveways or other diagnostic features to try to determine what the enclosures were used for.



4. The development of specialisation in pastoral activities throughout Cornovian territory may have been encouraged by the presence of permanent military establishments such as the legionary base at Chester and the smaller forts at Leominster, Whitchurch and Walltown. The troops posted here would have required substantial and regular quantities of foodstuffs, cloth and leather. Some of these food stuffs may have come from the territories of tribes bordering the Cornovii, but it is likely that the Cornovii were expected to provide the bulk of this material. The guaranteed market that this would have provided may well have acted as an important stimulus in the intensification of Cornovian agriculture along pastoral lines. If this interpretation is correct, analysis of the results of hypothesis 3 might well indicate areas of land suitable for arable use which were devoted to pastoral agriculture instead.

5. The pre-Roman landscape was apparently already extensively settled and developed. GIS analysis of field systems surviving as cropmarks will be tested against known elements of the Roman landscape to determine the degree and location of this organisation, and will attempt to detect changes to the landscape in the Roman period. These changes to the organisation of field systems should be particularly marked within the vicinity of the town where market gardening activities should predominate (cf. Duncote Farm).

With over one year of the project still to run, it is too early to reach substantive conclusions about the process and degree of Romanization in Wroxeter's hinterland. What is becoming clearer, however, is that it is only through the substantial increase in new data generated by the project, allied with the manipulation of existing data sets using GIS technology, that further progress will be made towards understanding the transformation of Cornovian society brought about by Wroxeter's creation.

#### *End note*

\* The possible enclosure is labelled as 'pre-Legionary features' on figure 6.12. The evidence has not been fully presented in print but will appear in Webster, forthcoming.

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# DEALING WITH RECENT POST-DEPOSITIONAL AND RESEARCH BIASES IN ARCHAEOLOGICAL LANDSCAPES\*

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## 1 INTRODUCTION

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This chapter builds on a previous publication on bias modelling (Van Leusen 1996) and is about recent post-depositional and research biases in the kind of data that form the basis for archaeological landscape reconstruction and settlement history – site-based data coming from desktop study and older surveys, and land parcel-based data coming from modern surveys. Recent post-depositional biases are nearly exclusively related to human changes to the landscape and its use; research biases are those biases that have occurred in the past, and still occur, during the construction of the archaeological record; I specifically exclude biases occurring during the formation process.

My main point is that recent post-depositional and research biases can not only obscure, but also create patterns in the archaeological record. This has two consequences: firstly, if significant biases in the data we work with are not dealt with, then our reconstructions based on those data will be significantly flawed; secondly, comparison of the archaeological records of the three RPC study regions is predicated on the assumption that such records are, or can be made, comparable.

### 1.1 AIMS & DEFINITIONS

When archaeologists collect data, they nearly always do so non-randomly. In many cases this is intentional, but it also happens under circumstances where the archaeologist is unaware of, or underestimates, the selectiveness of his or her sample. Even in modern field surveys, where the data collection method is intended to give the archaeologist a representative and un-biased sample of the archaeological material present on the surface, biases introduced by differences in land use, survey conditions, collection methods, and differences between the individuals taking part in the survey may conspire to create a highly non-representative data sample instead. My aim in this article is to outline

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\* Much work on this article was done while I was working with the Wroxeter Hinterland Project at the Birmingham (UK) University Field Archaeology Unit. My thanks go to Vince Gaffney, for allowing me to develop my interest in GIS-implemented bias modeling, and to Roger White and his volunteers for providing me with some of the most systematically collected survey data imaginable. Similar thanks should go to the surveyors – too numerous to mention here – for the various RPC project campaigns in south-central Italy, and to Peter Attema, for sharing forthcoming survey data. Luke Dalla Bona's kind invitation to attend his Ontario workshop on predictive modelling in spring 1997 provided a second and very welcome push to work on the problem of biases; and as always, members of the GISARCH discussion list were extremely helpful with their comments on various draft versions.

approaches toward dealing with the significant research biases which do occur in our data sets, and to substantiate this with several case studies.

The study of processes transforming the archaeological record is a natural consequence of the theoretical stance of the New Archaeology. Originally, interest centred on depositional and taphonomic processes because these provided the link between archaeological assemblages and their anthropological/ethnographic parallels. As processual archaeology took hold in the later 1970s, a more general interest in formation processes emerged because it was hoped that if these could be modelled in sufficient detail, the 'original' record might be reconstructed ('behavioral archaeology'; Schiffer 1976). This extreme processualist stance led to the emergence of the post-processual movement in the early 1980s.

Unfortunately the latter movement has given rise to a general rejection of 'rule-finding' approaches in archaeology, thus throwing away the baby with the bath water. This has been particularly clear in current criticism of GIS-based landscape studies as being 'environmentally deterministic' (see discussion in Gaffney & Van Leusen 1995). In view of this, I should stress that this article is not about the modeling of past or current taphonomic processes, but rather about past and current research processes - that is, the processes by which we study the archaeological record<sup>1</sup>. These have long been recognised as a separate set of distorting processes (eg, Daniels 1972:202) but have had most of their impact north of the Mediterranean region (see esp. Hamond 1978, 1980).

A subsidiary point I should make here is that biases operate at all spatial and temporal scales and resolutions, but that different biases may become significant at different scales and resolutions. For example, although land use and pedological conditions for the fields surveyed in the WHP were relatively uniform, the distribution of these conditions within the larger WHP survey transect and 30 by 40 km study area was decidedly non-random (Van Leusen & Gaffney 1996:303); good examples of the occurrence of biases at larger scales (smaller distances) are provided by the RPC surveys: historic earth movement in the Fogliano area, and the ploughing-up of pebbles from underlying conglomerates in the Francavilla area. I will refer to the issue of scale and resolution throughout this article, especially during the discussion of GIS-based landscape modeling.

In the remaining part of this introductory section, I will review the background and history of the treatment of biases in Mediterranean landscape archaeology (concentrating on Italy), in general methodological studies, and in GIS-based landscape studies. I will then briefly introduce the concept of bias modelling, which will be treated in detail in section 2. This will be followed by a concluding discussion (section 3) which also serves to establish a context for the case studies. These were conducted to demonstrate, firstly, the relevance of bias factors to the interpretation of survey data and of landscape archaeological data in general; and secondly, approaches to the inclusion of bias factors in geographic models of archaeological landscapes. The first of the case studies addresses biases occurring at a regional or supra-regional scale where, usually, 'sites' are the analytical unit, concentrating on the effects of differential land use / land cover history in the hinterland of the Roman *civitas* capital at Wroxeter (Shropshire, England). The second case study addresses research biases occurring at a local or regional scale where land parcels are the analytical unit, and concentrates on visibility-related biases in RPC project surveys in central and south Italy. The third case study again concerns the history of land use, this time in the context of 20<sup>th</sup> century land improvement of the Fogliano area of the Pontine region (chapter 17, published as Feiken & Van Leusen 2001).

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<sup>1</sup> I prefer this to the alternative name 'discovery processes' which stresses accidental effects.

## 1.2 HISTORY & TREATMENT OF BIASES IN MEDITERRANEAN LANDSCAPE ARCHAEOLOGY

### RESEARCH TRADITIONS

The treatment of biases is intimately tied up with more general traditions of archaeological research. Terrenato (1996) began his discussion of landscape archaeology in the Italian regions of Etruria and Umbria by remarking that ‘it did not succeed in standardising itself in the period 1960 – 1980’ (nor later; see also Cambi & Terrenato 1994), and that, in order to compare the settlement histories of these regions, we must first understand what methods were used in each. He defined two methodological traditions: the *Forma Italiae* approach originating in the early 20<sup>th</sup> century (including such non mapsheet-based projects as the South Etruria Survey), and the systematic sampling designs using transects that began in the late 1970s (such as the Ager Cosanus, Ager Tarraconensis, and Agro Pontino projects; Terrenato 1996:217-220). The latter all shared one important design trait - their stratified sampling designs were a-spatial, in the sense that they aimed to answer questions about properties of the sampled population as a whole, rather than to record spatial variables. Their aim was to establish differences and similarities between the strata which could be interpreted as differential use of landscape units (see Orton 2000 for a detailed review of methodology). In the late 1980s it became clear that neither approach produced satisfactory results<sup>2</sup>, as ongoing research began to show that vegetation cover and recent geopedological phenomena played an important role in the process of finding sites in Central Italy (e.g., Malone & Stoddart 1994:5).

In the early 1980s the general recognition of the existence and importance of biases led to a phase of experimentation (continuing at a slower pace today) aimed at determining the precise effect of the biases. An important publication because of its effect on survey work carried out by Dutch teams in Italy was Shennans East Hampshire study, which aimed to solve “many problems concerning the significance of information derived from surface survey”, in particular observer effects, differential visibility effects, and the effects of sub-recent landuse (Shennan 1985:2).

From the early 1990s onwards British and Dutch archaeologists in Italy also began to record off-site densities (for example, in the Pontine Region, Gubbio Basin, and Rieti projects) while Italians stuck to the site-based approach developed for the *Forma Italiae* series. The increasing research intensity required by off-site approaches, with its emphasis on high resolution data collection and quantification based on land parcels, has forced many researchers to recognise the importance of coming to terms with biases in the archaeological record. This point was reiterated recently in the influential (but sadly delayed) POPULUS project edited volume on ploughsoil assemblages (Francovich & Patterson 2000). It was recognised at the time (circa 1995) that a practical standardised approach to bias correction would have to be developed (Millett 2000:92-4). On the other hand, the category of ‘site’ remains a mainstay of archaeological interpretation in both research traditions, allowing the issue of bias to be ignored to a greater or lesser extent. Since both of the research traditions mentioned above have contributed data to modern GIS-based regional archaeological records created for landscape approaches to archaeological analysis and interpretation, the challenge now is to conceive of approaches which will be able to deal with biases in wide area, site-based data as well as in local area, parcel-based data.

### GIS-BASED ANALYSIS OF ARCHAEOLOGICAL LANDSCAPES

The emergence, in the early 1990s, of GIS as data management and analytical tools in landscape archaeology has had a marked influence on both data collection and analytical methods, including those that have a bearing on biases. The need to collect and standardise data on a regional basis has highlighted gaps, biases, errors and uncertainties. Not surprisingly, low archaeological data quality has been widely identified as a fundamental problem for the application of cartographic modelling techniques in archaeology. Solutions have been sought in two directions: firstly, to accept low data quality and find a

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<sup>2</sup> Most of these projects still await full publication.

lowest common denominator in point-based archaeological site records; and secondly, to study ways in which data quality can be improved.

Published cartographic models of archaeological landscapes (including my own) have, without exception, been based on point-based records rather than parcel-based distribution maps. However, as I have argued elsewhere (Van Leusen 1996) the set of point observations ('sites') resulting from a typical desktop-based survey of an archaeological landscape is equally, though differently, biased by the non-random effects of recent post-depositional research processes. This point will be substantiated in a case study on biases caused by land use, land cover, and research methods in the Wroxeter Hinterland. GIS analyses of point-based archaeological records have also suffered from two deficiencies which have prevented them from dealing adequately with biases, namely the absence of 'non-site' observations, and the fact that cartographic models cannot be tested with the aid of independent control samples. The absence of 'non-site' observations means that the landscape characteristics of sites cannot be compared to those of non-sites; the lack of independent control samples means that we cannot test cartographic models for biases in our input data.

In order to explain why these two are of such great significance when it comes to avoiding biases, I must briefly digress to explain some principles of locational (location-allocation) modelling in archaeology. Archaeological locational modeling in GIS is the modeling of the probability of the presence of archaeological site locations based on the properties of each topological unit (polygon, cell) in the study area; or in other words, the prediction of the chances of finding a site in any particular location on the basis of models of the ancient landscape. Many such applications have derived landscape 'predictors' by studying the known record of archaeological sites and by assuming that this input (the 'test sample') is more or less representative of all archaeological sites (the 'population'). Exactly what that 'population' is, almost always remains undefined, but it is implicitly assumed to be either a) original distributions of archaeological sites, b) distributions of sites modified through taphonomic processes, or c) distributions of sites modified by both taphonomic and discovery processes (Hamond 1980, Orton 2000).

In order to find which landscape characteristics are predictive of site location, and which are not, a statistical analysis of site characteristics is performed. However, most such methods require that 'site' characteristics be tested against 'non-site' characteristics, that is, the test sample should include data about site absence as well as site presence. But records of such negative observations were never kept, and thus the preconditions for such statistical tests cannot be met. To get around this, it has been argued that random observations, given the scarcity of sites, are likely to be non-site observations; and therefore a set of such random observations may be used as a stand-in for the missing non-site records. This method implicitly assumes that the intensity of research has not varied across the study area, but we know in fact that this is not true – both the quality and the intensity of research display huge variations as soon as the scale of the study area transcends that of a single project! Thus, the absence of 'non-site' observations in regional archaeological records is one cause of the tendency to ignore spatial variation in taphonomic and discovery processes as a factor in archaeological landscape analysis.

A second way lies in the manner in which models are tested. There are two criteria by which to measure the quality of any prediction: specificity (yield) and accuracy. Models with a low specificity are uninteresting; models with a low accuracy are wrong. The specificity of an archaeological locational model is usually expressed as the ratio of the percentage of input sites and the percentage of total study area. For example: if the model can describe 75% of its input sites by characteristics occurring in only 10% of the landscape, its yield is said to be 75/10 or 7.5. Once a model has been made, its specificity can be calculated; but its accuracy can only be assessed by testing the model - applying it to a set of independent observations which were not used to construct the model in the first place. Because such independent observations cannot be collected in a reasonable amount of time and money by doing new fieldwork, this 'control sample' nearly always derives from the same data set of known archaeological sites from which the test sample was taken. Since, *ipso facto*, it has been subject to the same biases as the test sample of sites, it cannot be used to remove those biases. Therefore, the typical locational 'predictive' model is in fact only a *descriptive* model, and what it describes are the characteristics of the *known* archaeological sites.

The second major approach to problems with archaeological data quality in landscape studies has been to improve matters either by collecting 'better' data or by correcting existing data. Both approaches entail greater attention to the understanding, recording and correction or avoidance of post-depositional and research biases, usually within the context of intensive 'non-site' or 'off-site' surveys. In contrast to the site-based analyses discussed above, GIS has been applied to the spatially continuous distributions of archaeological data collected in such surveys at a much more local scale (usually not more than a few square km). Since most of these studies – among them the analyses of the WHP- and RPC project surveys - are not yet published, there has not yet been a thoroughgoing discussion of approaches to dealing with biases in such data. The recent publication of Bintliff's reanalysis of the Boeotia survey data and the discussion that followed in the pages of the *Journal of Mediterranean Archaeology* (Bintliff et al 1999; Bintliff & Howard 2000; *JMA* 13) may be regarded as the opening shots in this debate. GIS in general are eminently suited for the management and analysis of archaeological data collected in the form of quantitative measurements per land parcel, but the higher spatial resolution required by modern intensive surveys does present the problem that increasingly low densities of artifact are being recorded, which have a lower diversity, a lower diagnosticity, and are relatively more sensitive to stochastic effects.

The increased emphasis on high resolution quantitative processing has led researchers to devise increasingly formalised and standardised methods for collecting and recording survey data. To avoid slowing down the fieldwork too much, these processes are now being automated through the use of digital field equipment. The potential of portable GPS attached to handheld field computers in particular is now being explored, and recent experiments suggest that future surveys will operate new, powerful and versatile navigation, recording and communication tools which are likely to replace all paper-based recording practises (Van Leusen & Ryan forthcoming, see chapter 7). The gain may be put to good use for increased attention to biases and methods for dealing with them.

#### TYPES OF BIASES

As indicated in section 1.1, I define biases not as distortions of some idealised archaeological record, but distortions in the way we go about obtaining knowledge about that record, and in that sense all biases are 'research' biases. The point I wish to make in the current section is, that research biases can (and do) occur at any stage from the definition of research aims through the design and execution of the fieldwork, and into the analytical and interpretative stages. In order to limit confusion in what follows, I will distinguish the following bias types occurring during these research stages: Conceptual bias, Visibility bias, and Observer bias.

*Conceptual* biases are biases caused by the classification of data under preconceived concepts. These play an important role at all scales and stages of archaeological enquiry and include the tendency to study only some geographical, typological, and chronological parts of the available archaeological record.

Paraphrasing the quote made famous by Cherry, Mediterranean archaeologists have been like frogs around a pond, with very little study taking place in inland and highland areas. Until very recently archaeological interest in southern Italy for example, was mainly targeted at the Hellenistic colonies there. Following Livy (XXV: I, 1), indigenous settlement was regarded as uninteresting. A comprehensive and systematic overview of indigenous settlement in southern Italy was therefore unavailable until recently, when the University of Lecce began building a regional archaeological site database containing settlements from the 9<sup>th</sup> (EIA) to the 3<sup>rd</sup> century BC. This highlighted both the previously ignored presence of a dense network of indigenous settlements contemporary to the Hellenistic colonies, and that of major geographical hiatuses in research, for example in central Puglia and Basilicata (D'Andria 1999). It also highlighted the typological concentration of research (especially for the Archaic, Classical, and Hellenistic period) onto necropoleis, wall circuits, and cult places. Similar conceptual biases occur at the local scale as well – in the 'judgmental' choice of the study area for example, based on landscape physiography and on the character of the known archaeological record. Many surveys are targeted at exploring the 'catchment' of some known highly monumental site – a town, hillfort, or large villa – and therefore the results of such surveys are biased in favour of central places and inadvertently stress the role of settlement continuity and hierarchisation in the landscape.

Another form of conceptual bias occurs during classification – the process of sorting our observations into sets of mutually exclusive classes both in the field and during finds processing. Among the most important high-level classes we use in the field are those of ‘site’ and ‘non-site’. An extensive literature exists on the theory of the siteless survey and why we should not employ the concept of ‘site’ in the field (Dunnell & Dancey 1983; Ebert 1992); in a very practical sense the continued definition of ‘sites’ in the field (as opposed to during the interpretation) may cause more problems than it solves. If we increase the ‘intensity’ of our survey once we have defined a ‘site’, not only does the density (numbers per unit area) of our samples increase, but so does their diversity (number of distinct material categories). Whereas the quantitative effect has been noted by many survey practitioners in the past, the more subtle effect on diversity has escaped general notice. For example, Small (1998:349) noted that the most significant concentrations of paleolithic flint in his Basentello surveys occur at ‘gridded’ sites, where the likelihood of recovery would be much higher; he did not note whether the diversity of flint types within those concentrations increased as well. It is to be hoped that the recent publication of re-analyses of the Boeotia survey data will kindle more interest in the subject (Gillings & Sbonias 1999:45; Bintliff & Howard 2000; see also below in section 2.1).

A second important set of conceptual biases comes into play during the collection, recording, and processing of individual finds. The distinction of ‘diagnostic’ and ‘indeterminate’ finds gives rise to a tendency to concentrate collection and recording practises on those parts of the surface archaeological record which are amenable to functional or chronological interpretation. Many past and current survey methodologies have relied to a greater or lesser extent on the walkers’ selection, and the ceramicists’ subsequent preferential processing, of ‘diagnostic’ sherds. Besides the admittedly practical reasons – a wish to limit the volume of finds to be processed – even the value of collecting non-diagnostic types of material is sometimes doubted. Thus Yntema, in his introduction to the diagnostic pottery types of the Brindisi area, writes “A field survey with a very limited quantity of diagnostic wares or without expert knowledge of regionally current ceramics of the periods on which the survey centres offers no sound basis for regional studies and is to be considered a waste of time and money” (Yntema 1993:29).

In the RPC survey areas in central and southern Italy the concentration on diagnostic wares and forms leads to biases in favour of the better preserved and better studied pottery types, which are chronologically tied to dated sequences outside the regions themselves (sometimes even outside Italy). This introduces the further danger of assigning too strict a dating range to particular types of ceramics (see Bintliff & Howard 2000). In this, survey ceramic specialists are perforce dependent on similar practises in excavation. Malone and Stoddart (2000:95-6) note that the tendency to date excavated features from lower frequency diagnostic elements (which are rare in surface deposits) is especially marked in the later prehistoric metal producing periods. Since the progressive degradation of prehistoric pottery leads to a relative dearth of diagnostic sherds anyway (Malone & Stoddart 2000: fig 11.1), and the recognisability of ceramics varies wildly over time with low recognisability occurring at phases of important reorganisation within societies (Malone & Stoddart 2000: fig 11.2), our reliance on diagnostic material indeed introduces strong biases.

All non-total collection strategies seem to me to contain built-in conceptual biases of this type because they require the field team, or even the individual walker, to make decisions about which finds are ‘diagnostic’ and ‘indeterminate’. Under typical survey conditions, not even a team consisting of period specialists could reliably make such decisions.

*Visibility* biases are research biases caused by regional and local variations in the visibility of the archaeological record. The term ‘visibility’ has been used to describe a number of things, but in the current context I will equate it to the *retrieval rate* – the probability that an artefact lying within a walker’s transect will be recorded. On the widest scales this type of bias is obviously mediated by land use and land cover, which circumscribe the outcomes of different types of regional research. Examples of this are the peculiar sets of sites generated by aerial reconnaissance in the Wroxeter Hinterland (LULC bias, see chapter 14) and by ‘topographic’ surveying in the Pontine Region, Etruria, and more generally in the Mediterranean (see chapter 13). On the scale of an individual survey, visibility bias is mediated by local variations in a large number of factors, of which traditionally the amount of vegetation covering the



soil surface has been seen as the most important one. As I will argue in more detail below, this is a simplistic view and the understanding of local visibility biases will require much more research effort.

*Observer* biases, as distinct from visibility biases, are concerned with the ability of the observer to record information which is available in principle. Again, examples can be adduced for both the regional and the local scale of enquiry. In taking aerial photographs, and again in mapping from aerial photography, researchers have consistently selected interpretable shapes such as circles, squares, and linear features. In surveys, many observers have noted the different abilities of individual walkers to ‘see’ different artefact types such as flint, but opinions differ as to how significant such biases are. My own opinion, which I feel confident would be backed-up by a survey of the relevant psychometric literature, is that the differences between observers are much larger than most students of the problem realise, and extend to such areas as general ability to recognise shapes and colours, and to concentrate for any length of time.

Besides individual differences, there are also generalised observer effects for which many examples can be adduced from the RPC surveys. The height of the observer is one such effect: the closer one comes to the surface, the more detail (including finds) one sees. ‘Hands and knees’ inspection of limited areas yields finds where normal upright survey does not; it follows that small people (all other things being equal) will find more stuff than tall people. Another effect is distraction, where one or more finds categories may become ‘invisible’ because the eye is distracted by more prominent features of the soil surface. For example, even though prehistoric ceramics may have lain on the surface in parts of the SIBA2000 survey, the presence of overwhelming numbers of similar-coloured and –shaped fragments of ploughed-up conglomerate rock made it impossible to pick up and inspect many fragments in detail; in other survey areas a similar role may be played by large numbers of more ‘attractive’ Hellenistic/Roman or recent ceramics.

Observer biases are treated here as a separate category despite their links with both conceptual and visibility biases, because they highlight weaknesses in one particular link in the whole research process – our ability to make reliable observations – which has been largely ignored so far. It is precisely in high intensity surveys of off-site areas that even minor observer biases can have major consequences on results and, eventually, interpretations.

Summarising all of the above, archaeological research can be biased by conceptual, visibility, and observer biases. Some of these we cannot avoid; others we may not even wish to avoid. But we must study these biases if we want to be aware of the systematic distortions they create in our archaeological record; and if the distortions can be quantified we can attempt to correct for them (see section 2).

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## 2      **BIAS MODELLING**

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Bias modelling is the cartographic modelling, usually with the help of a GIS, of the presence and value of factors influencing the discovery rates of parts of the surface archaeological record, and of the nature of that influence, with the aim of correcting the outcome of primary research results. The following sections detail the stages involved in this (with examples), ending with a discussion of current issues.

### 2.1      **DEALING WITH BIASES**

Archaeologists’ responses to the question of how to deal with biases have been three-fold: firstly, to ignore it because the problem is thought to be insignificant or insoluble; secondly, to avoid it; and thirdly, to model and attempt to correct for it. Before detailing my own approach to this issue I will need to say a few brief words about the first two types of response.

In spite of the arguments expounded in section 1 above, some will disagree with either the need or the feasibility of dealing with biases. As noted in section 1.2, while many researchers involved in

surveying in the Mediterranean will agree that there is a vast underestimation of the impact of distorting effects on the quantification of surface material, some believe that the effects of these biases are too complex to be modeled and corrected (Fentress and Ammerman, cited in Cambi & Terrenato 1994:168-71; Terrenato & Ammerman 1996:93-5; Fentress 2000). If taken literally, from this belief it would follow that the current practice of recording bias factors is largely a waste of time. It is difficult to judge the value of this belief without the benefit of having detailed published arguments available, but it may be pointed out we are not seeking to model all the distorting *processes* (which would indeed be impossible) but only their *effects*.

Bias modelling is an essential step in the production of locational models in any study that uses biased data sets – and there aren't any others in archaeology. It is similar in this respect to other historical sciences, which employ source criticism to trace and correct for distortions in their sources. Yet despite the occasional research into methods needed to correct survey data for known biases, current everyday practice seems very little affected.

One can think of both general and specific reasons for this: archaeologists (like other people) are generally overconfident when they estimate the reliability of their results; and having to deal with biases in our data adds to an already high workload. Archaeologists would rather spend their fieldwork time collecting fresh archaeological data than on what they perceive to be mere methodological niceties.

The second response type – to avoid biases altogether – is clearly a valuable approach if it can be realised; but so far I have been able to find only a single example of this. Van de Velde (1996, 2001) claims to have avoided surface visibility bias during the Riu Mannu survey in Sardinia by conducting, alongside a traditional extensive survey for diagnostic materials, a systematic gridded point sample survey, in which two square meters of ground surface were cleared at each sample point 'to provide quantitative control without visibility effects'. It is not clear that such a method can be extended to any other factors causing visibility bias or other types of bias; and Van de Velde himself acknowledged that geopedological effects cannot be controlled this way. In my concluding section I will return briefly to this issue.

Turning now to the third response type, methodologies for dealing with biases can be described as following three consecutive steps – recognition, recording, and correction. Each of these is described in more detail below, and then discussed in the following sections.

#### RECOGNISING BIASES

A bias factor must first be recognised as such, and its significance must be assessed in a preliminary manner in order to determine whether it is necessary to continue with the next step. Since the significance and even presence of bias factors varies over geographical space, it is probable that no regionally or supra-regionally valid 'standard' set of bias factors can exist. Instead, significant bias factors must be recognised locally and for each material category separately. Excellent examples can be cited from RPC fieldwork experience. Land improvement schemes in the Pontine region had resulted in the localised burial or removal of ancient land surfaces depending on the terrain morphology and soil type; since the Fogliano survey area straddled several such terrain units this had an obvious effect on the outcome of the survey (chapter 17). In the SIBA2000 survey, by contrast, the localised ploughing-up of conglomerate bedrock proved to be the most significant bias factor in many parts of the landscape unit under investigation, and the discovery of dull and undiagnostic prehistoric pottery was most significantly affected (chapter 12: 11). At this stage, surveys may be designed to avoid some biases.

#### RECORDING BIASES

Once it has been established which bias factors are likely to have a significant effect on the outcome of a regional or local survey, they must be recorded and assessed. These are two separate things though they are often confused. To record the bias factor means to measure or estimate the degree of its presence; to assess it means to measure or estimate the effect of that presence on the retrieval rates of all material categories.

For example, the stoniness of a field may be recorded as a bias factor by estimation using the MOLAS field guide (Spence 1990: chart 11), or by measurement in the field or from photogrammetry, but the actual amount of *bias* due to this factor is not yet known at that stage - 20% stoniness does not equal 20% less finds. Yet the two are often equated, especially in the case of vegetation cover which is the single most recorded bias factor in mediterranean surveys. In other words, a linear relation is assumed to exist between the bias factor and the bias itself, whereas in fact this relation has to be assessed either by estimation from field observations (the current, though rarely explicit, practise at almost all current surveys) or by statistical analysis of the correlation between bias factors and retrieval rates, or has to be measured by conducting field experiments.

Since in most cases there will be multiple significant bias factors present, it may be more relevant to evaluate their *combined* effect on the retrieval of each material category (for example by factor analysis or logistic regression techniques) than to do this for each factor individually. Typically, the end result of this step is one or more biases expressed on a percentage scale from 0 (no bias; perfect retrieval) to 100 (total bias; no retrieval).

The distinction between the bias factor and the bias itself, seemingly of academic interest only, may be seen to be important in the handling of differences between material categories. If the bias is equated to the bias factor, it becomes an objectified, measurable, 'environmental' variable rather than one which is relative to the characteristics of each material category - implying that the bias affects all material categories to an equal degree, which is patently untrue.

## CORRECTING BIASES

Once a bias factor has been recorded and its effect on the retrieval rates of all material categories assessed, the next logical step is to correct the 'raw' retrieval rates for this effect. Nance (1983:350) already advocated the formulation of correction factors in the context of probabilistic sampling. In current practise, corrections to raw survey data are typically applied by multiplying the counts or weights of retrieved material categories by the inverse of the relevant bias percentage. A good example of this is Gaffney's (Gaffney et al. 1991) correction of raw survey data for surface visibility percentage in the Hvar project. However, there are problems with this method at both the 'high' and the 'low' ends of the distribution of densities per collection unit, albeit for different reasons. At low retrieval rates, quantitative correction for biases ignores the problem of statistical diversity and enhances the effects of statistical noise: multiplying up low retrieval rates will not increase the number of distinct types within the assemblage, and insignificant density variations can become significant by multiplication. High retrieval rates typically occur at 'sites', where the collection strategy is likely to have been different in various respects from the one normally used, so that the collected assemblages are no longer representative of what lay in the field. Multiplication by bias correction factors would then result in completely unrealistic densities for some material categories.

In other words, current methods will not correct the fact that rare categories will be underrepresented in areas with a low retrieval rate, while changes in the types of samples taken from areas with high retrieval rates will tend to lead to overrepresentation of rare and 'diagnostic' categories, and underrepresentation of 'indeterminate' or 'uninteresting' categories. As will be suggested below, the problem of low diversity may be countered, at the expense of spatial resolution, by merging neighbouring collection units with low retrieval rates until sufficiently large assemblages have been created. The 'high end' problem can be avoided only by a rigorous separation of the 'standard' samples taken from every collection unit, from the 'special' samples taken once a 'site' has been defined.

## 2.2 IDENTIFICATION AND ASSESSMENT

### IDENTIFICATION

One of the effects of the 'New Archaeology' has been that, beginning in the late 1970s, many authors have identified and discussed the impact of factors that bias our knowledge of the archaeological

record. This is not the place to reproduce long lists of such factors; I will concentrate here on those factors that are most pertinent to the discussion.

The three factors which, since 1980, have attracted most attention both in the surveying literature and in the literature on GIS and spatial analysis, are geomorphological processes such as erosion and deposition (eg, Vermeulen & De Dapper 2000; Allen 1991), land use and land cover (eg, Van Leusen 1996), and sampling and surveying technique itself (Shennan 1985, Ammerman & Terrenato 1995, Verhoeven 1986).

Geo(pedo-)logical research is increasingly seen to be a requisite part of regional project designs, not just to map one of the most important factors in determining past land use, but also to map bias in the survey results caused by natural geomorphological and human processes. While geomorphological processes work over relatively long time-scales, RPC fieldwork experience in the Pontine and Salento Isthmus regions confirms that many landscapes have been seriously affected by recent or sub-recent anthropogenic soil movement and restructuring (see chapters 11 and 17).

The fact that the effects of bias factors vary by region, by period and by material category has been widely recognised in the last decades, but has so far not led to a systematic approach to the treatment of biases in Mediterranean archaeology. A major reason for this may be the difference in climates and sedimentary regimes as compared with north-western Europe. Whereas Mediterranean archaeologists have an extremely rich and, in the arid climate, well-preserved surface archaeological record to study, the situation in many parts of north-western Europe is radically different, with sedimentation burying many sections of the archaeological records and wetter climates giving rise to extensive areas of grasslands.

It is no wonder then, that north-western archaeologists were forced relatively early on to consider bias factors and how they affect different site types, periods, and regions. Among the published studies of regional landscape archaeology in northern and western European archaeology, Fokkens' (1991, 1998) thesis on the settlement history of the north-western Netherlands stands out for its clear and systematic approach. His regional, site-based study of 'map formation processes' stands out as a model still unrivalled by later GIS-based studies. Fokkens, using a somewhat different bias typology from mine, recognises post-depositional bias factors and research bias factors. Within the scope of his study, soil types, land use, and historical land reclamation activity are identified as significant for the former, while the localised activity of amateur archaeologists is identified as the main significant factor for the latter.

The fact that the Mediterranean surface archaeological record appeared to be generally much more complete than its northwestern European counterpart has caused Mediterranean archaeologists to take a different approach to biases, stressing one factor in particular that has a direct, observable, effect on retrieval rates: land use / land cover (LULC). Cambi and Terrenato (1994:151-2) report that, following the then recent recognition of the significance of biases by Italian archaeology, new volumes in the *Forma Italiae* series of regional site-based surveys have begun to include mapping of non-visible areas. As an advocate of the 'Anglo-Saxon' approach, Terrenato himself, in the Cecina survey, considered zones of geological deposition and zones where land cover largely impeded survey to be the most significant bias factors (Terrenato & Ammerman 1996). On the local scale, because surveys are targeted towards areas of optimal land use/land cover to begin with, many practitioners continue to equate 'visibility' with the percentage of ground surface not covered by vegetation.

As I have argued above, the tendency to think of the surface archaeological record as something which is there to be observed, and will in fact be reliably observed by any qualified observer unless blocked by intervening sediment or vegetation, has one further consequence for the identification and assessment of bias factors in Mediterranean archaeology - the low retrieval rates of material categories such as flint are regarded as a consequence of choices made during survey design (in this example, whether a lithic specialist would be included in the field teams, or not), rather than as a permanent, built-in feature of any type of archaeological fieldwork. While it is to be hoped that a specialist will attain a higher retrieval rate for his or her particular material category, it does not follow that his or her assemblages are unbiased.

Within Italy, the assessment of the significance of bias factors relative to material categories attracted early interest through the evaluation of the South Etruria project data. At the time, Di Gennaro and Stoddart (1982), already noticed the low visibility of prehistoric and medieval ceramics; later on, Malone and Stoddart (2000, echoed in Kuna 2000:34-6) went on to provide several quantitative arguments to explain this phenomenon in terms of formation, taphonomic, and recovery processes.

These authors begin their argument by pointing out that the relative abundances of prehistoric ceramics of different periods may be culture-specific, that is, related to a cultural tendency to dig pits (thus preserving archaeological materials sufficiently long for their discovery in the present). Kuna calculates that a prehistoric residential farm in his Bohemian study area may yield only a few ceramic fragments in a survey at 10% coverage. Although such calculations provide support for an assumption I made for the interpretation of the Fogliano survey data (Attema et al. 2001), they can only explain why prehistoric material is underrepresented in the ploughsoil (formation processes) rather than why archaeologists have trouble recovering a representative sample of the material which *is* in the ploughsoil. However, Kuna goes on to demonstrate that the probability of occurrence of a distinctive (diagnostic) fragment within such a sample varies by period, and decreases with elapsed time. And as we have seen in the discussion of conceptual biases above (section 1.2.3) the preferential treatment accorded to diagnostic finds implies that both the variable ratio of diagnostic fragments and its general decline through time constitute significant bias factors for some material categories.

RPC field survey experience suggests that even this does not come close to identifying all the relevant biases in regional and local archaeological data sets, as the following brief discussion will show.

At the regional and supra-regional scale, the site-based records compiled by desktop studies or in ‘topographic’ survey can be shown to be influenced by differences in accessibility of the terrain. Before about 1970, the probability of archaeological material being observed, recognised, and reported was largely due to chance and the activities of local amateur archaeologists. Field observations could only be made in accessible areas, and the more accessible an area the more likely that it would be visited by a person able to recognise archaeological features; ‘chance’ finds are therefore more likely to occur nearby modern infrastructure than away from it. Surveys conducted in the ‘topographic’ tradition (which requires a very large area to be surveyed by one or a few persons at most) continue this trend, as is shown clearly by the *Forma Italiae* volumes for the Pontine region which were produced between 1920 and 1970 (cf. the discussion in chapter 13).

At both the regional and local scales, the significance of the influence of subsequent human occupation and land use on earlier remains appears to be severely understudied by Mediterranean archaeologists<sup>3</sup>. Authors such as Shennan (1985), Verhoeven (1991), Van de Velde (1996) and Burgers and Yntema (1996) do not mention this factor at all, although it is in operation on any but the most short-lived site and can cause bias both because earlier periods tend to be ‘lost’ among remains of a later date, and because the greater research intensity at sites of a later date can lead to the discovery of low density remains of an earlier period. Both effects have a bearing on the apparent amount of settlement continuity in a study region, as is shown by Attema’s (1993, forthcoming; see also Van Leusen 1998) study of a possible Roman Republican ‘villa colonisation’ in the foothills of the Lepine mountains.

My third and final example concerns a previously unidentified bias in the recording of the surface area of collection units and the subsequent calculation of finds densities on that basis. Typically, the raw counts and weights per collection unit resulting from a survey will be ‘normalised’ to account for any differences in the size and coverage rate of the collection units. It was found during analysis of the Ostuni survey data (Attema et al 2001) that the digitised areas of many collection units were approximately 10% smaller than those mapped in the field on topographic maps at scale 1:10,000. The difference is explained by the fact that topographic maps generalise and omit features such as paths, wayside berms and scrub, and buildings; however these features were included in the detailed hand-drawn field maps made of each

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<sup>3</sup> Fokkens (1998:59) does mention this factor.

collection unit which formed the basis for the digital map. In the relatively well-mapped Ostuni survey zone the effect remains fairly small, but in the topographically complex and poorly mapped terrain of the SIBA2000 survey the areas of some agricultural fields were overestimated by as much as 50%, because the boundaries of ploughed fields were ‘stretched’ to include the surrounding unmapped scrubland as well. The variable percentage by which the areas of collection units are overestimated indicates how large the potential errors can be when ‘normalisation’ of survey results takes place. This is therefore a potentially significant bias, especially where it is intended to detect and interpret relatively small variations in finds densities across the landscape.

Assessing a bias factor means asking the question: Does this factor have a significant effect on the types or amounts of information I can retrieve from the archaeological record? A simple way to begin answering this question is by plotting the two against each other in a graph. Examples of such graphs were produced as far back as 1978, when Fred Plog and his colleagues plotted the number of person/days per square km surveyed against the number of sites discovered for 12 surveys in the American southwest (see figure 2; Plog et al. 1978, 389-94 and fig 10.1). Cherry (1983, fig 1) did the same for a large number of survey projects in Greece, adding a historical perspective by grouping the projects into broad types as practised since about 1950. In figure 1 I have extended his plot for Italy, including both extensive regional and intensive local surveys for the Pontine Region. Although Cherry used surveyed area, rather than the more precise effort in person/days, as his measure of research intensity, both studies clearly show that more intensive research leads to a higher retrieval rate (in this case, of sites). While Cherry’s historical perspective uncovers the incredible increase in site density achieved since the earliest surveys (10-fold even in the last 30 years), Plog’s diagram highlights the fact that there is an almost linear relation between intensity and result – for every duplication of research intensity, an approximate 75% rise in the number of sites may be expected.

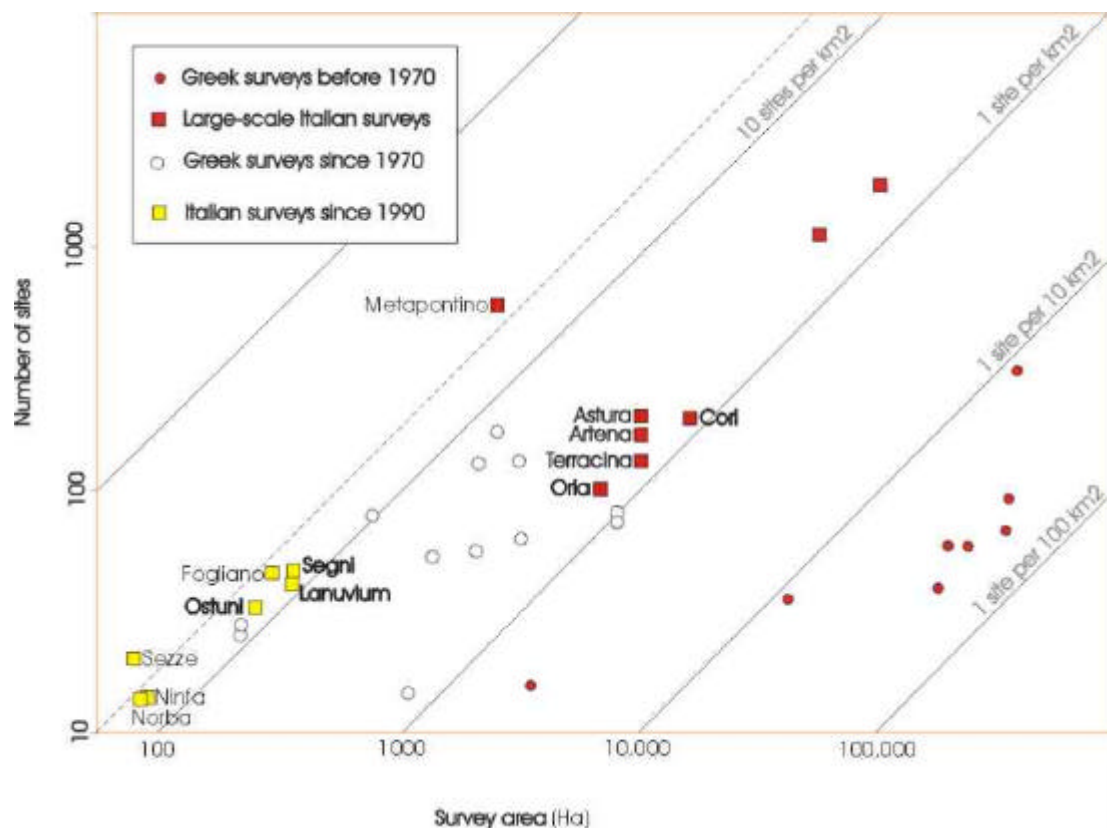


Figure 1 – Site productivity in relation to surveyed area for different survey types in Greece and Italy (adapted from Cherry 1983, fig 1). Note that the scale on both axes is logarithmic.

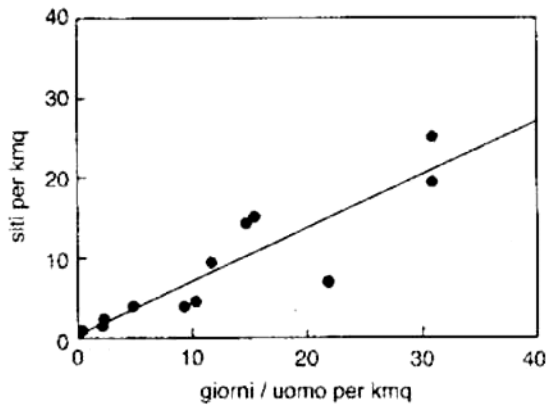


Figure 2 - the relation between research intensity and site density for twelve surveys in the American south-west (Plog et al 1978)

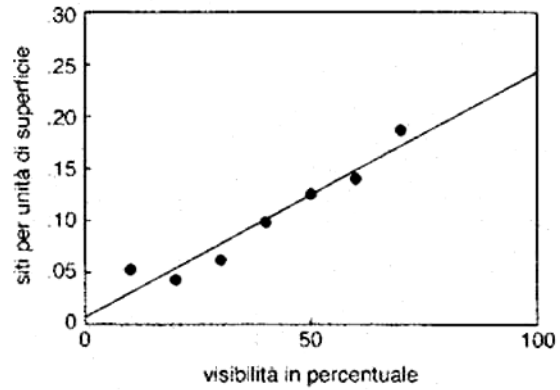


Figure 3: the relation between surface visibility (vegetation cover) and site density for the Keos survey (Cherry et al 1991)

On a regional and supra-regional scale, differences in research intensity have been shown to play an important part in creating spatial variation in site density. As noted already by Nance (1983:311), 'much of the variation apparent in data from survey to survey may be explained by differences in survey intensity'. Moving to more local scales, examples of the assessment of bias factors have been published since about 1990 and have concentrated on the relation of 'visibility' (however defined) and site density. Again, Cherry, in his analysis of the results of the Keos survey (Cherry et al 1991, fig 3.6), appears to have been the first to publish a plot of visibility versus site density (my figure 3), apparently confirming that vegetation cover is inversely related to site discovery rate. However, such plots presuppose the detailed recording of the bias factor, which is the subject of the next section, so I will discuss them there.

Four aspects of the examples discussed above are noteworthy: firstly, the relation between research intensity and site density cannot remain linear - there must be a point of diminishing returns, where increasing the research intensity will no longer result in the discovery of more sites. It is likely that modern high-intensity surveys, with crew spacings of less than 10m, have reached this point. Secondly, measuring research intensity is not trivial. Crew spacing and walking speed are the two most obvious factors involved, but in almost all cases only the former is recorded. A more reliable proxy measure of research intensity is therefore likely to be the ratio of the area covered and number of person/days spent, expressed as either person-days per unit area or area per person/day. Thirdly, measuring the 'result' of a survey by counting the number of sites per surveyed unit area becomes increasingly meaningless as the definition of 'site' has begun to shift and blur, including smaller and less dense scatters, and is even ceasing to be used as a unit of discovery. Fourth and lastly, increased research intensity leads not only to the discovery of *more* sites, as the examples above have shown, but also to the discovery of different *types* of sites: the ones that are smaller and less visible. In my intra-regional comparison of survey data sets of the Pontine region (chapter 13 section 2) all of these aspects are shown to play a role in confounding successful quantitative comparisons.

In view of the above, our assessment of research intensity as a bias factor at the regional and supra-regional scale must be, that differences in research intensity will not only result in significant spatial variation in site *densities*, but also in significant spatial variation in distributions of site *types*. This assessment can help us avoid misinterpreting variations caused by the bias factor, with obvious consequences for settlement chronology and landscape history; but only if it is properly recorded and if we succeed in quantifying its effects.

### 2.3 RECORDING AND EVALUATION

Whilst bias factors such as vegetation cover can be recorded, their effect on the retrieval rate (ie, the bias itself) cannot; it has to be evaluated. This section deals with methods for doing both, again with examples ranging from the supra-regional to the local scale.

#### RECORDING

Current approaches to the recording of bias factors in the field are based on, and in fact almost identical to, methods first developed for Mediterranean surveys in the early 1980s. In the Pontine Region, approaches to the recording of visibility and observer factors developed for the Agro Pontino Survey project (Voorrips et al. 1991: 82 ff.) were adopted by subsequent Dutch survey projects directed by Attema, and in turn formed the starting point for the recording experiments carried out during the RPC project surveys in the Pontine Region and elsewhere.

The most basic method imaginable for recording any bias factor is the 'binary' approach, in which each factor can assume only one of two values – present / absent. An example of this is the recording by Terrenato and Ammerman (1996) of visibility factors during their survey of the Cecina valley, during which conditions of geopedology and vegetation were classed as favorable or unfavorable (see figure 4a). While such an approach can be valid for some factors, it does tend to simplify the reality of field situations, and most other researchers have therefore adopted various simple ordinal rating scales to record bias factors. Where multiple bias factors have been identified, each is usually recorded separately on an ordinal scale. In the RPC surveys, five factors are recorded in this manner: vegetation cover, stoniness, sun/shade, soil weathering, and ploughing conditions. Overall visibility is independently recorded as a sixth variable. In the Fogliano survey (Attema et al. 2001) overall visibility was recorded as two related ordinal variables: Field visibility and Block visibility. The former, which rated the overall visibility of an agricultural field from low through normal and high to optimal, had to be corrected using the relative visibility rating recorded for each collection unit as low, normal, or high. Low relative visibility, for example, resulted in 'demoting' a particular collection unit to a lower overall visibility class.

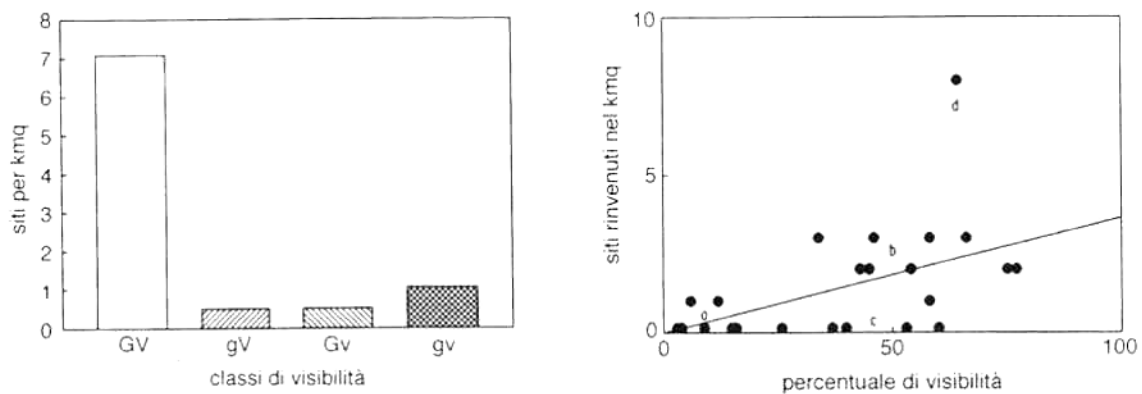


Figure 4 - relations between visibility and site density for the Cecina survey (from Terrenato 1996). A: site density by visibility class; note that the density in unfavourable geopedology and vegetation is twice that of the two more favourable central classes. B: site density by surface visibility for each of 23 square km

The rating of bias factors by estimation along an ordinal scale of measurement is to some (large but unknown?) extent subjective, so that it is not possible to compare these across projects. It may be possible to improve ratings using a method called CARS (criterion anchored rating scale) which anchors such ratings to specific criteria (Suenson-Taylor *et al* 1999). A rating will then be arrived at by assessing these criteria much like grain size is arrived at by comparison with standard grain sizes during the recording of soil properties. This method is claimed to give a proper numeric scale along which to



measure the factor, but has not been applied to field archaeology yet as far as I am aware.

## EVALUATION

The effect that a specific bias factor has on the retrieval rate of a specific material category can be evaluated by estimation, measurement, or statistical analysis. Measurement requires the setting up of controlled field experiments in which known densities of the material are surveyed under different conditions. Statistical analysis of the influence of bias factors on retrieval rates has only been pursued by relatively few researchers, among whom Shennan (1985) still takes pride of place. Shennan used techniques of logistical regression in order to study the impact of a large number of factors on the results of his experimental survey area in Hampshire; identical methods were later applied to the results of the Agro Pontino Survey project by Verhoeven (1991).

However, the large majority of past and current practitioners of field survey employs simple, 'intuitive' methods for evaluating the effect of bias factors. Because there is no formal method underlying this step, it receives little or no discussion in the literature. Examples from the RPC field surveys include the estimation of the overall percentage visibility effect for each of the visibility classes distinguished in the Fogliano and Ostuni surveys (see chapter 11, page 3). Often the rating for the bias factor is taken to be the rating for the effect itself, as in the Boeotia survey where the ground surface visibility score is derived directly from the 10 point rating scale used to rate land use/land cover (Gillings & Sbonias 1999:36). At a larger scale Fokkens (1998:64-5), too, based his calculations of archaeological visibility indices on estimations of the bias caused by each of his distorting factors, with 100% indicating optimal recovery conditions for each.

The statistical approach to evaluating bias factors initially seemed to hold promise of a much more precise and replicable method. Shennan (1985:38-9) concluded that, although not entirely negligible, distorting factors did not seem to have a major impact on the retrieval rates of his three most frequently occurring material categories (explaining some 17-18% of variation in them). Certainly their effect was less than that of environmental variables, which he calculated to be on the order of 40-60%<sup>4</sup>. Verhoeven (1991:87) found that the effects of weather and field conditions on the results of the Agro Pontino Project surveys had a similarly limited effect but that ploughsoil conditions (dust/rain) do have a strong influence on the recovery of flint and obsidian<sup>5</sup>. Going on to consider less frequent material categories, Shennan found that light conditions did play an important role (34% of variation explained) in the recording of Romano-British pottery.

Going one step further and using his detailed records of who surveyed where, Shennan (1985:40-44) statistically removed the visibility biases he identified, and went on to look for observer bias in the residuals. His analysis confirmed that observer bias, though fairly minor, was definitely present. For chipped stone, his analysis showed a small (3%) but highly significant observer bias; for burnt flint and post-medieval pottery the variability of the walkers was somewhat greater (explaining 9-10% of the variation in retrieval rates). Shennan also noted that the differences *between* walkers in picking up various materials were quite large.

It is unfortunate that, after these initial attempts at formal evaluation of bias effects, no further research was published, and practitioners reverted to estimation methods. Two new twists to this approach were added in the 1990s by, firstly, plotting the effect of bias factors against retrieval rates and, secondly, by employing simulation studies. Figures 3 and 4 present two examples of site density plotted against

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<sup>4</sup> This confirms my observation during the Fogliano survey – observer bias and differential visibility differ by finds category. The fact that Shennan chose to study his most frequently occurring find categories already entails less distortion!

<sup>5</sup> Van de Velde (2001) notes that the method used by Shennan and Verhoeven to calculate 'field effects' underestimates the true effect because it disregards 'zero' observations.

visibility percentage for the Keos and Cecina surveys. Terrenato (forthcoming) also investigated the effects of surface visibility (geopedology and vegetation) on the recovery of archaeological sites through simulated survey coverages.

To conclude: what seems to be lacking in the ‘estimation’ approach to recording and evaluation of bias factors, is the presence of a testing phase in which the accuracy and replicability of both the recording method and of the evaluation ‘rule’ can be assessed.

## 2.4 CORRECTION

Although bias factors are being recorded, the apparent failure of formal evaluation methods has meant that many researchers used this information only for informal adjustment of the raw survey results. Even simple map overlays of the bias factors onto the dataset being studied can be very effective in this respect, and neither Fokkens (1998) nor Attema (pers. comm.) went on to apply formal correction methods to their data. Three quantitative correction factors, however, are currently being applied in many Mediterranean surveys because of their computational simplicity – unit area, coverage, and overall visibility; these will be discussed in the following sections.

What constitutes ‘correction’? Following Shennan, Van de Velde (1996:23) and Verhoeven (1991), believe that observer effects such as the well-known ‘flint expert’ phenomenon can be corrected for by rotating individual walkers during a field survey. I believe this to be incorrect; while rotating the walkers would certainly randomise such effects, it does not eliminate them. For example, where-ever a colour blind observer is put in a field walking line-up, the transects walked by that person will turn up less small sites.

### UNIT AREA

Correction for unit area is needed because (*ceteris paribus*) a larger area will yield proportionally more finds. This requires the unit area to be measured with a specific precision and accuracy, relating to the desired degree of confidence that a specific density difference is indeed a significant archaeological variation rather than a result of random errors in the measured unit area. As we have seen above, such measurements can indeed be surprisingly inaccurate, and require the adoption of more stringent field methods (see chapter 7). The correction itself transforms finds counts per unit into finds densities, expressed as number of finds per hectare within the RPC project.

### COVERAGE

The single variable which has been successfully corrected for in surveys (in regional site-based records it was never recorded in the past), is the *coverage* (percentage of the collection unit actually observed). This correction method has even been applied in the field, in cases where the distance between walkers was adjusted whenever changes in vegetation cover were encountered. Van de Velde (2001) applied this relatively simple correction based on the % coverage of his survey to arrive at a corrected total number of sites for one of his survey transects, and reports that this outcome agrees reasonably well with the number of sites independently discovered by local amateurs within the same area. Such observations are the first step toward proving that retrieval rates corrected by formal methods are less biased, and form a better basis for interpretation.

However, coverage is itself composed of two variables: the average distance between walkers and the swath width. While the former is generally recorded, the latter is set to a notional value (usually 2 m, but values from 1 to 5 m have also circulated). Seemingly small differences in the swath width (eg, 1.5 vs 2 m) represent a large percentage change (25-33%) which, if used in a correction formula, will make comparison between surveys difficult. The correction usually takes place by multiplying the original finds count per unit by the inverse of the percent coverage for that unit, so that the new finds count represents what *would* have been recovered had the unit been fully covered.

## OVERALL VISIBILITY

The rationale for correcting for visibility is, as we have seen, that the probability of recovering a surface artefact decrease as the surface itself becomes less visible. Correction takes place by multiplying the original finds count with the inverse of the visibility score. Gillings and Sbonias (1999:36), for example, used the 10-point ground surface visibility score recorded by the Boeotia survey to correct raw artefact counts using the formula

$$\text{Corrected} = \text{recorded} * (10 / \text{visibility score})$$

This, in effect, represents a conversion of the visibility score to a visibility coefficient, which is then used to multiply raw artefact counts in areas of low visibility. Similar methods were used in the analysis of the RPC surveys near Ostuni and Francavilla Marittima (chapters 11 and 12).

## THE PROBLEM OF LOW DENSITIES

Modern field surveys, with their increasingly detailed and intensive study of ‘off-site’ areas, tend to result in large numbers of collection units containing very few finds. In addition, these finds tend to be less different from each other – in statistical terms, the diversity of the assemblage is lower. This gives rise to several interpretative problems. Firstly, the multiplication of finds counts in the course of bias correction, as suggested in the previous paragraph, will increase the numbers of finds but not their diversity, thereby causing a relative drop in variability. A method for avoiding this, namely the aggregating of collection units until a given minimum number of finds is obtained, was suggested as early as 1973 (Dunnell & Dancy 1983:272), but it remains to be seen how the loss of spatial resolution affects subsequent analysis.

A second implication is that low finds densities can no longer automatically be dismissed as insignificant ‘noise’ or ‘off-site material’. Instead, the survey intensity and visibility biases should be taken into account. Higher survey intensity equates to a higher diversity of the recovered finds assemblage; for example, Gillings & Sbonias’ (1999:46-53) detailed chronological discussion of a single site assemblage of the Boeotia survey ignores the fact that the site itself was much more intensively surveyed than its surroundings, and low density unobtrusive find types present on the site could just as well have been present outside the site grid. Likewise, re-surveying experiments at Fogliano have confirmed that a single sherd recovered under circumstances of very low visibility can develop into a scatter if the survey takes place under more favourable circumstances. As it is recognised that even intensive modern surveys cannot hope to collect representative samples of low density, low visibility categories such as the (possibly) prehistoric impasto occurring in the Sibaritide foothills (chapter 12), dedicated specialist (re-)surveys are required for such materials.

Beyond the purely quantitative aspects of interpreting low density ceramics, there are also some less easily categorised aspects. Low densities can, for example, be an artefact of the finds classification process, in that material from some periods can only be recognised if diagnostic forms or decorations are present. If these are rare or absent, finds will be classified into broad undiagnostic categories, or even as ‘indeterminate’. Finally, the belief that material can be transported very far from its origin by slope processes or ploughing, prevalent among archaeologists of the Roman school and invoked regularly to explain away the occurrence of low-density ceramic scatters near urban sites, seems unwarranted in many cases. Bintliff’s recent work on re-interpretation of the extra-urban ‘blankets’ of surface finds from the Boeotia survey is confronting this issue head-on, and is attempting to distinguish between several alternative causative processes for low-density distributions<sup>6</sup>.

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<sup>6</sup> Rather than posing a problem, Bintliff and Howard (2000) note that low densities, in combination with certain diagnostic types, may indicate the presence of a Hellenistic cemetery.

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### 3 CONCLUDING DISCUSSION

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Our ability to record surface archaeological material is not perfect; it is biased by visibility and research biases. An example of the former is current and historical land use / land cover (LULC; see especially chapters 14 and 17); examples of the latter are the recording and classification methods used (chapters 13 and 16). Of the two courses of action that have been proposed to remedy the problem, that of avoiding biases seems to have little if any potential beyond Van de Velde's experiments with surface cleaning. Recording and attempting to correct for biases is the only alternative, but before this can be done with any degree of confidence in the results, dedicated studies will need to underpin the methodology. Data on research and visibility biases have so far not been *systematically* collected at regional scales, although suitable methods have been developed. Terrenato (1996: 227–228) underlined the importance of recording bias factors if we are to attempt 'the correction, at least partially, of incomplete distributions', and advocated 'a series of methodological experiments dealing with the various aspects of how to document surface scatters', e.g. by replication studies, all within a local (regional) context. This research was then, and still is now, 'a high priority for survey practitioners in Central Italy'. In fact such experiments should probably have precedence over the collection of bias data, because we do not yet understand how best to do the latter.

The issue of bias is almost universally agreed to be an important one, but neither the intensive interest and study conducted in the early 1980s, nor the constant popularity of surveying or, latterly, the use of GIS, have so far led to anything resembling a concerted effort to develop a methodology which is valid across projects. The plethora of biases discussed in this article requires that we return briefly to the fundamental question raised most recently by Fentress: Could it be that we will not be able to disentangle the mess, and correct the distortions? I hope I have been successful in arguing that many lines of research remain to be explored before giving in to such a counsel of despair.

#### CASE STUDIES

The case studies presented in chapters 13, 14, and 17 were conducted to demonstrate a) the relevance of bias factors to the interpretation of survey data and of landscape archaeological data in general; and b) methods by which bias factors can be included in geographic models of archaeological landscapes. At the regional scale, studies of the data collected by the Wroxeter Hinterland Project and the Agro Pontino Project (Voorrips *et al.* 1991) demonstrate this for systematically surveyed data and general archaeological records; at the scale of a 'local' survey such as the Ninfa and Fogliano surveys conducted in 1998-9, case studies demonstrate this for specific visibility and research biases. In the WHP surveys, conducted in 1994-6, the choice of fields was limited by modern land use and land cover (LULC), in particular the availability of freshly ploughed surfaces. Since these are not randomly distributed over the landscape – relief, distance to Severn, soil type and hydrology all play a role – they result in the taking of a biased archaeological sample. In the surveys conducted by the Agro Pontino project, paleosurfaces dating to the paleolithic period had been covered in some parts of the Pontine plain by more recent alluvial and colluvial deposits, and similar though less clearly evident biases must have been present for material dating to later periods.

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# A REVIEW OF WIDE-AREA PREDICTIVE MODELING USING GIS\*

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1 INTRODUCTION

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*"Predictive modelling is a technique to predict, at a minimum, the location of archaeological sites or materials in a region, based either on the observed pattern in a sample or on assumptions about human behaviour"*

- Kohler & Parker 1986:400

The above quote, from a paper published in one of the later edited volumes on New Archaeology theory and method (Schiffer 1986), encapsulates the principles of what, only a few years later, was to become a cottage industry of predictive models when GIS became more widely available to archaeologists (Scollar 1999:7). Since then, several hundreds of articles and tens of edited volumes have appeared, most of them concerned with the predictive modelling of the location of as yet undiscovered archaeological remains, either in the context of cultural resource management (CRM) or of academic research.

Archaeological predictive modelling can be conceptualised as a specialised form of what planners call location-allocation analysis, in which the object is to allocate 'suitable' locations to specific types of human activities (and, by extension, to their archaeological remains), and in which the criteria for suitability are derived by location analysis – the generation of behavioural rules from a set of observations about how people actually behave or have behaved in the past. The study of 'spatial' archaeology began in the 1970s, but had different origins in the USA (economic geography) and Britain (the diffusionist school). Although by the early 1980s archaeological theorists had largely turned away from the rule-based approaches advocated by the New Archaeologists, this type of reasoning and analysis still received a boost by the end of the 1980s when its implementation was much facilitated by affordable computers and GIS software (see the overviews by Kvamme 1990, 1999).

As this new area of archaeological research unfolded, many became uncomfortable with the lack of theoretical depth and methodological rigour of most of the published work. In 1993 I presented two review papers on the role of GIS in locational modelling, one concentrating on then current approaches in Dutch archaeology (Van Leusen 1996), the other on its potential for archaeological resource management (Van Leusen 1995). More recently, I and others co-authored an updated review of predictive modelling in the Netherlands (Verhagen et al. 2000), concluding that basic concerns about the quality of published and ongoing work had not been adequately addressed in the meantime. Looking ahead, the current chapter is intended to assess the potential of predictive modelling for wide-area (regional and supra-regional)

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\* This chapter is partly based on my earlier review of Dutch approaches to archaeological predictive modeling (Van Leusen 1996b). Many of the issues discussed here were developed and clarified in meetings of the 'bath-house' group, resulting in a preliminary version of this chapter, co-authored with Philip Verhagen and Milco Wansleben, being presented at the 4th international conference 'Archäologie und Computer' in Vienna (1999, published as Verhagen et al. 2000), and the successful submission of a project proposal for an in-depth study of predictive modeling in Dutch archaeological resource management (Kamermaans 2001). The current chapter, however, substantially reflects my own personal research and opinions with regard to predictive modeling.



archaeological research, and to argue the importance of adopting formal modelling procedures. In this introductory section I shall first discuss the range of aims and approaches to predictive modelling for which GIS has been used since the early 1990's, followed by an evaluation of the underlying theory and concepts. In section 2 the scope and limitations of predictive models are discussed with reference to data quality and methodological issues. A concluding section looks at the future use of predictive models in both CRM and academic research.

## 1.1 AIMS AND APPROACHES OF PREDICTIVE MODELLING

Archaeological location models have been made with two types of aim in mind. In academic contexts, the aim has generally been to generate models that explain the observed distribution of archaeological remains, whereas in CRM contexts the aim has been rather to generate models that estimate the probability of an archaeological site being present anywhere within the study region. Whilst in theory these two aims might have been approached in different ways, as we shall see in practise there is little difference between the approaches adopted by cultural resource managers and academic archaeologists.

Many conventional accounts of predictive modelling in archaeology attempt to draw a geographical distinction in which North American approaches are set against those prevalent in Europe. The North American attitude toward the use of GIS for predictive modelling is said to be 'pragmatic': GIS is a tool that can be used to apply traditional archaeological analytical methods to very large (previously too complex) data sets, especially in the context of CRM where it can be used for prediction as well as modelling the state of preservation and vulnerability of archaeological remains, and to provide management options (Wescott & Brandon 2000, chapters 3-5). In other words, society needs to manage and protect its cultural resources, and predictive modelling is a relatively cheap and effective way of doing this.

The British, and to some extent European, approach is 'idealist': we must attempt to understand past behaviour before we can successfully attempt to predict it. These divergent approaches to the issue of archaeological prediction have been seen to exist since the early use of GIS in the late 1980s and early 1990s, and to be exemplified by the studies presented in two recent edited volumes (Lock 2000, Wescott & Brandon 2000). However, on closer reading we find that the papers published in the latter volume were originally read at the 1996 Society of American Archaeologists meeting, in reaction to the 1990-5 phase of early and uncritical enthusiasm about GIS, and a direct comparison with the papers in the former volume (presented at a 1999 symposium in Ravello) would be unfair.

In addition to the 'minimum' aim of modelling the location of archaeological remains, predictive models could conceivably also be used to predict the type and quality of those remains, their current state of conservation and likely rate of deterioration, and from these deduce their cultural and scientific interest. Work in this direction has so far been limited to quality studies of known monuments (Darvill & Fulton 1998) and theoretical work (Deeben *et al.* 1999).

### MANAGEMENT VS. RESEARCH BASED MODELS

Predictive modelling was initially developed in the USA in the late 1970s and early 1980s, evolving from governmental land management projects in which archaeological remains became regarded as 'finite, non-renewable resources', and gave rise to considerable academic debate (Carr 1985; Savage 1990). Until the start of the 1990s the emphasis of this debate was on the statistical methods used to evaluate the correlation between archaeological parameters and the physical landscape (e.g., Parker 1985, Kvamme 1985). Within Europe, the Dutch practice of predictive modelling has been most clearly influenced by the American tradition, probably because archaeological predictive modelling was first introduced in the Netherlands relatively early on by Kvamme (Ankum & Groenewoudt 1990, Brandt *et al.* 1992), and has since been used widely for CRM purposes at regional and national scales (Verhagen 1995; Deeben *et al.* 1997, 2001; Deeben & Wiemer 1999).

European academic interest in predictive models using GIS grew out of its long-standing concern with locational models in general, and has been largely directed at an understanding of the modelling process itself. The primary result of this has been a series of papers critical of the inductive, CRM oriented approach common in Dutch predictive modelling (van Leusen 1995, 1996; Kamermans & Rensink 1998; Kamermans & Wansleeben 1999); at the same time alternative methods and techniques were explored as well (Wansleeben & Verhart 1992, 1997, 1998; Kamermans 2000; Verhagen & Berger 2001). More recently, European researchers have begun to concentrate on the incorporation of social variables into their predictive models (Wheatley 1996; Stancic & Kvamme 1999; cf. papers in Lock 2000).

The contrast between academic and CRM-driven predictive models is likely to continue to play an important role for the foreseeable future. Reflecting a European trend, all three Dutch universities with a European archaeology department (Leiden, Groningen and Amsterdam) have in recent years founded excavation firms<sup>1</sup>. The privatisation and commercialisation of the archaeological field has unmistakably increased the influence of tight schedules and customers waiting for the end product, on the actual work. Unlike academically employed archaeologists, commercial firms have only limited possibilities to investigate new lines of research, to contribute to the scientific interpretation of their finds, and to improve research methodologies. Good archaeological research in a commercial context is equivalent to efficient research: only a limited number of tried and tested methods will be applied. The development of new methods is restricted to situations where direct benefits are expected for the company. These benefits can be either a more efficient research strategy, or a new product that will attract the attention of potential customers. Predictive modelling in a CRM context has been employed in both ways: it can be used by consultancy firms to guide surveys more efficiently, and it can be used by planners to integrate archaeology in urban and rural planning at an early stage. In addition to prediction, GIS can be used for modelling the state of preservation and vulnerability of archaeological remains, and to provide management options.

Since cultural resource management continues to be a driving force behind the development of predictive modelling methods using GIS, academic researchers now face the choice of ignoring this development altogether, or of attempting to establish a research programme that will result in the improvement of current management-oriented predictive models. For example, Lang (2000:216) noted that GIS “are becoming increasingly common tools for the national and local inventory records (...), and are essential elements of the 30 or so Urban Archaeological Databases developed in England (...)”; hence, new research into spatial analysis in archaeology should be especially concerned with archaeological resource management. Within Europe, archaeological risk assessment – in which predictive models play a central role - will become a standard procedure in planning after the implementation of the Valletta treaty (Verhagen 2000:234).

#### THE TYPICAL AND THE EXCEPTIONAL: TRENDS AND RESIDUALS

Whereas predictive modellers typically attempt to discover and model patterns and trends in the characteristics of a set of archaeological site locations, these models can also be used to detect the converse – the exceptional or, in modelling terms, the residuals remaining after removal of the trend. The potential value of such an approach for both management and academic purposes, while recognised by some (eg. Altschul 1990:231), has remained largely unexplored. As we shall see below, their primary interest may be in removing broad environmental trends and focusing attention on less well understood aspects of the data.

### 1.2 THEORY AND CONCEPTS

Kvamme (1999: 171) recently reviewed the analytical capabilities of GIS, describing predictive models of archaeological location as “[models that] go a step further by multidimensional merging of what is known

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<sup>1</sup> respectively Archol, ARC and AAC.

through locational analysis. In one sense such models are *descriptive* statements that summarise the multivariate environmental and spatial pattern of archaeological sites; in another they form *predictive* statements because a good model can indicate likely locations of as yet undiscovered sites' (my emphasis-MvL). In what follows I shall discuss the various elements of this description.

#### THEORETICAL BASIS: THE LOGIC OF PREDICTION

A review of the literature reveals that much of the energy of the first generation of archaeological predictive modellers has gone into developing and debating an understanding of the theoretical basis for predictive modelling itself. This debate has generally been cast in the form of a series of dichotomies, the first two of which have already been mentioned:

North America	↔	Europe
CRM	↔	Academic
Inductive	↔	Deductive
Ecological	↔	Cognitive

Parallel to the American/European divide and the CRM/academic contrast, debate has also raged on the appropriate logic of prediction, and has become polarised around the issues of the use of inductive vs. deductive logic, and of ecological determinism vs. social/cognitive models. I will briefly discuss the content and significance of these debates before proposing some alternative concepts on which to base archaeological prediction.

#### *Inductive vs. deductive approach*

Part of the early appeal of GIS for archaeological predictive modellers was its ability to handle and visualise large and complex data sets consisting of both archaeological site records and large numbers of mapped environmental variables. Querying these allowed researchers to derive the 'properties' of archaeological sites with ease, and to extrapolate likely locations of unknown archaeological sites on the basis of these properties in the form of maps. This has been termed the 'inductive' approach because it derives rules from observations rather than from theory. Inductive models have been popular in academic archaeology as well as in CRM, but more attention was paid to methodological issues than to actual 'working' predictions of site densities. By the early 1990's papers began to appear criticising the predictive models made for CRM as being rather crude, lacking a theoretical foundation and therefore failing to take into account the cultural and environmental mechanisms that produced the statistical correlations that were found (Wansleben & Verhart 1992, 1997; van Leusen 1993; 1995; 1996). At the time, Ebert (2000) argued strongly against the then current practise of purely inductive predictive modelling, and for the need to include archaeological explanation within a systems theoretical context. In inductive models gain, he thought, might never get higher than about 70% because of inherent limitations to the approach (Ebert 2000:133). Yet cultural resource managers in the Netherlands as elsewhere have continued to produce inductive predictions, taking into account some of the methodological critique (Verhagen 1995, Wescott & Brandon 2000).

The alternative, 'deductive' approach attempts to construct predictive models on the basis of our understanding of past human behaviour – especially economic behaviour. For a particular archaeological period and region an assumption of "self supporting agriculture without manuring, but with long fallow periods" might be made. On the basis of environmental variables that are relevant to this assumption, the site distribution is predicted and the known archaeological sites are only then used to evaluate the prediction. One early study which demonstrates the potential of this approach is Chadwick's (1978, 1979) model of the Late Helladic (Mycenaean) settlement system, entirely on the basis of premises about environmental preferences and the prior Middle Helladic population distribution. Later, Kamermans introduced land evaluation into Dutch archaeology as a fully deductive way of predictive modelling

(Kamermans 1993, 2000; Kamermans *et al.* 1985; Kamermans & Rensink 1998). This work has to date not resulted in a formal methodology for deductive modelling that can easily be applied in the context of archaeological resources management, although some attempts in that direction have been made by Dalla Bona (1993, 1994, 2000) and Dalla Bona and Larcombe (1996). The trend to reject inductive models for deductive ones continues to gather pace in the USA as well as in Europe. In their concluding paper to the 'predictive modelling kit' volume, Church *et al.* (2000) advocate adapting approaches from landscape ecology. And this is indeed the direction taken by subsequent modellers, witness Krist's recent thesis on paleo-indian subsistence and settlement in northern Michigan (Krist 2001), and papers presented at a recent conference on the future of predictive modelling in Argonne (IL, USA; esp. Whitley 2000, 2001). However, it should be noted that several influential authors (among whom Kvamme) are resisting this trend and continue to point out the advantages of the inductive approach.

It should be noted that the inductive-deductive dichotomy does not run parallel to the environmental-cognitive dichotomy. More-over, the division between inductive and deductive approaches to predictive modelling itself is in practice not very distinct<sup>2</sup>. On the one hand, supposedly 'inductive' models incorporate many assumptions about past human behaviour – why else would one attempt to correlate the location of sites with, say, terrain slope? Critique by many post-processualists and some processualists that induction lacks a theoretical basis is therefore misguided (cf. Kvamme 1999:173). On the other hand, at least part of the archaeological 'expertise' that goes into deductive models is based on *informal* induction - Why do we think that the Linear Band Ceramic people in the southern Netherlands preferred loess soils? Because that is where we have found most of their settlements. For example, Dalla Bona (2000:90) claims no actual sites were used to generate his predictive model of boreal forests in Ontario (Canada) and therefore it is a deductive model. However, this is not quite true because the geographic rules established for prehistoric activities have been formed partly under the influence of known sites. Recent predictive models by RAAP and ROB have therefore been termed 'hybrid', since inductive statistics are only used to obtain a first impression of site location characteristics, and general knowledge about the locational behaviour of human societies in the past is then added to the model.

#### *Ecological determinism vs. Post-modernist approaches*

A second dichotomy which has unduly polarised the debate regarding the theoretical foundations of predictive modelling is to do with the perceived theoretical poverty of what has sometimes been termed 'ecological determinism' (for an extensive treatment see Gaffney & Van Leusen 1995), usually contrasted with the theory-laden humanistic approaches advocated by various strands of post-modernist archaeologists. As a dispassionate evaluation of the *practical* differences in approach between the two sides in this debate shows, the only significant difference is in the use of 'cognitive' variables (see also the brief discussion by Kvamme (1999:182)). Since both sides in the debate have stuck to deterministic modelling, the middle ground in a theoretical sense may be said to be accurately represented by Renfrew and Zubrow's (1994) *cognitive processualism*.

#### *Alternative distinctions based on the Model Aims*

Our understanding of the logic of archaeological predictive modelling is therefore not helped by the above distinctions. I would therefore like to propose here two alternative sets of distinctions based on the model aims rather than its methods or theoretical stance. A first useful alternative classification of predictive models, into *correlative* and *explanatory* classes, bases itself on the ultimate *aim* of the modelling attempt. If the ultimate aim of a model is to *understand* aspects of past settlement and land use behaviour, then prediction is only the means by which that understanding can be tested, and the model may be termed *explanatory*. If, on the other hand, the ultimate aim is to conserve the archaeological heritage, then

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<sup>2</sup> Kvamme (pers. comm.) notes that the terms 'inductive' and 'deductive' were originally used to describe only the method by which the so-called layer weights in predictive models were determined; derivation by multivariate statistics was 'inductive', while derivation by expert judgement or intuition was 'deductive'. Later, these terms were applied to predictive models as a whole, leading to the current terminological confusion. He further notes that pure induction, though rare, has been used in prediction of archaeological site locations by regression analysis of satellite remote sensing data.

the task of prediction is to estimate, as accurately as possible, the probability of the presence of archaeological remains in all parts of the study region, and the model may be called *correlative*. This distinction was in fact made early on but has since been forgotten (cf. Sebastian & Judge 1988:4). Strangely, very little attention has been paid to a second alternative distinction, concerning the choice between two fundamentally different approaches to prediction: possibilism and probabilism. Almost without exception, archaeological predictive models have been *possibilistic*: they only indicate how *suitable* an area is for a specific activity. In a possibilistic model gain (see below) can never be very high – providing an explanation for Ebert’s (2000:133) observation that in practise it never seems to get higher than about 70%. Despite its restricted scope it has been confused with the *probabilistic* approach which expresses how *likely* an area is to have been used for a specific activity.

#### MODEL ASSUMPTIONS AND EVALUATION

Archaeological models are simplified representations of processes or phenomena occurring in reality (depending on whether they take an explanatory or a correlative approach). Their value as ‘predictors’ is constrained by their aims and assumptions, and by the means available for testing. The validity of the assumptions depends on the aims and vice versa. Testing can provide an independent method for evaluating the quality of a model.

A fundamental but debatable assumption of all current ‘inductive’ (and, for that matter, most deductive) models is that the known archaeological remains are a representative sample of all extant archaeological remains. If a precise and accurate *description* of the known sample can be made, so the argument goes, then we will automatically have a precise and accurate *prediction* of the parent population of sites. As I have argued elsewhere in this thesis (chapter 3.1), this assumption has serious consequences for both our management and our understanding of archaeological resources. In management, predictive models are employed in order to locate and protect archaeological sites even in areas where no direct proof of their existence is available. As archaeological evidence only becomes apparent through the destruction of sites - surface finds and crop marks implying, for instance, that agricultural practices have damaged a site - we should expect the best preserved and therefore most valuable archaeology to be in areas from which none or few ‘sample’ sites are known.

While, in theory, predictive models could attempt to predict one or more of location, quantity, quality, and nature of archaeological values (cf. Kuna 2000:181-2), in practise they have been almost exclusively concerned with predicting the *location* of archaeological *settlement* remains. The precision with which such predictions have been made varies widely, depending on the modelling approach taken. In the simplest case, illustrated here in figure 1, predictions are binary (a site is either present in a particular map area, or it is absent). In this approach there are only four possible ‘states’ of the model. In general, the correct prediction of site presence (state 1) and site absence (state 4) should be maximised, with the corresponding states of incorrect prediction of site presence (3) and absence (2) minimised, but archaeological resource management (ARM) concerns mean that a greater importance may well be attached to lowering the incorrect prediction that no site will be present (state 2). *Predictive models therefore do not aim to obtain the statistical maximum.*

	P(site)	P(no site)
O(site)	1	2
O(no site)	3	4

Figure 1: predicted vs. observed presence / absence of sites

In addition to this simple approach resulting in nominal predictions, other approaches have been used to yield predictions at ordinal/interval (Boolean multivariate) and ratio (probabilistic multivariate) scales of measurement. Such approaches to prediction are possibilistic or weakly probabilistic in nature, that is, they only provide *relative degrees* of probability of site presence – usually of the ‘low, medium, high’ type. Such weak predictions can only be tested through an appropriate sampling scheme, which if properly executed will result in a particular *probability* that the prediction is correct, at some desired level of confidence.

As already discussed above, predictive modelling rests on the assumption that human activities in the landscape are patterned in various ways and scales. *Correlative* approaches further assume that available archaeological data are representative of the ensemble of discovered and undiscovered archaeological remains (henceforward referred to as the ‘soil archive’) in general (a sampling-theoretical assumption), and that better (more, and more detailed) data and statistical techniques will result in better predictions. Similarly, *explanatory* approaches assume that past societies have particular structures and economies, and that taphonomic and post-depositional processes have transformed their remains into the current archaeological soil archive. Whilst it must be emphasised here that under both types of approach testing is crucial if any of these assumptions is to be falsified (proven incorrect), one important practical ‘advantage’ of the correlative approach is that it can be conceptualised as the modelling of the *discovery* of archaeological remains rather than of their *presence*. In other words, the prediction is not concerned with what may be in the ground, but only with what will be discovered in the ground if past mechanisms causing the discovery of archaeological remains continue to operate in the future - a defensible stance from a CRM point of view. However, in both approaches the issue of data quality remains crucial (see section 2.2).

In the calculation of measures of statistical correlation between the location of archaeological remains and properties of the physical or social landscape, modellers implicitly rely on assumptions inherent in the statistical tools applied. Foremost of these is the assumption of *normality*, that is, the assumption that the values taken on by a variable, when plotted in a histogram, are distributed according to a normal or Gaussian curve. It can easily be shown that this assumption is incorrect for many of the variables typically used in predictive models (eg, the distance of sites from the nearest water source). In general, it cannot be assumed that any relevant population distribution is normal, and therefore *non-parametric* statistics such as logistic regression, discriminant analysis etc. are to be preferred unless the data can be normalized.

A second inherent, but mistaken, assumption is that statistical tools developed for non-spatial applications (think of the drawing of red and white balls from a vase, familiar from high school statistics) can be applied to geographical data as well. It has long been observed that “...conventional statistical tests usually require independence among observations, something that is generally untrue of spatially distributed information, and these procedures are usually aspatial in nature and design” (Cliff & Ord 1981). The most common methods of measuring the statistical relationship between a pair of variables - Pearson’s product-moment coefficient and rank order index and Kendall’s tau - do not consider the association that may exist between nearby locations (spatial autocorrelation) and cannot therefore be used for the analysis of spatial data in this form. However, some other non-spatial analytical techniques, such as Spearman’s rank-size rule and principal components analysis (PCA)<sup>3</sup>, continue to be important in archaeological analysis. Thus, Kuna (2000:37-41) uses factor analysis to determine diachronic change in settlement patterns from survey data in Bohemia (Czech Republic). Kvamme (1993:92) provided a clear demonstration of the significance of the ‘first law of geography’ in a GIS context by reshuffling his initially uncorrelated sample data to produce two obviously correlated spatial variables, which these tests would still claim to be uncorrelated. Statistically, a high degree of spatial autocorrelation means a lower effective sample size, thus lowering the significance of any correlations as measured by non-spatial statistics.

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<sup>3</sup> To perform principal component transformation on GRASS data layers, `r.covar` is used to get the covariance (or correlation) matrix for a set of data layers, `m.eigensystem` to extract the related eigen vectors, and `r.mapcalc` to form the desired components. Then, using the `W` vector, new maps are created of the principal components in the input data, in decreasing order of variance.

Most research on archaeological predictive modelling has concentrated on correlating a set of known archaeological sites to a multivariate environmental data set, and modelling the presumed distribution of such sites by extrapolation. Various rival methods have been developed, of which the main two are the logistic regression (logit) analysis perfected by Warren (e.g. Warren 1990, Warren & Asch 2000) and the rule-based methods exemplified by the work of most European researchers. Criticism of these methods has been targeted at both the theoretical underpinnings (as in the 'environmental determinism' debate, see Gaffney and Van Leusen 1995) and the methodology (Van Leusen 1996). Some researchers are turning to qualitative evidence derived from oral history and ethnographic studies in an attempt to construct predictive models that are partly based on cognitive factors (Pilon et al. 1997). Others, taking a leap of faith, interpret correlation as causation. A recent example of this can be found in Stancic & Veljanovski (2000), who interpret the statistically significant nearness of some Roman villas on the island of Brac (Dalmatia) to a geological unit known as 'Brac marble' as an indication that these villas were somehow associated with marble exploitation.

### *Model Quality*

Since many alternative models could conceivably be made for any specific area and period, it is important to be able to rate the models relative to each other. How is one model 'better' than another? What is a 'good' predictive model? Several answers to this question have been suggested, depending on whether one's focus is on results, methodology, or explanation.

- Specificity

If the aim of a predictive model is to circumscribe the 'allowable' geographical space for a specific set of archaeological remains, then a good model might be one that circumscribes this space very narrowly – it should be *specific*. A non-specific prediction is a useless prediction. But of course the predictions made by a good model should also be *accurate*, because a very specific but also inaccurate prediction is worse than useless. The quantitative *quality* of a model should therefore be measured along both of these axes, and this is in fact done by Kvamme's *gain* measurement (%sites - %area), popular mainly in the USA (cf. papers in Wescott & Brandon 2000). Because the proportion of sites included in the model is important in itself, and normalisation of the gain parameter is desirable, Wansleben and Verhart (1992:103-7) advocate a refined measurement  $K_j = \sqrt{(\%sites * gain / \%area \text{ without sites})^4}$ . However, it should be born in mind that such calculation of model gain are typically based on existing site records, and strictly speaking they therefore do not measure the quality of prediction at all, but rather of *retrodiction*. While for CRM purposes being able to predict the *absence* of archaeological remains might be extremely valuable, current approaches have no method for handling nonsite data - that is, the proven absence of archaeological sites in an area - exists. Such data are needed for a) exercising control over statistically derived predictive models and b) optimising any predictive model (see Kvamme 1983 for the role nonsites play in the calculation of probabilistic models).

- Falsifiability

From a procedural point of view a 'good' predictive model is one that follows a defined set of rules (*protocol*), is *testable*, and responds in predictable ways to new data. These characteristics ensure that models can be evaluated, without which no progress can be made in their scientific understanding. Many current models incorporate 'black box' stages of expert assessment and adjustment, and therefore fail on the criterion of protocol. Examples of good models in this procedural sense are presented by Warren (Warren & Asch 2000:6) and Dalla Bona (2000:77).

A model is a simplified version of reality; a useful model must suggest a hypothesis that allows the model builder to do an experiment or test. If a model generates no testable hypotheses, then it is useless. If the hypotheses generated by a useful model are not tested properly, then the model may be incorrectly

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<sup>4</sup> In cases where nothing is known about non-sites they revert to the simpler formula  $\sqrt{(\%sites * gain)}$ .

believed or disbelieved. The logical concomitant of a prediction is a *test*, resulting in a measurement of model quality, and in some cases even in a verification or a falsification of predictions made by the model. Whereas proper testing requires observations to be made 'blind' (i.e. independently of the model being tested), in practise such tests have rarely if ever been carried out. Instead, much weaker forms of testing have been used, usually by seeing how well the model fits existing evidence, or by looking for confirmatory evidence (e.g. by surveying areas of high predicted probability).

- Expert consensus

A 'good' model may also be defined as one that is recognisably congruent with patterns and processes occurring in the past. Since such a judgement can only be made by appropriate experts, this definition carries the seeds of circular reasoning - a model is 'good' if its results conform to the expectations of the experts. This criterion should therefore be discounted on procedural grounds.

From this brief discussion it is clear that the choice of model assessment criteria is fundamental. The three potential criteria cannot be easily brought into accord with each other, and much therefore depends on the practical use to which the model will be put. For example, *how* specific and accurate archaeological predictive models should be is a question to be answered by planning scientists; current models such as the Dutch national Indicative Map of Archaeological Values (IKAW) get away with a high level of generalisation and predictions of unknown accuracy. On the other hand, the principle of public accountability requires that any models being employed in a formal sense to apply legal restrictions must be procedurally transparent.

The contrast between the inductive and deductive approaches, discussed earlier, is also expressed here with respect to the role of expertise in the modelling process, and focuses on the question of whether models *excluding* expert knowledge can ever attain a high quality, and whether expert judgement can ever be formalised in a procedural sense.

### *Testing*

As mentioned above, one way to assess the quality of a model is to test it. Generally, any useful model must suggest at least one hypothesis that allows the model builder to do an experiment. Since we are concerned here with *predictive* models, the logical *test* to perform would be to see if predictions of site presence/absence or probability are born out in field research. Ideally, such a test should result in the adjustment of confidence limits associated with the model being tested (an outright verification or falsification of model predictions is much less likely). Whereas proper testing requires observations to be made 'blind' (i.e. independently of the model being tested), in practise such tests have rarely if ever been carried out. Instead, much weaker forms of testing have been used, usually by seeing how well the model fits existing evidence, or by looking for confirmatory evidence (e.g. by surveying areas of high predicted probability). In the Netherlands, an opportunity for a rather stronger form of testing is presenting itself in the large-scale infrastructural and sand/gravel extraction works being conducted. First generation national and regional predictive models developed at the ROB are now being 'field tested' through archaeological watching briefs at these works.

Both locational and predictive modelling relies heavily on the use of statistics in order to determine whether the characteristics of a particular set of locations (namely, those where archaeological sites of interest were found) is sufficiently 'unusual' to imply something of interest to the archaeologist. The 'unusualness' of the sample characteristics may be tested against those of a random sample of the same size (requiring two-sample tests), against *all* locations in the study area ('the population', requiring one-sample tests), or against a large number of random samples of the same size (Monte Carlo approach, see Kvamme 1996).



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## 2 METHODOLOGY

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### 2.1 IMPACT ASSESSMENT

It is not the *presence* per se, but the *value* of the archaeology which should result in the imposition of planning restrictions and the listing of monuments; any working predictive model should therefore incorporate a formal evaluative stage in which such a value is assigned. This is as much a political as a scientific decision and is therefore to some extent outside the scope of this review. Although researchers at the Dutch State Service for the Archaeological Heritage (ROB) have been active since the mid-1990s in studying the methods and data available for impact assessment (Groenewoudt 1994, Groenewoudt et al. 1994, Groenewoudt & Bloemers 1997) and resource evaluation (Deeben et al. 1999), these developments lag some years behind those in England. There, at a *national* level, the Monuments Protection Programme (MPP) monument assessments indicate how important a particular monument is and how much it needs conservation (Darvill et al. 1987, Startin 1992, English Heritage 1996), mainly with a view of providing statutory protective designations to the most important monuments. Evaluation systems developed for this purpose unfortunately remain unpublished in order to prevent their being used as an automated judgement mechanism (English Heritage 1996:2-3). The MPP methodology to arrive at a national evaluation of a particular monument type consists of four steps:

- *classification and characterisation*; relevant information is collected and a full monument type description is written
- *data collection*; a thesaurus of monuments is created following consultation with experts, and sites of potential national importance are identified
- *assessment*; site-by-site evaluation resulting in overall quantification and ranking
- *evaluation*; conservation and management options are set out so that policy can be formulated

The MPP evaluation system is based exclusively on *known* archaeological sites and landscapes, an approach also taken by CRM groups in the Netherlands and fundamental flaws in which I have discussed earlier (Van Leusen 1995, 1996). Formal models of threats to recorded archaeological remains in England were to be based on the national census of the condition and survival of archaeological monuments conducted by the Monuments At Risk Survey (MARS) project (Darvill & Wainwright n.d., Darvill & Fulton 1998, Anon. 1998), but so far none have been published. Furthest along in the implementation of actual threat models seems to be the Ontario Ministry of Natural Resources, where archaeologists have been building blocks of an ARM system for the past five years (Dalla Bona & Larcombe 1996, Dalla Bona 2000). This includes the detailed modelling of type and amount of damage (impact assessment) expected from the activities of the logging industry, which has a direct impact on the planning restrictions imposed (Gibson 1997).

Nor are data regarding the survival of sites available in anything like the required amount. Many of the sites on record for more than a decade have disappeared by now. The two major factors here will be geology (erosion/deposition) and land use (drainage, building, deep ploughing; cf. Hinchcliffe & Schadla-Hall 1980 and various books and papers on taphonomic processes by M Schiffer, e.g. Gould & Schiffer 1981).

The role of GIS within a wider archaeological information system has already become crucial in CRM in many parts of the western world. In the Netherlands, the second version of the IKAW and its local offspring are currently being used to help make planning decisions from the national to the municipal level (Deeben et al. 2001). A third generation of the IKAW, currently under development at the ROB (internal memorandum, 2001), aims to improve its potential as an advisory and decision-making tool, as

well as to gain more insight into the relations between the potentially extant soil archive, our current record of it, and the levels of threat and protection afforded by the current landscape. To this end, the IKAW must be enhanced with a data layer covering all land- and coastal surfaces, and assessing their paleogeographic, hydro- and pedological potential for preservation of cultural remains; a similar layer will be needed to estimate the probability of future degradation through land use (especially the piecemeal degradation through agricultural land use, forestry, and nature development), urban outlays and infrastructural works; and finally, procedures for legal protection of archaeological resources are to be reviewed in a manner similar to MARS and MPP, so that in future the value of a resource can be assessed using a scoring system based on the underlying IKAW data layers for rarity, preservation, group value, etc. (Deeben et al. 1999).

## 2.2 DATA QUALITY

Although I have in the previous pages already indicated that issues of data quality play an important role in limiting what can be done with predictive models, a more detailed discussion of issues relating to the quality of the archaeological and environmental input data follows.

### THE ARCHAEOLOGICAL RECORD

The ‘official’ archaeological record contains only a small subset of both currently known and historically attested archaeological observations, a fact recognised by most if not all students of archaeological records. Lang (2000:225) neatly encapsulated the problem when writing about the gap between ‘current knowledge’ and ‘deposited knowledge’. Exactly how much of a gap there is, remains to be determined by appropriate studies, but the author's experience suggests that as little as one quarter of currently available knowledge (as measured in numbers of find spots) may have been deposited in the central archaeological archive of the Netherlands. The same impression is conveyed by Verhagen (2000:232) who suggests that “the amount of data that has never been published in an accessible form is probably staggeringly large”.

We must therefore ask ourselves by what mechanisms archaeological observations in the past became (or did not become) part of the official record, and study the potential biases caused by this process (this thesis, chapter 4). We must further be aware that predictions based on the limited and biased subset of observations that has become part of *deposited* knowledge run the risk of being substantially incorrect – an insupportable situation from the management point of view if not from the academic one. Any regional predictive model should therefore be preceded by an assessment of the relation of deposited to current knowledge.

Furthermore, the archaeological record is a historically accreted one, with varying amounts of quality control applied during the entry process and typically without the metadata required to assess the quality of the data (cf. Garcia Sanjuan & Wheatley 1999). When the contents of the Dutch ‘paper’ archives were being transferred into a relational database format in the early 1990’s (Roorda & Wiemer 1992), many records could not be transferred because the quality of the information (especially its geographical, chronological, and functional resolution) was too low. These latter records have therefore been, to all intents and purposes, lost to archaeological prediction. Undoubtedly, a large part of the knowledge that is not part of the formal archaeological record is still part of *current* individual or institutional knowledge of professional and amateur archaeologists; but it is also precarious knowledge in that, unrecorded, it will disappear with the death of its bearer. The use of ‘expert judgement’ in predictive archaeological models either through the Bayesian mechanism of ‘prior probabilities’ or for ‘tuning’ the results is therefore unstable for two reasons: firstly the expert judgement cannot be scrutinised because it is unpublished, and secondly it all depends on which expert’s opinion is being taken.

Lang’s (2000) idea that CRM databases could function as test beds for research hypotheses, pattern detection, etc, rests on a belief that more data will do the trick; given the many problems with the quality and representativity of such data this may be doubted. A better understanding of the biases in deposited

as well as current knowledge is urgently needed (see chapter 4).

#### PHYSICAL AND COGNITIVE LANDSCAPE PARAMETERS

Problems associated with the quality and appropriateness of parameters of the current physical landscape have been the subject of abundant and detailed discussion, and need not be repeated here. Among the less thoroughly reviewed issues, especially relevant to predictive modelling in active geological areas, are the use of historical and palaeo-geographical reconstructions, and land evaluation based on methods developed for the world Food and Agricultural Organisation (FAO 1976). In most parts of Europe land evaluation, which present research suggests may become more widely used as a basis for ‘deductive’ landscape ecological modelling, will require detailed and extensive geopedological fieldwork and historical research if reasonably accurate landscape reconstructions are to be generated. The latter are again crucial in the evaluation of the presence, quality, value and sensitivity to threats of archaeological resources for management policies.

Whilst for some regions and periods, historical sources and documents may provide some evidence of past cognitive landscapes, this will not be the case for most pre-modern landscapes. The use of cognitive landscape parameters in predictive models therefore rests in the main on ethnographic analogy, the simple transfer of modern landscape interpretations, or unsupported ‘narrative’ constrained only by the characteristics of the extant archaeological record. Foremost among the cognitive parameters investigated are landscape visibility and accessibility (and their converses), which are discussed elsewhere in this thesis (chapter 6). Recently, the context for their use has been mainly derived from landscape architecture and has been applied to relatively well-preserved archaeological landscapes such as the ritual landscape of the southern British chalk downs (see especially the papers in Lock (ed) 2000). Authors such as Lock himself have stressed the hypothetical and heuristic nature of such reconstructions, and it is not yet to what degree rule-based approaches to cognitive landscape reconstruction will be able to improve predictive settlement models.

Both physical and cognitive factors tend to be used in the modelling of *static* patterns of archaeological settlement or ritual land use, and only implicitly of the processes that result in these patterns. This is largely due to the poor temporal resolution of the available archaeological data (see next section) and tends to hide the fact that the most obvious constraint to the use of the landscape at any particular moment is its *current* use – any activity resulting in recognisable archaeological remains is normally performed within the context of a fully developed, and continually changing, physico-cognitive landscape. It is the ‘how’ and ‘why’ of this change, the *dynamics*, that we ultimately wish to understand. Rather than the quality of the physical and cognitive map layers themselves, it may therefore be that the quality of the sociological-behavioural rules governing the actions and reactions of a society will become paramount in future predictive models, which will then become based on simulations rather than on locational analysis. One simple example of this could be the application of a ‘splitting threshold’ for communities to model the process by which agricultural colonisation of a region takes place.

#### SCALE

At all stages of a predictive model, it is necessary to specify aspects of *scale*. Scale refers both to the spatio-temporal extent of the model and to the resolution of the data used by it. In addition to the relatively well-known importance of specifying and properly handling *cartographic* (spatial) scale (e.g., Sydoriak Allen 2000), *chronological* (temporal) and *analytical* (functional) scales assume roles of central importance in archaeological predictive modelling<sup>5</sup>. Since the past processes being targeted for modelling also occur at a variety of spatio-temporal scales, the quality of a model cannot be said to depend on high-quality input data only (the ‘more is better’ approach); rather, the scale of the data must be appropriate to the scale of the problem.

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<sup>5</sup> Note that this is not a reference to so-called ‘spatio-temporal’ GIS, the name for experimental systems that can handle four-dimensional data (esp. Harris & Lock 1996).

Space, time, and function can be thought of as different axes along which the available data can be differentiated; and the smaller the scale, the less differentiation is possible. In the realm of cartographic scale this means that mapped variables are always averaged across an area of space, eliminating variations that may have archaeological significance. Along the temporal axis a smaller scale means that archaeological and palaeo-geographical dynamics become averaged over periods of hundreds of years or 'bunched' into a small number of relatively well-recognised periods. Along the functional axis it means that many different types of human actions and their remains are lumped together to obtain a generic 'settlement' model. Archaeological predictive modellers have been forced into using small scales because of the limitations of the available data (see previous section), resulting in models of low gain (Ebert 2000).

### *Aggregate archaeological units*

One instructive and central scale problem in predictive modelling relates to the use of the 'site' (a point-like feature on all but the largest-scale maps) as the basic unit of record and analysis. The statistical nature of much predictive modelling requires that careful thought be given to the archaeological 'dependent variable' being analysed. In essence, the problem consists of deciding which are the appropriate archaeological units to analyse, and under what circumstances should multiple observations ('sites') really be taken to represent one such unit<sup>6</sup>. One practical reason for aggregating 'sites' into larger units might be the fact that the resolution of most environmental maps is too low anyway to be able to say anything reliably about a single site (cf. Sydoriak Allen 2000:103).

The Dutch State Service for Archaeological Investigations has attempted to tackle this issue by defining a new area unit, the Archaeological Resource Area (ARA), which typically includes a settlement and its 'infields' up to a distance of 200m (Deeben et al. 1997), and in the context of Mediterranean archaeology it might entail the aggregation of features such as building remains, ceramic scatters, and terracing into a new unit 'farm / rural villa' (see also my discussion of regional database design, this thesis, chapter 13). The aggregation of a number of point-like observations into an areal unit of a variable size takes us into uncharted methodological waters. For example, the increase in the number of raster cells taken up by the ARA relative to the area of the 'sites' it was based on, affects the calculation of statistical measures of correlation because it produces sets of highly clustered 'observations' (Van Leusen 1996:190). Other unanticipated effects on the outcomes of our models are likely to occur as seemingly 'technical' variables such as our choice of analysis region, scale, and resolution impinge on the archaeological problem being analysed. Future predictive models, not only in the area of CRM but in academic usage as well, should contain safeguards against such fatal mistakes.

## 2.3 DATA QUANTITY

Although the need to create separate models for each significant chronological and functional subset of sites was already apparent by the early 1980s (Kohler and Parker 1986), subsequent CRM-oriented models often disregarded this aspect, and frequent reminders have therefore continued to appear in the literature (cf. Verhagen 2000:229-232 for a recent example). The reason for this lies in the inavailability of a sufficient number of observations. Methods for establishing the existence and strength of statistical correlations invariably require a set minimum number of observations to be made before a given confidence level can be reached. In many cases where the observations must be selected from a limited set of archaeological 'site' records of sufficient quality, this quantitative minimum can not be reached unless a very low confidence level is accepted.

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<sup>6</sup> Although not the subject of discussion here, it may be noted that an object-oriented approach to the construction of regional archaeological data sets seems the most appropriate in this respect.

## 2.4 EXTENSIONS

Given the current state of predictive modelling methodology in the Netherlands, it may be claimed that the approach is not yet sufficiently matured to begin yielding high quality predictions. While data quality can only be improved with great effort and much time, better methods can be developed and adopted relatively quickly. The following four extensions are therefore proposed as likely avenues for the further development of an improved predictive modelling methodology.

### *Bayesian inference*

Van Dalen (1999) experimented with the use of Bayesian inference techniques in models applied to archaeological data from the Rieti basin (Italy) survey. A formal Bayesian approach has the advantage of transparency – allowing methodological separation of expert judgement (= prior belief) and observations, and therefore represents a step towards the formalisation of the 'seat of the pants' archaeological predictive models typically used in Dutch CRM (e.g., Scholte Lubberink *et al.* 1994). Verhagen (2001) recently discussed the potential of this method as well.

### *Fuzzy Logic*

Given the uncertainties inherent in mapped environmental data and, most worryingly, in archaeological records, predictive models would benefit from a methodology that can deal with uncertainty. Enabling fuzzy GIS and database types and operations may be one way in which uncertain data can be represented and analysed. Although fuzzy GIS operations are not entirely unknown in archaeology (e.g., Nackaerts *et al.* 1999), Crescioli *et al.* (2000) only recently introduced the use of fuzzy logic in the database part of a GIS. Using the public domain PostGreSQL-GRASS combination, they added fuzzy data types and functions in order to store, query, and display fuzzy age, gender, and chronology attributes for graves and skeletons of the Pontecagnano cemetery. In as much as this enables operators to store the many uncertain properties of both archaeological objects and cartographic representations of real-world features, this development has the potential of clearing the way for a considerably improved practise of predictive modelling.

### *Landscape Reconstruction*

The potential of land evaluation as a formal method for modelling environmental potential and constraint has so far been explored in a limited number of case studies only, but can be applied to any early agriculturalist society for which the physical landscape can be reconstructed to a sufficient degree. Models based on land evaluation have the further advantage that they are *generic* (they can be applied to any area with a similar environment without reference to its archaeology) and *falsifiable* (they can be tested both against existing archaeological records and by a straightforward programme of fieldwork); they therefore offer hope of a more constructive and objective approach to the study of past landscapes than has hitherto been possible. Dalla Bona's models of prehistoric non-agricultural occupation of the wooded Canadian landscape hold out the hope that the logic, if not the method, of land evaluation can be extended to cover pastoralist/arboricultural/hunting lifestyles as well (see also Kamermans 1993 for similar work in central Italy). Land evaluation is an important component of the RPC project (Van Joolen, forthcoming).

However, since land evaluation will often require a large investment in palaeo-geographic reconstruction (coring programmes, palynological reconstructions), other means of reconstructing past landscapes deserve more attention as well. Early historic landscapes might, for instance, be reconstructed using additional sources of historical information deriving from place-name etymology, historic literary and cartographic sources, etc.

### *Spatial Statistics*

*“Archaeology is an eclectic discipline; where it calls on scientific and statistical knowledge, few individuals combine all the necessary archaeological, scientific and statistical skills at a high level. Ideally, collaboration should take place between archaeologists and statisticians in those areas where a statistical input is of potential interest. Unfortunately, not all archaeologists regard statisticians as useful creatures and there are, in any case, not enough interested statisticians to go around.”*

- Baxter (1994: 219)

This quotation is particularly relevant to the use of GIS by archaeologists, because the visual nature of the software makes it easy to remain unaware of, or disregard, the essentially quantitative nature of operations and the biased nature of the available data samples.

### **Statistical decorrelation**

Earlier (Van Leusen 1996:190) I identified the failure of practitioners to deal with the regular occurrence of strong correlations between the variables typically used in predictive modelling as one of its principal methodological shortcomings. Yet methods do exist to remedy the statistical problem, albeit usually at the price of producing a set of decorrelated variables which cannot easily be understood in real-world terms<sup>7</sup>. Principal components analysis (PCA) can be used to construct a set of less correlated components from an original set of potentially strongly correlated cases (Q-mode) or variables (R-mode), followed by K-means clustering of components in order to find out if interpretable clusters exist.

### **Spatial Autocorrelation and Geostatistics**

As argued in section 1.2.2 above, statistical tests of significance must be used in a manner appropriate to the type of data being analysed. In particular, tests assuming independence between observations (cases) and/or normality of test distributions should be replaced by tests which take into account the degree of spatial autocorrelation displayed by each variable involved, and which either make no assumptions about the shape of their distributions at all (eg, Monte Carlo type tests), or make assumptions which can be shown to be realistic (eg, many distributions may resemble that of the Poisson curve). In spatial autocorrelation, nearby observations tend to be similar because geographic variables do not change quickly over short distances. If a set of archaeological observations is spatially clustered (as may result, for example, from an intensive survey of a small area) their geographical characteristics are likely to be similar, and could therefore lead to the derivation of overly strong locational 'preferences'. Dealing with this issue, Kvamme (1993) presented Moran's I test, which attempts to measure the correlation of a single variable with itself over space - the distance between any pair of observations being measured, for example, as Euclidean distance (but any measurement of 'distance' is acceptable). Moran's I statistic can be calculated on the basis of the *covariance* of the variables under consideration. Using the apparent sample size N and Moran's I, a new corrected (lower) sample size may be calculated to which non-spatial 'critical-point' tables such as chi<sup>2</sup>-tables can be applied. In other words, the original cluster of observations is reduced to a lower number of observations from which more realistic 'preferences' may be inferred.

Geostatistics are a body of theory and methods designed for the analysis of spatially correlated, geographical variables. Despite the reservations expressed by Barceló and Pallarés in their discussion of the theory and method of social space (1998:65), that geostatistical methods do not perfectly fit archaeological purposes because social action and, with it, social space is discrete rather than continuous, I believe that the construction of geopedological units on the basis of point measurements (corings) and areal observations (geomorphological units) is sufficiently similar to the construction of meaningful archaeological entities (eg, site catchment areas and urban manuring zones) on the basis of excavations

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<sup>7</sup> This need not be an objection if the model is not intended to further understanding, but rather to maximise predictive power. Factor analysis, which is an attempt to explain the correlations between observable variables in terms of underlying factors which themselves are not observable, may be a more appropriate technique if meaningful explanations are desired.

and surveys to warrant a further exploration of the potential of geostatistical models for variables such as artefact density. Methods such as constrained co-Kriging would even allow the use of correlated variables such as slope and distance to water, and the modeling of discontinuous variables. The underlying assumptions (eg, regarding the normal distribution of the variables) should of course be born in mind when applying geostatistical methods to archaeological data.

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### 3 CONCLUSIONS

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Wide-area predictive modelling using GIS is poised to play a very important role in CRM at the national level in most of Europe because of the imminent implementation of the Valletta Treaty, but at the same time it has remained an important tool for academic research as well. For both types of users the ability to generate formal, rule-based, and testable hypotheses in the form of predictive maps is fundamental, and these require a better understanding of the underlying theory, data and methods. In this article, I have identified and discussed several issues which are relevant to future wide-area predictive models. This leads me to the following conclusions:

- research into, and discussion of, predictive modelling has been hampered by a lack of definition of core notions, e.g. what exactly is a predictive model supposed to predict? How do we decide what is a 'good' model? Many 'predictive' models in fact do no more than describe the input sample of archaeological site data, and none have formal quality criteria that were actually tested. Such definitions and criteria should be a requisite part of any predictive model;
- there are still major quality problems with current predictive models. They do not yet have sufficient spatial, functional, and temporal resolution to provide predictions to rival those of experts, they do not allow for the formal inclusion of archaeological theory and expertise, and they do not formally incorporate stages of source criticism (bias correction) and quality testing. The surest (and perhaps even fastest) way to improving predictive modelling of archaeological site distributions is to conduct properly designed field tests. Expert knowledge must be given a formal place in the process of predictive modelling, possibly through the use of Bayesian inference.
- correlative predictive modelling rests on statistical procedures for determining presence and type of patterning in the input data. This has two important consequences. Firstly, improper use of statistical procedures strikes at the heart of the models; secondly, the ensuing predictions take the form of probabilistic statements which can easily be misunderstood by end users of predictive maps. It is therefore imperative that predictive models incorporate safeguards against incorrect use of statistical inference, and that a clear distinction be made between the predictive model itself, and any derivative maps that indicate the value and/or need for protection of the archaeological record;
- Most known archaeological patterns are the result of archaeological research bias, whether this is by the influence of vegetation, the difficulty of detecting buried sites, or specific interests of archaeologists in certain kinds of sites and artefacts. A phase of source criticism of both archaeological and environmental input data should therefore be mandatory, and the modelling methodology should be sensitive to the characteristics of the available data set. Taphonomical maps that assess the nature and extent of the distortions of the known material heritage should be an integral part of any predictive model. If this is not done, 'low potential' zones run the risk of being regarded as 'zones of no interest', whereas they may in fact be zones of insufficient data within the archaeological record. Predictive maps run the risk of turning into self-fulfilling prophecies if these zones, because of their 'low potential', are not included in subsequent surveys.
- predictive models, and especially the maps they give rise to, already play a significant and useful role in the cultural resource management (CRM) process, not just because they provide a structured and

formal archaeological participation in this process for the first time but, at a technical level, because they have helped shift attention from site-based to zone-based conservation. However, such models have barely touched the question of how to model quality, rarity, nature, and indeed 'value' of archaeological remains (Deeben et al. 1999). Incorporating these factors will bring predictive models closer to true expert systems and must be regarded as the next major stage in the development of geographical models for archaeological resource management.

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# LINE-OF-SIGHT AND COST SURFACE ANALYSIS USING GIS\*

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## 1 INTRODUCTION

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This review article assesses the majority of accessible archaeological studies based on two GIS techniques (viewshed analysis and cost surface analysis) over the decade 1990-2000. The two techniques are taken together because of certain similarities in methodology and underlying theoretical principles, which express an emphasis on the human experience of being and moving in the landscape; not surprisingly, these techniques have been at the centre of processual – postprocessual debate almost from the beginning.

### 1.1 AIMS

This paper reviews published work in two related areas of GIS application in archaeology – line-of-sight analysis (LOSA) and cost surface analysis (CSA). Line-of-sight analysis uses the ability of most GIS to calculate the intervisibility of two given points on a given digital elevation model; cost surface analysis uses cost accumulation algorithms to calculate the cumulative cost of travelling over a digital cost landscape. These two techniques have received much attention in recent years, first because they were seen to be implementations of well-established ‘processualist’ analytical procedures, and latterly because of their supposed potential to escape from naïve quantitative processualism into ‘enriched’ qualitative post-processualist (post-structuralist) types of analysis. Because it provides the context for much current work, this debate is summarised here in section 1.2. However, as I hope to show in this article, the theoretical affiliations and rhetoric of the various researchers appear to have little influence on the practicalities of implementing GIS-based LOSA and CSA; rather, it is the type of question that is being asked that determines methodological possibilities and constraints.

The larger part of this article (sections 2 and 3) is therefore concerned with reviewing *procedural* aspects of CSA and LOSA studies.

The field of CSA and LOSA has reached a stage where stocktaking has become useful (see, for example, Van Leusen 1999, Witcher 1999, Wheatley & Gillings 2000, in press). A subsidiary aim of this review has been to provide the reader with a starting point for locating case studies and methodological studies relevant to their own research – hence the extended bibliography section.

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\* An earlier version of this article, dealing with developments up to about 1998, was published in the proceedings of the 1998 Annual Meeting of CAA (Barceló et al. 1999), but this has been substantially revised and updated for the current version. In conjunction with this article, two other chapters in my thesis (15 and 16) present case studies conducted over the years in order to investigate aspects of ‘dominance’, territory, and accessibility arising from archaeological thinking about the role of Late Iron Age hillforts and markets in the Wroxeter hinterland (UK), of early Roman colonies on the Lepine Margin (Pontine Region, central Italy), and of Middle Bronze Age to Early Iron Age settlements in the Sibaritide (southern Italy).

Much of the work discussed in this review has only comparatively recently become accessible in the form of published proceedings (Dingwall et al. 1999, Barceló et al. 1999, Gillings et al. 1999, Lock 2000, Stancic & Veljanovski 2001) which, however, tend to give voice to a specifically Anglophone community. Although I have tried to alleviate this bias by also including examples drawn from work done elsewhere, I cannot claim to have succeeded in this. I hope that my emphasis on the methodology rather than the content of the examples has palliated the effects of this failing. Furthermore, I have taken care to include the work and views of non-archaeologists (geographers and landscape planners in particular), as well as materials that are only available on CD-ROM (Dingwall et al. 1999, Johnson & North 1997).

## 1.2 THEORETICAL CONTEXT

Following an initial period in which an increasing number of archaeologists experimented with the use of GIS to grapple with a variety of questions, many critics argued that the naive use of GIS has led to a revival of *environmental determinism* (an issue discussed more fully in Gaffney & Van Leusen 1995), and have advocated a post-processualist approach to using GIS. The root of the problem was seen to lie in the geographic approaches from which GIS were built, in which space was treated as an abstract geographical concept ('Cartesian space'). As Llobera (1996) puts it, there is no observer, no perspective, and no history in this kind of space. The alternative, post-processual concept of space has, by contrast, been 'humanised': space derives its meaning and properties from the presence of observers.

Others think however that despite appearances, GIS can be used in various ways for the modelling of cognitive landscapes (Wheatley 1993, Taylor & Johnston 1995). Attempts to address the perceived rigidity of current GIS applications include the incorporation of concepts of uncertainty (Gillings 1996, 1998, Loots et al. 1999, Nackaerts et al. 1999), the ideal organisation of space and society (Zubrow 1994), time and change, and of affordances (Llobera 1996). This is signalled as an important current development in the *GIS Guide to Good Practice* (Gillings & Wise 1998), but it is not yet clear what, if any, improvements these approaches will bring. This issue is discussed in more depth in section 3.3.

What makes us think GIS can be used in reconstructing past landscapes? The landscape, both in the past and in the present, is structured by the fact that resources are distributed unequally over it. This applies to both natural and social resources - drinking water and infrastructure are only available in some places; good farming and stock rearing land is not available everywhere or is already occupied by others; centres of political power, civic administration, and ritual significance are few and far between. People's choices both structure this 'resource landscape' and are structured by it, and we therefore expect archaeological remains to exhibit structuring of this type. Viewshed and cost surface analysis are two ways to reveal such structuring.

The latter has aroused widespread scepticism about the usefulness of GIS in archaeological research as, for instance, at the 1995 meeting of the UISPP (Bietti et al. 1996; Johnson & North 1997; reviewed by Bampton 1997). A balanced outsider view of the issue can be found in Taylor and Johnston (1995), who placed then current uses of GIS in the context of the 'quantitative revolution' and the 'New Geography' that took place in the 50s and 60s. These authors provide a useful and provoking discussion of the dangers of much current data-led GIS use but also stress the potential - mainly in pattern analysis (see also Gaffney & Van Leusen 1995).

Whilst American researchers have tended to continue in this processualist tradition, much recent European work, largely driven by a British post-structuralist school, stresses humanistic (as opposed to abstract, Cartesian) forms of spatial reasoning. The latter rely heavily on LOSA and, to a lesser extent, on CSA for modelling past perceptions of the natural and human environment. Hermeneutics (the art of interpretation) has been put forward as offering a theoretical basis for viewshed analysis in particular (Lock et al. 1999:61). Thus, philosophical positions appear to be irreconcilable at the moment. On the other hand, it is not clear that these positions result in substantially different approaches to LOSA and CSA. Post-processual contributions may be replete with references to Bender's (1993) edited volume on landscape perspectives and Tilley's *Interpretative Archaeology* (1993) and *Phenomenology of Landscape*

(1994); talk may be of ‘perception’ and ‘meaning’ rather than of ‘viewsheds’ and ‘patterns’, of ‘the hermeneutic spiral’ rather than of ‘exploratory data analysis’; but there the differences end. As Tschan et al. (2000:33) remark, many recent theoretical ‘advances’ are entirely devoid of any current methodologies or even of the potential of such.

Rather than classifying LOSA- and CSA- based studies on the basis of –isms, a more fruitful approach would be to look at the subject matter (type and amount of archaeological data, geographical and temporal scale) and research aims. Accordingly, two types can be distinguished:

- At a relatively local scale, students want to explore cognitive space around single monuments or synchronic/diachronic systems of monuments. This type of study often has a dynamic component, either in space (movement) or in time (creation of monumental landscapes). The objective is to explore what is *unique* about the situation.
- At regional scales, students are intent on using social/cognitive variables in order to build models that allow us to detect and explain observed patterns site locations and attributes. Here, the objective is to explore *similarities* between situations, and models are typically static and quantitative in nature.

The former, qualitative, approach seems most useful in situations where high quality archaeological data are available, whereas the latter represents more of a continuation of the quantitative deterministic approach - albeit with the use of an enlarged set of variables to play with. In this regard it is noteworthy that *qualitative* GIS models are nearly all based on well-studied landscapes replete with monuments and symbolic meanings.

The aim of the current review of methods is to allow us to turn our attention to the more fruitful task of answering archaeological questions. But there is also a second reason for reviewing current archaeological applications of viewshed and cost surface analyses - archaeological arguments that are ultimately, if only partly, based on their outcome become invalid if they have been improperly applied or if the results have been wrongly interpreted.

### 1.3 CSA AND LOSA: TWIN TOOLS FOR COGNITIVE LANDSCAPE ANALYSIS

The reader might wonder why the two separate techniques are discussed together. Although they are superficially different, viewshed and cost surface analyses are intimately related techniques because they both define aspects of the social space surrounding an observer. Take, for example, territorial markers. These must be highly visible (though not indiscriminately so, as we shall see below) and also be located at the edge of some kind of ‘territory’. The former is modelled through LOSA, the latter through CSA; the two cannot be separated.

A more abstract way of looking at the relation between the two techniques would be to note that both are based on the notions of *focus* (in the sense of a point-like location which might be the current or intended location of the protagonist, or might have a significant level of visibility or accessibility) and *direction* (as in megalithic alignments pointing at midsummer sunrise points, or in the travel networks discussed below). As was recently pointed out by Wheatley and Gillings (2000:4), post-structuralist theory provides another argument for linking the two techniques, in that *perception* is meaningful only to *mobile* observers.

Such interrelations are expressed, consciously or unconsciously, in studies that combine both types of analysis in order to construct an archaeological argument. See, for example, the work of Gaffney et al. (1996a, 1996b:37-8), where cost surface derived catchments are compared with viewsheds of Iron Age hillforts on the Dalmatian islands; the suggestion in Belcher et al. (1999:98-100) that Archaic tombs around the urban settlement of Nepi in Tuscany are situated in areas difficult to reach while easy to see; Madry and Rakos’ (1996:123) use of the visibility of Roman roads from hillforts in Burgundy as an

input variable for cost surface analysis; and Llobera's (2000:72-5) use of viewsheds to define 'attractive' and 'repellent' factors influencing movement near certain types of monuments.

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## 2 COST SURFACE ANALYSIS

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### 2.1 PRINCIPLES AND APPLICATIONS

'Cost surface analysis' is here used as the generic name for a series of GIS techniques based on the ability to assign a cost to each cell in a raster map, and to accumulate these costs by travelling over the map. Early examples were published by archaeologists working with the Arkansas Archaeological Survey and the US National Parks Service (Limp 1989, 1990). Cost surface analysis is rooted in traditional site catchment analysis, introduced to archaeology by Vita-Finzi and Higgs (1970), who wanted to study the economic basis of prehistoric life by looking at optimal foraging models of resources available within a *catchment area* or territory associated with a settlement<sup>1</sup>.

The first step in site catchment analysis is to derive a territory (catchment) belonging to a given focus (site) by applying some geographical rule. In its simplest form this would be a distance rule, resulting in circular catchments with a typical radius of 5 or 10 km. The second step is to analyse the properties of the catchment area, usually to see what economic benefits (e.g., agricultural yields) would accrue to the focus. The radius would be chosen by experimenting with actual travel times, or by reference to ethnographic data (Chisholm 1968). Deriving a circular catchment area within a GIS is a trivial operation, and reporting and tabulating the presence of variables within each catchment can be automated. Recent examples can be found in Saile (1997) and Lock and Harris (1996:234-8), who used such buffers to model areas of in- and outfield agriculture around Iron Age Danebury hillfort. A more sophisticated form of such analysis is the construction of distance buffers around the focus, allowing a statistical analysis to see if some archaeological correlates gravitate significantly toward or away from it. One well-known example of this is Hodder and Orton's (1976) calculation of the distance distribution between coins and Roman roads in southern Britain<sup>2</sup>; a very similar application with an interesting twist in the tail was presented recently by Rajala et al. (1999), who interpret the correlation between site locations and distance to Roman roads as indicating discovery biases.

Closely related to catchments are *tessellations*, which have a more specific and theory-laden meaning. Whereas catchments are generally used to describe economic characteristics of the archaeological landscape, tessellations of archaeological landscapes are used to postulate a social (political, administrative, religious) structuring – for example, in Renfrew's (1986) peer polities. The most widely known traditional method for doing this is the calculation of Thiessen (Voronoi, Dirichlet) polygons. These are based on a simple nearest-neighbour method for partitioning a featureless space, equivalent to a gravity model operating in 'Flatland', and result in a complete tessellation of space. Both traditional catchments and tessellations rely on the simplifying assumption that the landscape is a flat, two-dimensional space, and resistance to movement across it is isotropic (the same in all directions). They also result in choroplethe maps rather than mapping the continuous fall-off of variables such as accessibility and control. In a real landscape the size and shape of a catchment area or territory would be much more variable, depending on the nature of the terrain, the topography, and a host of other factors. In a real landscape, the economic use of, and social control over, an area becomes less with distance rather than suddenly switching from yes to no (1 to 0) as the boundary of the catchment or territory is crossed.

Cost surface analysis provides a way out of this by allowing the simple 'flat' geographical space to be supplanted by a set of complex cost surfaces incorporating many relevant properties of the terrain. It also allows for the distance- and gravity based rules for defining the catchment or territory boundaries to be replaced by a time- or energy expenditure based rule for accumulating costs. As the resulting cumulative cost surface is a continuous raster map, any number of values may subsequently be used to provide



'cut-off points' or boundaries to the catchment or territory. Alternatively, cost accumulation starting at multiple points may be allowed to run on until all available space has been used, in which case a tessellation of space similar to Voronoi tessellation has resulted. For example, Verhagen et al. (1999) calculate cumulative travel time in order to construct 'accessibility catchments' which are then used as an input variable in a predictive settlement model. Stancic (1994) Stancic et al. (1995) compare and contrast all three methods (Thiessen polygons, circular catchments, and cost-derived catchments) using protohistoric settlement data from the Dolenjska region in Slovenia. As we shall see in the next section, the possibilities offered by this technique have led to some confusion as to the best way of calculating costs.

## 2.2 ALGORITHMIC CONFUSION

Employing a simple radius to define a catchment area is equivalent to travelling over a flat cost surface; accumulation in this special case is constant in all directions and the maximum horizontal distance therefore defines the boundaries of the catchment area. If accumulation from a number of starting points is allowed to continue until the entire cost surface is covered, a Voronoi tessellation results. Just as the traditional method can be modified to employ travel time as a limiting factor, so cost surfaces can be modified to reflect the difficulty of travelling over various types of terrain. Accumulating such costs will result in irregularly shaped catchments for any particular total energy expenditure. This principle can be extended so that any combination of factors can be used to define costs, and any combination of criteria can be used to derive a cumulative cost surface from those costs. Exactly how all this should be implemented is a question that seems to have been answered differently by each individual author. In the published research there is a wide variety in the parameters used to calculate cost/energy surfaces and in the algorithms used to perform cost accumulation - a sign of the immaturity of the field.

A further refinement of the technique, originally discussed by Renfrew and Level (1979) as 'XTENT modelling', would result from assigning differential weights to the sites or *foci* of the catchments, so that accumulation proceeds with different degrees of ease over any particular cost surface. Ruggles and Church (1996) first applied it in a GIS context in a weighted Thiessen tessellation of their Mexican study area, but no implementations using CSA have been published as yet.

Most studies have relied exclusively - and continue to do so - on slope as the factor determining cost (e.g., Gaffney and Stancic 1991, Gaffney et al. 1993, Massagrande 1996, 1999, Bell & Lock 2000). This may work in areas where topography has an overriding effect on human behaviour; see, for instance, Huckerby's (1999) study of how well four rival foraging theories fit with the costs of accessing mammalian resources in Queensland, Australia. But more realistic calculations, based on physiological measurements of energy expenditure on different types of terrain, are now feasible and have recently been employed in several studies (see below). A recent comprehensive review of the literature on all forms of walking is contained in a volume edited by Rose and Gamble (1994).

Some authors have attempted to derive costs inductively, from archaeological observations relating to actual territorial boundaries or actual distances travelled per time slice. One example of this is the work of Glass et al. (1999) and Anderson and Gillam (2000), who derive costs from observed dates of first occupation of North and South American sites, and assume that the 'delays' between colonisation of successive areas are caused by the cost of travelling from one to the next. Apparently no universal set of absolute real-world travel costs is to be found in the literature, but this need not be a problem so long as a universal set of relative costs can be found.

Travel cost surfaces can be isotropic (the same in all directions) or anisotropic<sup>3</sup>. Because of the effect of both slope and terrain, the cost of traversing a particular location may differ depending on which direction it is being crossed in. Crossing cells representing a river is an obvious example of terrain anisotropy - travelling down-river in a boat incurs different costs from travelling up-river, and different costs again when crossing the river. Surprisingly, until very recently raster GIS did not provide the functionality to introduce anisotropy; a closer merging with the functionality generally present in

vector GIS seems needed. Examples of models based exclusively on isotropic cost surfaces can be found in Savage (1990); Rajala (1998) mapped territories in the Ager Faliscus using an isotropic cost surface derived from slope and based on empirical walking effort data; finally, Bell and Lock (2000:88-9) derive the *relative* isotropic slope-related cost from the ratio between its tangent and the tangent of 1°, assigning the latter a cost of 1. Thus, the cost of ascending or descending any slope  $\theta$  is determined by the formula

$$\tan(\theta) / \tan(1^\circ)$$

which produces a non-linear relation between slope and cost (also visible in the downslopes of figure 1), becoming significant on slopes steeper than about 25°.

However, most authors agree that travel cost has both an isotropic and an anisotropic component; the former exemplified by costs relating to the type of terrain (soil, vegetation, and wetness), the latter by costs relating to slope and streams. Verhagen et al. (1999) calculate the accessibility of settlements in the Vera Basin, Spain, on the basis of slope according to a formula provided by Gorenflo and Gale (1990). They specify the effect of slope on travelling speed by foot as:

$$v = 6 e^{-3.5 |s + 0.05|}$$

where  $v$  = walking speed in km/h,  $s$  = slope of terrain in degrees, and  $e$  = the base for natural logarithms. This function is symmetric but slightly offset from a slope of zero so the estimated velocity will be greatest when walking down a slight incline. Bell (Bell et al. 2002) also employs an anisotropic cost surface based on slope to generate a cumulative path network between Samnite sites in central Italy.

It should be noted that anisotropic functions only work if the direction of travel is taken into account – otherwise they revert to isotropy. For instance, the variable representing slope in the Gorenflo and Gale formula (above) has to be signed in order for the slight ‘preference’ for downslopes to emerge. Introducing anisotropy in slope costs is not trivial, and recent approaches, which are based on the capability of GIS to generate aspect (direction of steepest slope) maps, are forced into making simplifying assumptions about the direction of travel. Bell and Lock (2000:90) introduce anisotropy in slope related costs by interposing an aspect checking step – cutting costs by 50% for ‘angled’ ascents and benefits by 50% for ‘angled’ descents<sup>4</sup>. Likewise, the isotropic formula

$$\text{Effort} = (\text{percent slope}) / 10$$

was modified by Hayden (pers. comm.) into an anisotropic formula by calculating full cost upslope, no cost cross-slope, and half-cost downslope. Hayden then added an isotropic cost layer for different terrain types and terrain roughness (calculated as the change in slope). However, the best published work in this regard is by Krist (2001a,b), who used the general orientation of historic native American trails in Michigan to determine which aspects represent up, down, and sideways. On this basis he calculated an adjusted slope  $S_a$  using the formula

$$S_a = S * \cos(A_t - A)$$

where  $S$  and  $A$  are the original slope (in percent rise) and aspect values, and  $A_t$  is the direction to the starting point. The multiplier  $\cos(A_t - A)$  ranges from  $-1$  to  $1$ , generating negative values for downslopes while attenuating the effect of sideslopes. To convert the adjusted slope values into cost surfaces representing energy expenditure in kcal, they and a constant for average human walking speed of 100m/minute were entered into McDonald’s (1961) three physiological equations for topographic energy expenditure<sup>5</sup>. The resultant cost surface could then be combined with a second, terrain, cost surface representing additional barriers thrown up by lakes and wetlands.

Because anisotropy was introduced into the cost calculations, Krist then had to repeat them for both directions of travel along each trail segment. A very similar approach was taken by De Silva and Pizzolo (2001), who adapted an anisotropic function deriving from backpacking (Ericson and Goldstein

1980) to calculate a maximum friction surface for round trip movement in the Neolithic of the Biferno valley (Italy), modifying it to:

$$\text{effective friction} = \text{stated friction} |\cos^k \alpha|$$

where  $k$  is a user defined coefficient (2 for movement on foot), and  $\alpha$  is the difference in degrees between the walking direction and the direction of maximum friction.

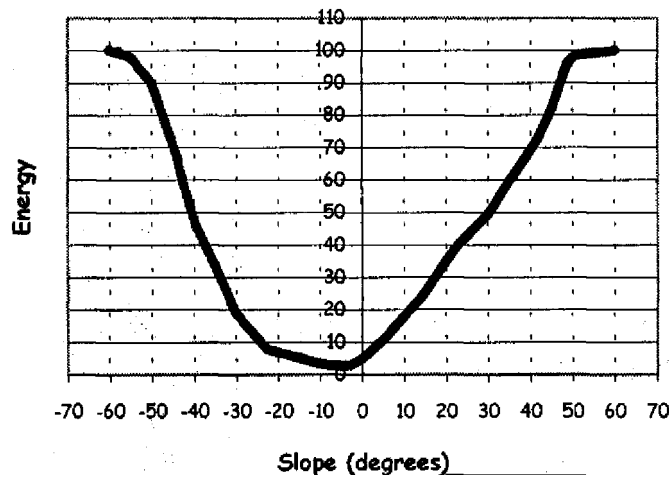


Figure 1 – Relation between terrain slope and energy cost (after Llobera 2000: fig 2).

Marble (1996) suggests that, since the function relating physiological expenditure to slope is approximately symmetrical, we can safely ignore the whole problem of anisotropy. However, as the graph in Figure 1 shows, the axis of approximate symmetry is at  $-6^\circ$  of slope. Consequently, different optimal paths may obtain between two points depending on the direction of travel; hence, the sign of the slope becomes a significant factor in the calculation of friction surfaces and least cost paths.

Krist’s approach (above) for calculating a direction adjusted slope map may be combined with the idea of an axis of cost symmetry at  $-6^\circ$  of slope, and the formula developed by Pandolf et al. (1977):

$$M = 1.5W + 2.0 (W + L) (L / W)^2 + N (W + L) (1.5V^2 + 0.35V * \text{abs}(G + 6))$$

This formula calculates the actual physiological expenditure  $M$  (metabolic rate in Watts) involved in moving over natural terrain, and incorporates total weight moved (body  $W$  plus load  $L$ ), velocity  $V$ , a terrain factor  $N$  describing ease of movement, and percent slope  $G$ . I have replaced the final term  $G$  in Pandolf’s formula by the absolute value of  $G$  plus 6 to represent the cost symmetry depicted in Figure 1. Although it is not clear that Pandolf’s simple formula represents physiological expenditure as accurately as the more complex functions advocated by McDonald (1961), it at least has the advantage of incorporating the additional factors of load ( $L$ ) and terrain ( $N$ ). The terrain factor  $N$  is represented by a separate cost surface constructed on the basis of terrain features known to influence movement - marshy areas, roads, and streams of various widths. Marble (1996:5) supplies coefficients for a number of different terrain types, relative to a standard hard but unmetalled surface.

### 2.3 DISCUSSION

Many of the techniques discussed above, by which costs are calculated, yield *relative* rather than absolute costs; accessibility indices derived from these are therefore also relative. How should this affect our interpretations? I have not come across any cases where absolute (physiological) cost played a direct

role; however, relative costs sometimes do have to be ‘calibrated’ afterward. For example, in order to derive 1 hour catchments for hillfort sites on the island of Hvar, Gaffney and Stancic (1991) were forced to establish experimentally which cumulative costs were equivalent to 1 hour’s walk, by logging them at the 1 hour cut-off point in several walks starting at one of these sites.

Llobera (2000:75) wondered how to combine the effect of landscape features (by which he meant archaeological monuments) and ‘topographic’ (physiological) cost into a cumulative cost calculation. On the surface, this may seem to be a ‘technical’ question, and Llobera himself hints at potential approaches (2000:81-2), but a more fundamental issue surfaces as well. Whereas measurement and experimentation can establish physiological costs, it is unlikely that ‘social’ costs can be established with any degree of objectivity. More importantly, it is possible to imagine an endless variety of ‘social’ cost factors whose effects may overlap, interact, and vary over space and time. The incorporation of social (cognitive) costs into CSA therefore implies that the objective of establishing cost surfaces and paths whose values have intrinsic meaning (for example, expressing travel time or metabolic energy) has been abandoned. It is not at all clear that the values in the new, ‘enriched’ cost surfaces may even be regarded as relative (ratio scale) measurements, as seems to be suggested in several of the case studies presented in the volume edited by Lock (2000).

Other than trying to agree among ourselves on the actual cost of travelling, are there any other immediate tasks before us? I can see two. The first concerns one of the improvements I suggested in 1992 (Van Leusen 1993), namely the differential weighting of the sites or foci used for cost surface calculations. In a thought experiment, Llobera (2000:74) provided an example of this when he used a monument’s ‘rank’ (the derivation of which was not specified by him) as a multiplier to increase or reduce costs nearby.

The other task concerns improvement of least cost path analysis, one of the more promising areas of development in cost surface analysis. Least cost paths between any pair of points can be generated from cost surfaces in two steps: a cumulative cost surface is generated from the end-point of the pair, which is then ‘drained’ from the starting point to find the lowest-cost route between the two. Single least cost path calculation has been used by archaeologists on a few occasions, for instance to derive optimum routes between pairs of hillforts in Burgundy (Madry and Rakos 1996:113-117) or between Anasazi communities in New Mexico (Katner 1996). Bi-directional least cost paths and *corridors* (i.e., least cost zones wider than one pixel) were implemented by Krist (2001a,b) in recognition of the fact that many approximate least-cost solutions could have been used in the past.

Compiling multiple least cost paths into a ‘least cost network’ was suggested early on by Tomlin (1990:170-176 and 212-223) in an application searching for an optimum logging road network and was first archaeologically implemented by Gaffney (pers. comm.) in order to model approaches to Stonehenge; together with Gaffney I calculated similar least cost networks in the late Iron Age and Roman landscape around the town of Wroxeter (Shropshire, UK; this thesis, chapter 16). The first published European implementation is by De Silva and Pizziolo (2001:284-5), who calculate least cost pathways between major Neolithic settlements of the Biferno valley (Italy), and note that secondary settlements are located along these paths. Bell and his colleagues (2002) demonstrate a similar least cost network simulating routes connecting Samnite settlements in central Italy, but refine the implementation by basing it on the calculation of all possible reciprocal pathways.

However, these early examples are still based on relatively simplistic assumptions and coarse data. Route networks are maintained by a range of user groups for a range of purposes: some routes – especially local ones between individual settlements – are used relatively often by a small number of people, whilst other routes are used much less often but by a much larger group of people. The latter tend to form a *dendritic* network originating at the habitual locations of the inhabitants of a region, and converge on a small set of shared resources such as market and cult places. Whilst current approaches concentrate on such dendritic resource-centred networks, little or no attention has yet been paid to the importance of day-to-day social networks by which neighbouring families and villages form and maintain a community. In future models of archaeological landscapes it would make sense to combine resource and social networks.

At a technical level, the accumulation and drainage algorithms used for creating least-cost paths are also far from perfect:

- Even a basic choice such as the selection of the grid resolution for analysis can have a major influence on the outcome of a cost accumulation algorithm, implying that no confidence should be placed in the *precise* line of a ‘least cost’ path; hence least-cost *corridors* could well present a more realistic approach.
- Cost accumulation is usually performed using either a 4-neighbour or an 8-neighbour filter; even if the latter is used, the ‘Knight’s Jump’ accumulation results in slightly incorrect accumulated costs for most cells. Allowing more directions of movement can further reduce this so-called ‘elongation error’ of geometric distortion (Harris 2000:121).
- Drainage algorithms, in looking for the lowest neighbouring cell value, cannot reproduce the actual overall least cost path, and in fact are quite likely to deviate significantly from it. Harris (2000:121) mentions several alternative algorithms for calculating optimal routes, and these will have to be evaluated for archaeological use.

Finally, we should carefully examine our model assumptions. Travel rarely if ever happens in a virgin landscape – the landscape has a history of use, which means it is riddled with animal tracks and human infrastructure as established and maintained by the forebears of the current inhabitants. These, in turn, would have had intimate knowledge of this landscape. One could almost assume that, wherever one could wish to go, some sort of path would have already existed! On a less grand note, rather than climbing or descending very steep slopes, people will resort to hairpin bends in order to keep to a comfortable degree of slope<sup>7</sup>. Usually there will be animal tracks to allow this. Thus, surmounting a steep slope (ridge) only requires travelling a greater horizontal distance at a lesser vertical angle.

Most fundamentally and worryingly, a real traveller uses his knowledge of the terrain, the expected length of the trip, the weather forecast, the final and intermediate goals, etc., to decide on the route - a decision that weighs the global costs of alternative routes (cf. Bell and Lock 2000:92). All of the GIS least cost implementations discussed here, in contrast, only make *local* decisions as to which neighbouring cell has the highest or lowest value - they incorporate no *global* knowledge of the landscape at all. This defect can perhaps be turned to good stead if GIS-generated least cost corridors are compared to historic routes: deviations from the ‘optimum’ route should then indicate the presence of intermediate goals which can be further investigated. In general, more research into such comparisons is indicated, so that we are able to assess precisely *how* far from reality our GIS-generated models still are.

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### 3 LINE-OF-SIGHT ANALYSIS<sup>8</sup>

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#### 3.1 PRINCIPLES AND APPLICATIONS

The significance of visibility in the study of archaeological monuments was documented as long ago as the early 18th century, when Stukeley first remarked on the ‘false horizon’ setting of barrows. Since then, visibility has been an acknowledged factor in the location and construction of archaeological monuments such as hillforts, henges, watch towers as well as barrows, and both intervisibility and viewsheds were formalised, though not yet digital, techniques by the 1970s. Until appropriate digital tools became available in the late 1980s, the laboriousness of having to derive viewshed properties by field observations and manual cartography meant that it never received more than incidental attention. One of the tools that GIS has offered to archaeologists is viewshed analysis. It not only enables researchers to quickly generate and test hypotheses about the (non-) visibility of salient sites and landscape features, but also breathes new life into the study of landscape perception or *cognitive archaeology*.

Single viewshed analysis is now a well-trodden area in archaeological landscape modelling. The basic technique operates on a digital elevation or terrain model (DEM, DTM<sup>9</sup>) to determine which areas are visible from a given three-dimensional location. Single viewsheds indicate whether any two points are intervisible and which area is visible from a particular point; they may also include information about the angle of view. Applications in archaeology range from visual impact analysis for cultural resource management - minimising the visual impact of modern development upon an archaeological landscape (Katsaridis and Tsigouragos 1993, Knoerl and Chittenden 1990, Kvamme 1992) - to reconstructions of Celtic road systems (Madry and Rakos 1996) and explorations of how prehistoric ritual landscapes might have been perceived by contemporary populations (Fisher et al 1997, Ruggles and Medyckyj-Scott 1996, Wheatley 1995, 1996). In further GIS analysis, the basic viewshed can be used to derive properties of the visible areas, relating to such activities as hunting (van Leusen 1993, Krist and Brown 1994), security (Loots et al. 1999, Madry and Rakos 1996), and the confirmation of cultural identity (discussed below). Ruggles et al. (1993, 1996) and Fisher et al. (1997) employed viewshed analysis in the study of bronze age monuments on the island of Mull, western Scotland, extending the idea of visibility to include prominent horizon features and astronomical events. Prehistoric stone rows add the idea of *directionality* to viewshed analysis, possibly aligning with landscape features to ‘pinpoint’ relevant astronomical locations such as points where the moon rises and sets.

For specific purposes, the concept of viewshed calculation has been refined in order to study *intervisibility* (whether two or more monuments are intervisible and might therefore be part of the same ‘system’; e.g., Gaffney & Stancic 1991, Bradley et al. 1993, Ozawa et al. 1995, Bell 1999, Haas and Craemer 1993, Moscatelli 1998) and *visual alignment* (whether two points align in order to visually emphasise or frame a third point; Ruggles et al 1993). Single viewsheds have also been merged to yield multiple viewsheds (Jacobson et al 1994) and added to yield *cumulative* viewsheds (Gaffney et al. 1996b; Wheatley 1995, 1996), both of which will be discussed in more detail below. Finally, the concept of viewshed analysis logically extends to the complement of visibility, the study of *non-visible* areas and monuments. Whereas one particular viewshed will show which areas are hidden from view from a particular vantage point, multiple viewsheds will highlight areas hidden from view from a *class* of monuments, with the potential of having a regional (ritual?) significance. Cumulative viewsheds refine this idea by giving a measure of how hidden particular locations are, enabling us to rank these locations by degree of seclusion. While viewshed exclusion – the deliberate placing of monument or activity so as not to be visible from specific other locations - has figured in archaeological studies, notably Tilley’s *Phenomenology of Landscape* (1994), it has only been the subject of one GIS publication in recent years (Lock and Harris 1996:224).

A rather different set of applications arises when viewsheds are used in ‘cookie cutters’ fashion to derive properties of other data layers in the GIS. Such an approach looks beyond quantitative visibility properties *per se* and asks which objects and terrain features, present within the viewshed, might provide a *reason* for there being a viewshed in the first place. I suggested the example of deriving physiographical properties of the viewsheds of Mesolithic sites in the southern Netherlands, some of which might be camps relating to big game hunting (Van Leusen 1993:118-121). Recently, Wheatley and Gillings (2000: 14-23) have applied the cookie cutter technique in the framework of the so-called ‘Higuchi’ viewshed properties used in landscape planning. They demonstrated the derivation of the distance-related property of *clarity* (using distance classes based on the visual appearance of standard objects (trees)) and the property of *directionality* based on a calculated aspect layer and ‘directionality’.

### 3.2 METHODOLOGICAL ISSUES

In ascending order of complexity three areas of methodological concern can be distinguished with current viewshed applications – those of realism, of edge effects, and of significance.

Firstly, the issue of realism – is the modelled viewshed sufficiently congruent with the ‘real’ viewshed to allow archaeological interpretation? In one sense, this is a fairly straightforward technical issue, and

a fair amount of GIS literature already comments on the pertinent issues of data quality (especially of the DEM that underlies all viewshed analysis – see the important study by Wood (1996), who also supplies further references), operational assumptions such as the viewing parameters and the use of palaeo-environmental reconstructions (cf. Tschan et al. 2000), and the algorithm employed in the calculation of viewsheds (Fisher 1991, 1992, 1993, 1994; see also Loots et al. 1999; Nackaerts et al. 1999 on the calculation of ‘fuzzy’ viewsheds). The issue is complicated, however, by theoretical considerations such as the relative merits of employing an ‘objective’ Cartesian view of geographical space, or of using subjective notions that involve viewer and viewed in a more complex interaction.

Secondly, the issue of edge effects. Since viewsheds are generally large relative to the study region (especially if their radius is unconstrained), they tend to ‘fall off the edge’ of the region. Conversely, viewsheds of sites lying outside the region would fall partly within the region – but those sites are not part of the analysis so their viewsheds are never calculated! If not properly corrected for, this effect will lead to incorrect multiple and cumulative viewshed calculations, hence to incorrect archaeological interpretations. For example, in a 20 by 20 km study region, calculating viewsheds with a 7 km radius would leave only a 6 by 6 km area in the centre of the study region where the visibility index values are correct; in all areas within 7 km of the edge of the region the cumulative viewshed index (CVI) rises inversely proportional to the distance from that edge (see chapter 16 for a relevant case study).

The edge effect can manifest itself in unexpected ways. For example, Madry and Rakos’ (1996) study of the Celtic road network in the Arroux valley in Burgundy suggests that there is a viewshed relation between these roads and the nearby hillforts, and that the intention was to keep the transportation network under constant visual control from these defensive sites. A cumulative hillfort viewshed is calculated and the roads are found to lie largely within the high visibility values. Statistical support for this is obtained by comparing the visibility index of the roads with those of the total study region. However, as no account was taken of the edge effect, the visibility values for the region are incorrect and the conclusion that the roads have a significantly high visibility is unsupported (though it may well be true).

Thirdly, the issue of statistical significance – are the visibility characteristics associated with archaeological remains *significantly* different from background values? Wheatley (1995) discusses one correction that should be standard in all cumulative viewshed operations – the ‘view to itself’ effect. In the examples discussed by him, this effect entails that the number of barrows observed to occur in a particular viewshed is always one higher than it should be, leading to misinterpretation of statistical results. Even more insidious is the ‘viewshed radius effect’; I conducted some simulations (this thesis, chapter 16) that show that the size of the viewshed radius has a profound effect on the distribution of visibility index values across the terrain. For *any* set of points (including archaeological objects), choosing a small viewshed radius will result in a ‘preference’ for the lower elevations (valley bottoms) occurring in the study area, whereas choosing a large radius will result in a ‘preference’ for the higher elevations (peaks and ridges). A good example of this effect at work can be found in Lock and Harris (1996: 224, fig 13.5), who note that viewsheds of Neolithic long barrows in the Danebury region are apparently selected so as to ‘alert people crossing the surrounding ridgetops’. My work indicates that this ‘rim effect’ might or might not be entirely due to the choice of viewshed radius.

It is no longer sufficient just to report on the properties of the viewsheds generated for groups of archaeological monuments – archaeological relevance depends on such viewsheds being sufficiently different from the background visibility properties of the study area. For example, viewsheds taken from high points in the landscape will tend to include relatively many other high points – ridges, peaks and such. A sample of viewpoints drawn from such locations (hillforts, barrows) will therefore preferentially ‘see itself’. For example, Wheatley (1995, Plate 1) employs cumulative viewshed analysis to study the spatial relationship between barrows in the Stonehenge and Avebury areas. His analysis clearly demonstrates the correlation between viewsheds and landscape morphology, with ridges and peaks being preferentially seen. Wheatley rightly cautions (*ibid.*, 180) against equating such statistical correlation with causation, but does conclude that being able to see other barrows is likely to have been a determining

factor for barrow placement in the Stonehenge area.

It is all too easy to employ viewshed analysis simply to support one's preconceived ideas about the cultural and cognitive significance of archaeological monuments, especially if there is little or no methodological control on these quantitative models. Gaffney et al. (1996a:148ff), in their discussion of the viewsheds of monuments in the Kilmartin area of Scotland, fail to convince for this very reason. If, as these authors themselves state, the rock art and standing stones in this area are not visible from more than 100 meters and 3km away respectively, then what is the use of calculating 15km viewsheds?

### 3.3 VISIBILITY, PERCEPTION, AND THE COGNITIVE LANDSCAPE

It is becoming increasingly clear that archaeologists working with GIS want to be able to escape from the 'objective' geographical space enforced upon them by the design of the software. They want to be able to represent social space - the subjective experience of past people, their perception of their physical and social environment, and their cognitive representation of their world. This is part and parcel of the general cognitive-processual trend in recent theoretical work, a good overview of which can be found in Renfrew and Zubrow's *The Ancient Mind* (1994). Perception and cognition of the landscape are two different concepts, although our perception of the landscape is obviously steered and modified by our cognition (or lack thereof) of its history and constituents.

*Perception*, as the simple act of being aware of the landscape, has already been to some extent the subject of GIS-study among both geographers and archaeologists. Geographers intend to incorporate qualitative spatial reasoning into formal GIS models (see, for instance, Frank 1996, for a discussion of how reasoning with cardinal directions can be so formalised). Archaeologists have concentrated on less complicated visibility issues involving significant ritual and political landscape features (e.g., Boaz and Uleberg 1995, Nunez et al 1995, Gaffney et al. 1996a, Llobera 1996). Some thought but little action has so far gone into the generation of perceptual variables such as 'enclosedness' vs. openness of the landscape (Llobera, pers. comm.); the potential of such approaches is therefore not yet clear.

*Cognitive archaeology* in the context of landscape archaeology is the archaeology that concerns itself with the cognitive aspects of past geographical and human landscapes, that is, the perception of significance. According to Zubrow (1994), 'one goal [of cognitive archaeology] is to show that people had preferences independent of economic necessity, and some decisions are independent of utility'. He continues 'as archaeologists, one of our ultimate goals is to extract the cultural ideals from the complicated reality in the complex patterns of prehistoric material remains'.

If we abandon our viewpoint as an external, even extra-spatial, observer of the archaeological landscape as represented by GIS-generated maps, we may instead adopt another role - that of the participant in a cognitive landscape. The link between visibility and cognition has been well made by Gaffney et al. (1996b):

"A viewshed represents the area in which a location or monument may communicate visual information. Viewsheds may overlap, producing zones in which an observer might be aware of the presence of many such locations, all of which may carry information. The increased density of such information can in some circumstances be interpreted as a measure of the importance of a particular area. It provides a spatial index of perception, mapping the cognitive landscape within which the monuments operated."

Many authors have begun to explore the prehistoric cognitive landscape via visibility in recent years, even though, as Fisher (2000:9) reminds us, 'it is not at all clear how we might compute *modern* cognition in the landscape with GIS' (my emphasis, MvL). For good reasons, such experimental GIS applications tend to concentrate on well-preserved and well-studied ritual landscapes such as the Stonehenge environs, that offer unusually complete data sets and a relatively high a priori degree of certainty that visibility was an important consideration when the monuments in these areas were constructed. These explorations,



when visualised appropriately, have the potential of involving us much more closely with the past. Woodward and Yorston (1996) bring the study of landscape perception closer to dynamic Virtual Reality by interactively presenting changes in viewsheds as the viewer moves along the Stonehenge Avenue and different groups of barrows come into view.

### 3.4 FURTHER WORK

Further work in improving viewshed analysis will need to deal with two issues. The first concerns the technical application of viewsheds; the second, their theoretical justification.

Various technical improvements to viewshed analysis have already been proposed. For example, distance decay functions and ‘fuzzy viewsheds’ have been used in order to simulate the loss of visual resolution with distance (Fisher 1991, 1992, 1993) and to move from deterministic to probabilistic viewshed models (Fisher 1994, Nackaerts et al. 1999, Loots et al. 1999). Wheatley (1995: 181-2) includes a useful discussion of error and uncertainty in viewshed maps. Others (Ruggles and Medycky-Scott 1996) have applied a correction for earth curvature that is particularly relevant for the modelling of astronomical observations<sup>10</sup>. Further improvements follow from the discussion of methodological problems above. The preliminary visibility significance tests I conducted indicate that statistical control of viewshed analysis needs to be much stronger before any archaeological interpretations can be built upon it. The tests will have to be generalised so that reproducible results can be obtained from them, and a proper way of incorporating background visibility data into viewshed analysis has been found. One way forward might be by resorting to *relative* visibility measures – for example, Lock and Harris (1996:232 and fig 13.15) note that early Iron Age hillforts in the Danebury area are positioned to maximise visual dominance over adjacent valleys and surrounding farmsteads *at the cost of* all-round defensive visibility. I am less happy with the tack taken by Gillings (1999) and Woodward and Yorston (1996). Gillings looks to Virtual Reality visualisations in order to explore the significance of archaeological viewsheds; Woodward and Yorston have implemented an application similar in spirit, that uses Java software to create interactive maps of the barrows in the Stonehenge area, where barrows visible from the current position of the mouse cursor light up. Although this type of work certainly comes closer to the post-processualist ideal of being participant in, rather than an observer of, the archaeological landscape, I am worried by what must be an increasing temptation to throw technical rigour to the wind.

Justifying viewshed analysis on a theoretical level is equally as important as its technically competent implementation. How important is it in fact to be able to see directly a particular site, monument, or social activity, as opposed to knowing or being aware of its presence and location? Smoke and fires, the latter especially after dusk, must surely rate among the most visible phenomena even from a great distance, and it is not at all necessary to be able to see the *source* of the smoke and fire to be aware of what is going on.

And of course there is no reason to limit ourselves to vision: things heard or smelled might be as significant as things seen – the Neolithic barrows of the English chalklands, when first constructed, would have been highly visible, but their visibility must have dropped as they gradually became overgrown with moss, lichen, and grass. Could it be that the less permanent features of a barrow cemetery were in fact the most visible (totem poles), audible (wind chimes), or smellable (decomposing offerings?). The first hints of research turning in this direction are now detectable: classical farmsteads in the countryside surrounding the ancient Greek city of Hyettos are thought to take ‘advantage of the unique acoustic effects of the basin ‘auditorium’ surrounding the acropolis and lower city, enabling them to partake aurally as well as visually in the activities taking place’ (Gillings 2000:115; Gillings refers to the modelling of such perceptions as ‘sensuous’ GIS).

Following this line of reasoning to its logical conclusion, one might even question whether the cognitive landscape is not constituted as much by ‘unsensed’ presences as it is of the more direct sensed kind. Inspiration for such thinking will no doubt be found in the ethnographic literature, but there is also the

danger of over-interpretation – *anything* in the landscape could have had cognitive significance. That does not mean to say that it had.

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## 4 CONCLUSIONS

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### INCREASED REALISM

It is evident that, a decade after the first LOSA / CSA studies were conducted, an initial phase characterised by naïve applications and constrained by the capabilities of generic GIS has drawn to an end. It is currently being replaced by a phase in which specific procedures are being proposed in order to implement ever more realistic models of human perception of the landscape.

Although opinions about how to improve studies based on viewshed and cost surface techniques are divided, all are agreed that they can and should be improved. On the one hand, exploration of refinements to the ‘environmental’ approach current throughout the past decade continues - see, for example, the experimentation with the inclusion of a variable representing seasonally changing vegetation in the Polish Mesolithic in viewshed studies by Tschan et al. (2000). On the other hand, proponents of the ‘enrichment’ approach are particularly vocal regarding methodological improvement, which they see coming mainly from the field of landscape analysis. Baldwin et al. (1996) provide a very useful review of actual and potential approaches to modelling environmental cognition through line-of-sight analysis in GIS from the perspective of landscape analysts. They divide personal experience of the landscape into four categories - physiographical characteristics, the presence of specific physical features, cognitive variables, and viewer interest, and conclude that deterministic analysis in GIS can become more accurate by adopting a flexible approach to cognitive criteria. Early explorations of such an approach are Wheatley and Gillings’ (2000) investigations in the framework of Higuchi viewshed properties, and Llobera’s (2000) implementation of ‘attractive’ and ‘repellent’ features in the landscape.

However, fundamental limitations to the use of GIS in such landscape studies have already come in sight, causing Lock (2000:60-62) to predict that refining current approaches will continue to produce inadequate models because they continue to represent meaning as attributes of the landscape rather than as properties of the people in it. Such a fundamental shift in emphasis suggests that future models should take the form of artificial societies built by programs representing individual humans, their intentions and reactions to external stimuli (cf. Llobera 2000:81-2). This new phase is likely to be dominated by a much more limited number of researchers who have access to the specialist software tools needed for this type of landscape analysis.

### TESTING & VALIDATION, OR EXPLORATION?

The apparent conflict between adherents of processualist and post-processualist approaches has been shown to be beside the point from a pragmatic point of view. The practical differences between studies presented so far by either side appear to be small, and a much more significant watershed is likely to separate studies that fail to adduce proper supporting evidence to their interpretations, from those that do. Whilst naïve processualist approaches have since long rightly been criticised for failing to address pragmatic and procedural shortcomings (most recently in Wheatley & Gillings 2000: 5-14), having a post-structuralist outlook in itself does not help to establish procedural rigour. Both Fisher (1999:9-10) and Llobera (2000:66) note the lack of validation or even methodology accompanying post-processual works.

A general point that emerges is the lack of supporting evidence given for claims of unusual cost or viewshed properties for particular locations within a region. Fisher (1999:8) is not the only one who has noted that most ‘contextual’ studies do not attempt spatio-statistical analysis, and therefore lack proof for their inferences. Yet tests can be carried out to demonstrate that the results obtained are unlikely to have arisen by chance, as is shown by Fisher and others (1997), who employ Monte Carlo testing of their

hypotheses.

The general approach advocated to substantiate LOSA and CSA results obtained for a sample of archaeologically meaningful locations is to compare them with one large or many similar-sized samples of random chosen locations (cf. Wheatley 1995). This is typically done by generating a cumulative visibility index (CVI; see, for example, Lake et al 1998:36-38, Bell & Lock 2000: 96-98) or a cumulative accessibility index (CAI; for example, Llobera 2000: 70ff) for all or a representative subset of locations within the study region. The result obtained for the sample of interest can then be formally compared to the population (one-sample tests) or to a representative sample of it (two-sample tests).

Lake et al. (1998), investigating whether the viewshed sizes (areas) of Mesolithic sites on the island of Islay off the Scottish west coast were significantly different from those of non-sites, used a two-sample significance test of sites against a 5% random sample of locations and found that their hypothesis was not supported by the evidence.

Another method by which LOSA- or CSA-based models may be supported is by comparison with independent archaeological evidence. For example, networks of least-cost paths may be compared to historically known networks such as the mule-paths that criss-crossed the Italian highlands until recently. If this approach is taken, circular arguments are to be avoided: in some cases, models have been 'tweaked' until they fit the evidence, after which the fit is taken as evidence for the correctness of the model. For example, the optimal path calculated by Bell and Lock (2000) adheres to the known route of the Ridgeway not only because of the constraints imposed by the distinctive landform of the region (as noted by Harris 2000:119), but also because the authors adjusted several parameters in the cost calculation in order to *force* the optimal path into resembling the route of the Ridgeway. Clearly, in such a case the resemblance between the two paths cannot be taken to be supporting evidence for the correctness of the calculation.

#### PROCEED WITH CAUTION

This paper critically examines the logic of assigning cognitive significance on the basis of multiple or cumulative visibility and accessibility indices, and finds that insufficient attention has been paid to some important methodological aspects of spatial analysis – most notably the need to calculate 'background' or 'potential' indices against which an actual outcome may be judged. Recent work points to least cost path analysis as the most profitable avenue for further research in cost surface analysis. There are at least two avenues for further work here; firstly, analysis of historic infrastructural networks which may serve to 'calibrate' data-independent models; and secondly, vector analysis of networks constructed through raster-based cost surface analysis. Recent viewshed applications seem to concentrate on studying the (inter-) visibility of ritual monuments, but as has been made clear here will need to apply a lot more rigour to their technical execution.

Two specific approaches have been suggested: firstly, since there are a large number of potential sources of error, it is deemed unwise to believe the outcome of any particular LOSA or CSA. As Wheatley and Gillings (2000:5) suggest, we should instead study the trends emerging from an accumulation of such single outcomes. Secondly, rather than attempting to interpret the viewshed or accessibility properties of sites directly, we should study the *differences* between sites and between sites and 'background'. These approaches express a probabilistic view of modelling - one where models are used to indicate only how *probable* it is that certain activities take place in certain places.

Rather than continuing a fruitless processual / post-processual debate, this paper shows current GIS implementations of 'cognitive' landscapes to be little more than a semantic change of clothes. The post-processualist argument has mostly taken the form of a bashing of supposedly 'data-led', 'environmentally determinist', and 'naïve' applications copying the worst of New Archaeology practices. However, applications billing themselves as 'cognitive archaeology' seem to boil down to the same combinations of viewshed and cost surface analysis explored by others as well. It is also possible to argue that cost surface and viewshed calculations are themselves deterministic methods. Llobera's (1996) study of the

visibility of late prehistoric ditches in the Wessex chalklands, although couched in a theoretical context rather different from that of systems theory and processualism, still attempts to derive cognitive aspects of late Bronze Age society (the awareness of being inside a territory) in a deterministic manner - the location of the ditches is fixed, the calculation of their visibility is based purely on properties of the elevation model. So the difference with what has been termed environmental determinism is in the *environmental*, not the determinism, and we might as well speak of *cognitive determinism* when describing such work.

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<sup>1</sup> For an accessible review of the underlying theory and method of site catchment analysis, see Roper 1978. For a brief discussion of spatial allocation, territoriality, and cost surfaces in a GIS context, see Kvamme 1999:174-176.

<sup>2</sup> For a GIS re-analysis of the same data, see Kvamme 1992.

<sup>3</sup> Part of the following is reproduced from an e-mail sent by Mark Gillings to the GISARCH mailing list (Gillings, Fri. 10 Oct 1997).

<sup>4</sup> Regrettably, insufficient details were published to allow a proper evaluation of this method.

<sup>5</sup> For those who would like to experiment with alternative cost models, I reproduce these functions here. V is speed, G is the adjusted slope value. For slopes from -40 to -20 degrees, McDonald (1961) calculates energy expenditure F as follows:

$F_1 = 0.000049V^2 - 0.00415V - 0.13276G - 0.004692G^2 - 0.00005213G^3 - 0.0003257VG + 0.000002036V^2G - 0.8588$ . For slopes from -20 to +5 degrees, the function becomes:

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$F_2 = 0.00202V + 0.000021V^2 + 0.0256G + 0.00154G^2 + 0.000044VG - 0.00000314V^2G + 0.3515$ . For slopes from +5 to maximum, slope S must be entered in degrees instead of percent, and the function becomes:

$$F_3 = V * (0.00275 + 0.049\sin(S)) * \cos(S) + V^2 * (0.00002 - 0.00033\sin(S)) * (\cos(S))^2 + 0.396 + 0.17\sin(S).$$

After merging of the map layers generated by the functions  $F_1$ - $F_3$ , and adjustment for pixel size, a 'topographic' cost surface in kcal results.

<sup>6</sup> This physiological function was apparently derived by Llobera (2000: 71, Figure 2) from multiple sources: Margaria 1938, Kamon 1970, Minetti et al. 1993, and Minetti 1995.

<sup>7</sup> Thus, the cost of ascending a very steep slope to a specific height could be approximated by dividing that steep angle by some acceptable angle of ascent – say, 15° – and using the outcome as a multiplier for the *horizontal* costs. For example, the cost of climbing a 45° slope over a horizontal distance of 200m (i.e., to a height of 200m) is equivalent to  $45 / 15 = 3$  times the cost of 200m horizontal travelling.

<sup>8</sup> Since the calculation of a line of sight between a pair of points is the 'primitive' operation underlying all viewshed-related analysis, I have thought it proper to use this term rather than the more widespread 'viewshed analysis'.

<sup>9</sup> Although much of the literature treats these two terms as interchangeable, there is an important technical distinction between them – a DTM contains information about terrain features such as ridgelines, breaks in slope, etc., while a DEM is a simple rectangular lattice of elevation values.

<sup>10</sup> The correction for earth curvature applied to DEM data is:  $d^2 / 1.273 * 10^7$ , where d is the horizontal distance in meters to any point in the study area. A point at 10 km distance would thus be set nearly 8 metres lower, influencing the viewshed coverage.

# EDUCATING THE DIGITAL FIELDWORK ASSISTANT\*

Martijn van Leusen & Nick Ryan

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1 INTRODUCTION

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1.1 IMPROVING THE EFFICIENCY AND ACCURACY OF FIELD WORK PROCEDURES

Modern field walking surveys have become increasingly labour-intensive both because a higher coverage rate (often with total collection of artefacts) is now thought to be essential, and because more stringent demands are now put on the precision and accuracy of field recording methods. The management and analysis of modern survey data within GIS requires the accurate mapping of large numbers of small collection units so that minor variations in the densities of all material categories can be detected. The processing of large numbers of, often undiagnostic, finds puts a strain on the ceramic specialists. In some recent surveys, the overall speed has slowed to as little as 1 hectare per person/day spent in the field; there is therefore a need to improve efficiency by any means available.

Modern survey practise also requires the accurate mapping of collection units, and the detailed recording of environmental variables which may influence the finds circumstances ('visibility conditions'). Collection units are usually mapped directly onto a large-scale topographic or cadastral map of the survey area, using existing landmarks for orientation, and a series of forms is normally used to record information about the collection unit and the finds made in it. Forms are also used to track finds through the various pre-processing steps and the specialist classification stage into storage. The information is later transferred from the forms into a DBMS. In current practise, a certain number of errors, omissions, and illegal entries is unavoidable because maps may be incorrectly interpreted or outdated and hardcopy forms cannot prevent erroneous or illegible entries; further errors may (and will) arise where the procedure requires a transcription step. Procedures based on independent self-location and direct digital data entry should prevent most types of errors from being made.

Finally, modern field surveys are multidisciplinary. Typically, geopedological research and a study of historical maps and records will take place in conjunction with the field walking. In many cases it would be helpful if the information collected by each of the participants were available to the others in the field. For example, archaeologists might want to steer away from areas where the geopedologist has mapped severe erosion or deposition, and might want to have 19<sup>th</sup> century maps available in order to correlate finds distributions and landscape features to the pre-industrial landscape. In practise, this is hardly ever

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\* This chapter was recently published in: Burenhult, G & J Arvidsson (eds) 2002, *Archaeological Informatics: Pushing the Envelope – CAA2001 Computer Applications and Quantitative Methods in Archaeology* (BAR S1016). Oxford: Archaeopress.

possible because the additional hardcopy maps, if they are available in time, are too cumbersome to carry about in the field.

## 1.2 DEVELOPMENT OF A DIGITAL FIELD-WORK ASSISTANT

A potential solution to this problem presented itself in the form of digital Fieldwork Assistants (dFA's) based on small handheld computers linked to GPS receivers. One such system that has been developed to address the requirements of a range of field sciences is *FieldNote*. This originated in a project that set out to examine the utility of "context-aware" systems as fieldwork tools in a range of disciplines, including archaeology and ecology (Ryan *et al.* 1998). A context-aware system is one that actively monitors its working environment, or context, and adjusts its behaviour according to changes in that context. Contextual input may be supplied by the user, or derived automatically from internal or external sensors.

*FieldNote* includes several modules that work together to monitor context and trigger events under user-defined conditions. Essentially, they provide context-aware and communications services to support a range of applications designed to meet specific fieldwork requirements. The most frequently used modules are the *LocationTracker* and *ContextClient*. *LocationTrackers* exist in various specialised forms designed to work with different proprietary GPS receiver protocols as well as the widely used, but limited, NMEA protocol. The *ContextClient* handles network data exchange between handhelds and other machines.

Note taking and mapping modules *FieldNote* and *FieldMap* build upon this infrastructure to directly support the fieldworker's recording and navigation needs. *FieldNote* uses the context services in two ways. Firstly, when recording information, it automatically tags all records with additional context, including the current location, derived from a GPS receiver, the date and time, and the user's identity. Secondly, whenever the context of a recorded note matches the user's current context, that note will be 'triggered' and its contents displayed on-screen. Although many criteria might be used in matching recorded notes to the user's context, proximity of location is most commonly used. When the user approaches the location of some previously recorded information, it will be brought to their attention.

The notes, together with background maps and other data, may be displayed using the *FieldMap* program. This uses information from the context service to keep its display centred on the user's current location and to select which map layers (note symbols or cartography) are displayed.

This system had originally been developed for the now defunct Apple Newton, and a similar, but conceptually simpler, set of programs, the Stick-e-note suite, had been developed and tested on early Palm Pilot devices. These had been evaluated in several field trials with archaeologists from Southampton University (Ryan *et al.* 1999a) and ecologists from Manchester Metropolitan University (Pascoe *et al.* 1998). These early trials confirmed the essential utility and potential of the system and, in 1999, work began on a new version of the system based on the experience gained in these trials.

Previous versions had all been implemented using what was, at the time, the most appropriate language for the target device: NewtonScript for the Newton and C/C++ for the Palm. To ease portability between different hardware platforms, this new version was written in Java and has been successfully implemented on a variety of handheld devices including those based on Windows CE and EPOC operating systems, as well as laptop and desktop Windows, Macintosh and Unix machines<sup>1</sup>.

The note taking software had previously used either plain text or HTML formats for storage and exchange between handheld and desktop. Although some experiments in using XML based formats for

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<sup>1</sup> In practice, we have not achieved the full platform independence potentially offered by Java. The WindowsCE version of *FieldNote* used in this campaign was in fact written in *waba* (see [www.wabasoft.com](http://www.wabasoft.com)), a Java-like language with its own libraries and independently developed virtual machine. Despite these differences, a high proportion of the code is common to this and the pure Java versions.

data exchange had been carried out, this aspect of the system was not extensively developed (Ryan *et al.* 1999b). The new version provided an opportunity to fully implement these areas with the aim of simplifying the process of exchanging data between handheld field computers and either a remote server, or a laptop or desktop machine at the survey team's base.

One of the main strengths of *FieldNote* is that the user can carry their own and other researchers' georeferenced data around in the field. Their current location is always available, either as raw coordinates or as a moving cursor on a map display. This facility becomes particularly useful when there is a need to confirm earlier work or to re-examine an area of interest located by another member of the team. Potentially, this might be exploited to provide continuity between successive seasons of work in the same area.

An opportunity to test the new version of *FieldNote* came when, in the spring of 2000, a survey team composed of staff and students from two Dutch universities (University of Groningen and the Free University of Amsterdam) prepared to conduct a three week survey campaign in October of that year, near the village of Francavilla Marittima in the Sibaritide region, province of Calabria, in Italy.

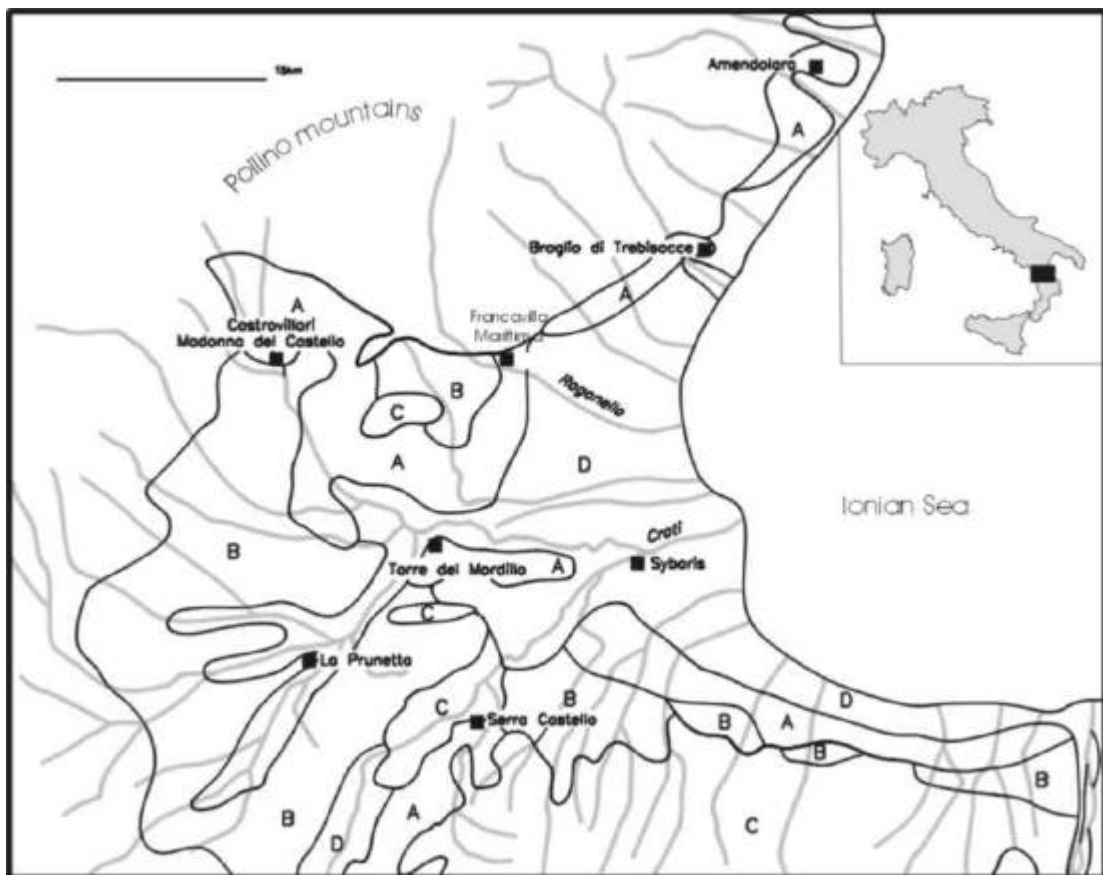


Figure 1 - Major landscape units of the Sibaritide. The coastal and alluvial plain (D) is surrounded by a series of marine and fluvial terraces (A) which merge into the lower slopes of the Pollino and Sila ranges (B).

### 1.3 THE SIBA2000 CAMPAIGN

The Sibaritide is a small alluvial plain on the Ionian seacoast, named after the Archaic and Classical Greek colonial town of Sybaris. It is surrounded by the limestone massifs of the Pollino and Sila ranges, and

its margins are formed by a series of terraces of marine and fluvial origin mostly composed of pebbly sands and conglomerates, dissected by the wide pebble beds of several seasonal rivers. Early archaeological research in the area concentrated on the rediscovery of the Greek colony of Sybaris and its Pan-Hellenic and Roman successors (Thurioi and Copia), which are now covered by up to 6 meters of alluvium. Later, archaeological interest expanded to include the larger indigenous settlements and sanctuaries surrounding the plain, and the University of Groningen became involved in research at the indigenous hilltop sanctuary of Timpone della Motta and its nearby necropolis (Kleibrink 1993, 2000). Next to the small number of sites being excavated over the decades, the wider regional archaeological record was mainly created by in a large-scale survey conducted by Lorenzo Quilici and his teams in the late 1960s. These surveys, mapped at scale 1:10,000 but available only at the published scale of 1:200,000 (De Rossi et al 1969), were intended to provide the context for the ongoing excavations at Sybaris and its successors. Largely targeted at the Hellenistic-Roman landscape, these data were more recently complemented by a regional compilation of pre- and protohistoric sites supervised by Renato Peroni (eg, Peroni & Trucco 1994).

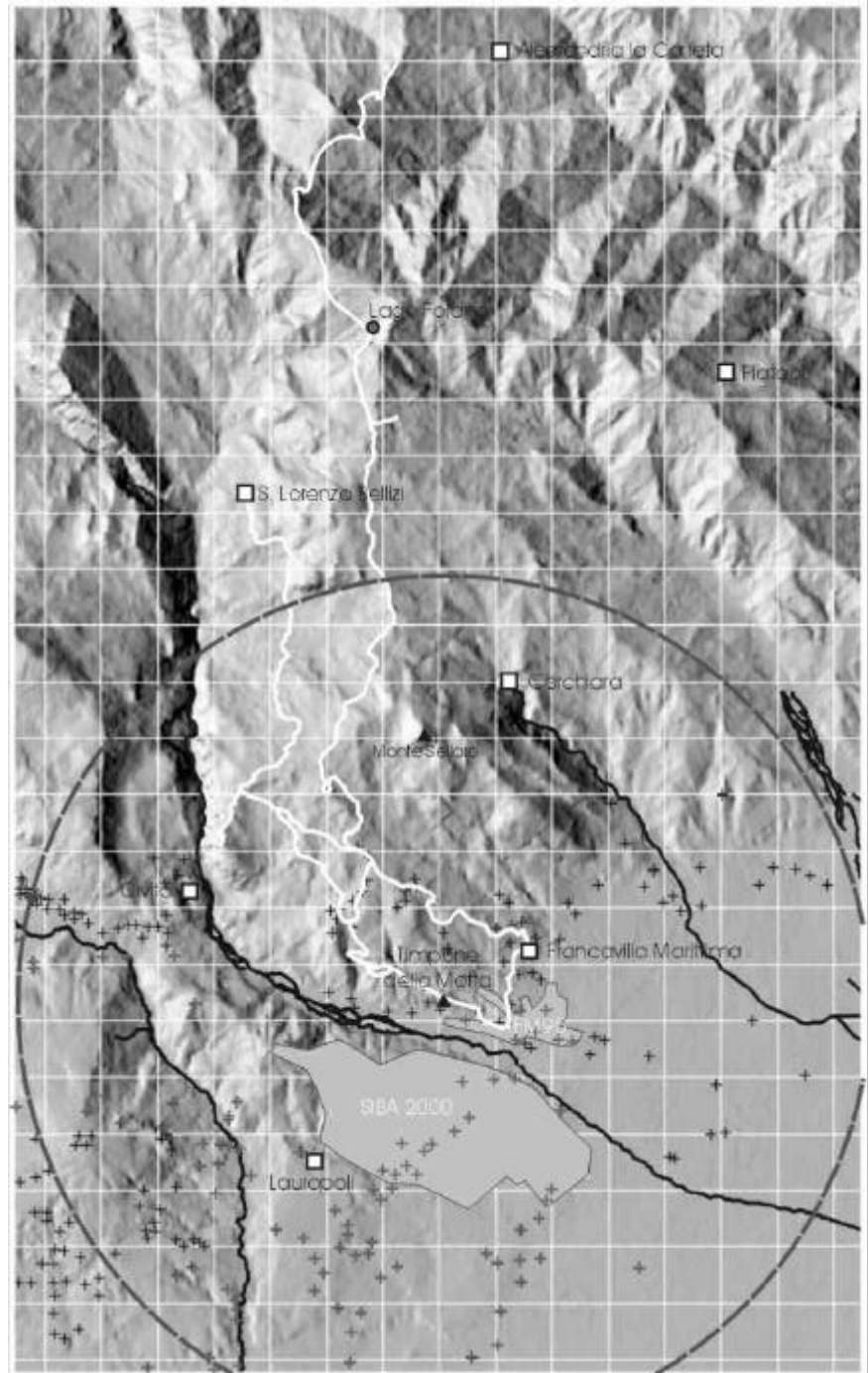
The SIBA2000 fieldwork campaign forms part of the wider Regional Pathways to Complexity (RPC) project running at the University of Groningen and the Free University of Amsterdam (for an overview, see Attema et al. 1998). Its main objective was to assess the quality of the existing archaeological record in preparation for an analysis of the regional settlement history in the light of processes of centralisation, urbanisation and colonisation occurring from the Iron Age onwards. Specifically, it was unknown which fields and areas had been visited by the Quilici teams, and whether the large-scale clustering of sites visible in the Quilici maps might be related to differences in the accessibility and surface visibility of agricultural fields in the 1960s. It was decided to approach this objective through a systematic survey of a representative section of the transitional landscape unit (see figure 1) using both intensive and extensive methods. This would allow us, on the one hand, to check the recorded size, location, and interpretation of the sites mapped by the Quilici teams (plus one site mapped by Peroni) and, on the other, to collect the distributional data needed to establish the presence and nature of any spatial patterning in the extant archaeological record. A preliminary report on the campaign is provided in chapter 12 of this thesis (Van Leusen & Attema, in press).

As in previous RPC project surveys, an important objective of the fieldwork was to develop appropriate and efficient survey methodology for the local circumstances. The Sibaritide was known to be relatively poorly mapped in a series of 1:10,000 scale map sheets produced in the 1950s, and parts of the survey zone were expected to contain few if any topographical reference points by which collection units might be located and sites relocated. Hence the decision to experiment with the *FieldNote* system developed by Ryan and his team for efficient and accurate relocating and mapping of fields and features. The system was expected to be particularly useful in a subsidiary project being carried out at the same time as the main survey. This aimed to relocate and accurately map protohistoric settlements and caves in the hinterland and to map subrecent transhumance routes from Francavilla Marittima into the mountains of the Pollino massif (see figure 2). This project was carried out by a small team under the guidance of local speleologist/archaeologist Nino Larocca.

Prior to the SIBA2000 campaign, the new version of the *FieldNote* system had received only limited testing in familiar environments and by users who were experienced with its predecessors. The XML-based mechanisms for exchange of data between the handheld devices and base system had yet to be tested with large volumes of data. Experiments with the archaeological use of earlier versions had all taken place in relatively well mapped areas and within clearly constrained areas, typically within, or very close to, the boundaries of large urban sites. The SIBA2000 project provided an opportunity to evaluate the new system on a significantly larger geographical scale under poorer map control, and with a group of users who were not familiar with the system or its predecessors.

This campaign also provided an opportunity for the first significant testing of the system following the decision by the US military to remove the deliberate degradation of GPS accuracy known as Selective Availability (SA). This change took place on May 1<sup>st</sup> 2000 with the effect that even simple handheld GPS receivers improved their apparent accuracy from around +/-80m to better than +/-10m. Previously

we had needed either to use an additional receiver for live differential correction, or to record raw satellite range data and to post-process all GPS measurements against data from fixed base stations in order to remove the effects of SA. There was a need to evaluate whether the recently improved accuracy obtainable with simple equipment was sufficient for a range of fieldwork needs.



*Figure 2 - The SIBA2000 survey zone centres on the Late Iron Age to Hellenistic hilltop sanctuary at the Timpone della Motta de Francavilla Marittima, under excavation by the Groningen Institute of Archaeology since 1991. The locations of the survey areas, GPS tracks of highland survey, and Quilici sites are indicated. Grid size: 1 km*



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## 2 THE FIELD TESTS

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Field tests of the dFA during the SIBA2000 campaign were conducted in a range of conditions, from extremely mobile recording of movements and observations during a survey of highland transhumance routes, to the detailed recording of grids during intensive survey. The results of these tests are described and evaluated in the following sections.

### 2.1 HIGHLAND SURVEY: THE RECORDING OF TRANSHUMANCE ROUTES

Since the indigenous societies of southern Italy are assumed to have had largely pastoral lifestyles into the early Iron Age, the presence of late prehistoric and early protohistoric remains was to be expected both in the foothills and in the mountainous hinterland of the Sibaritide, and possibly correlating with subrecent transhumance corridors. In preparation for the design of an appropriate research proposal, the team decided to test the kit by walking along some of these routes (see figure 2), making digital notes of archaeological material found along the way while at the same time recording accurate locations for a number of known highland prehistoric settlements and cave sites. The equipment functioned as expected, and a large number of observations, including georeferenced photographs, were recorded along routes running from the foothills near Francavilla Marittima toward the highland villages of Alessandria Carreta and San Lorenzo Bellizi. These included observations of Hellenistic farmsteads (up to 1000m asl), junctions of transhumance routes, subrecent structures relating to pastoralism, natural springs, potential locations for pollen cores, cave sites, and even individual sherds. The GPS trails of these surveys are depicted in figure 2; figure 3 gives examples of notes taken at such observation points.

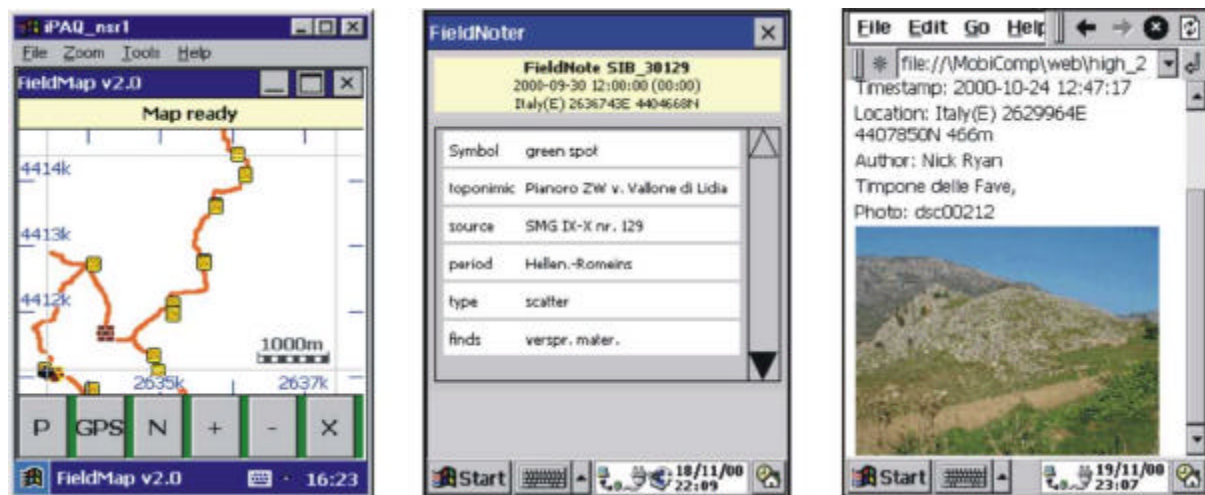


Figure 3 - Examples of archaeological FieldNotes. A) section of GPS trace along a transhumance route, with fieldnote points; B) popup note for Quilici record no. 129; C) a georeferenced photographic note.

### 2.2 (RE-) LOCATION AND RECORDING OF SITES

The capabilities of the dFA system for wide-area mapping tasks were tested during the SIBA2000 campaign by using it to relocate sites mapped in the 1960s by the Quilici teams, and by tracing agricultural field boundaries and centroids and circumferences of archaeological sites to a specified accuracy (figure 4). In the absence of detailed up-to-date topographic maps for the area, the latter test was of direct

practical utility to the survey team, as it turned out that the infrastructure of roads and tracks had changed considerably over the years and changes in land use and ownership had resulted in the removal of microrelief and old field boundaries. Thus, in many cases it was no longer possible to relocate sites mapped more than 30 years earlier by reference to mapped landmarks only. In contrast, the use of the dFA as a navigation instrument allowed existing sites (the positions and identities of which had been pre-loaded onto the kit) to be relocated in a straightforward manner. Both the map layer containing the Quilici sites and the operator's current position were marked on the display, and with the kit set to respond to the operator's current geographical position, nearby sites were brought to our attention by a beep followed by a display of the site's database record.

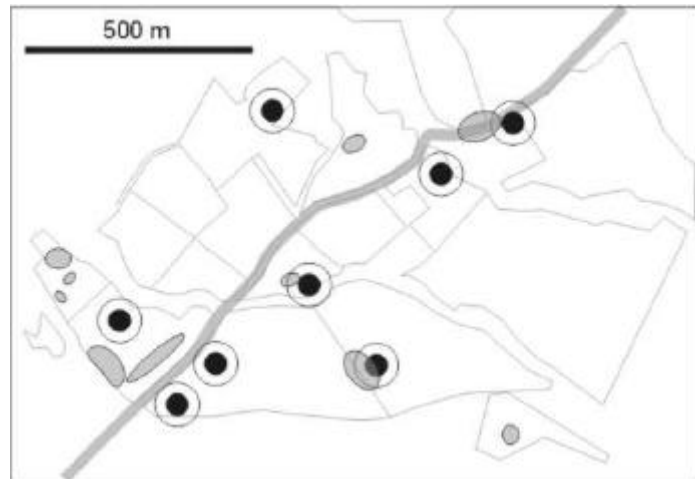


Figure 4 - Detail, showing disagreements between notional and actual positions of sites. Quilici site locations as derived from De Rossi et al. 1969 are indicated with 25m and 50m radius; approximate shape and location of RPC surface scatters is indicated by grey ellipses.

Only a few field and site boundaries were digitally recorded, but this was enough to show that the system functioned well. However, it was noted that the current procedure for tracing field boundaries on foot is inefficient, and alternative methods should be explored (see section 3). The digital recording of the centroids of ceramic scatters using a single GPS reading with an attached note, which only involved previously tested functionality of the dFA, again was a trivial exercise.

It should be noted parenthetically that the criterion used to draw site boundaries during the SIBA2000 survey was a simple finds density drop-off, and the reason for recording these boundaries was not analytical but practical, enabling easy and reliable relocation at a later stage. It is recognised that the concept of 'site' has come under attack from many quarters in recent years, and that future surveys may choose to ignore it altogether, preferring instead to record collection units at higher resolutions and accuracies.

### 2.3 RECORDING OF TOPOGRAPHIC REFERENCE POINTS AND COLLECTION UNITS

Doubts about the quality of the available topographic maps and about the possibility of accurately mapping gridded collection units were the main reason for including measurements of topographic reference points in the SIBA2000 fieldwork. Separate measurement grids, consisting of square units approximately 50 by 50 m (0.25 hectare) in size, were set up in preparation to surveying (groups of) agricultural fields, and cardinal points in each grid were located in reference to these topographic landmarks. As the survey grids were established using a combination of sighting and pacing methods in sometimes difficult terrain, we felt it would be a good idea to obtain additional GPS measurements of the grids; accordingly, in some cases the locations of the canes used to mark the corners of collection

units were also recorded using the dFA. All grids, landmarks, and GPS positions were mapped on field maps at a scale of 1:2000. Each of these field maps was later digitised along with its GPS points, and the latter were used to calculate a simple 1<sup>st</sup> order georeferencing transformation<sup>2</sup>.

Although having a large number of GPS points, with attached notes, available during GIS processing did allow us to resolve some mapping problems, it was found that the procedures described above were insufficient for obtaining the desired mapping accuracy for many of the collection units. Where a large number of corners of collection units had been measured by GPS, the collection units could be mapped directly, without having recourse to transformations of the field maps. But for most field maps only a small number (from 3 to 8) of GPS points had been taken, and it proved impossible to ‘rubber sheet’ some of these onto the relevant GPS points in a satisfactory manner – apparently because there were too many internal distortions to the survey grids.

The georeferencing of the field maps brought to light other problems as well; in a few cases GPS points were so poorly placed for georeferencing transformations that additional points had to be constructed using plane geometry. In others, the inherent (standard) locational error of the GPS points confounded our attempts at georeferencing. Clearly, we have to rethink our approach in this regard (see discussion in sections 2.4, 2.5 and 3.1).

## 2.4 GPS ACCURACY

During the SIBA2000 survey, we experimented with three types of GPS measurements at different levels of accuracy:

1. For most readings (eg, field boundaries) speed is more important than accuracy, so we took the readings on the move or even set the equipment to continuous logging, which typically yields positions with a standard error better than 7m.
2. For field reference points (topographical landmarks, cardinal survey grid points) our experience suggests that the accuracy should be increased to 2 to 3m by taking several minutes for each reading.
3. For base reference points the accuracy can be increased even further to about 1 to 2m by leaving the equipment to record a position for several hours.

Figure 5 shows a plot of GPS measured points collected over a period of nearly six hours at the Francavilla Marittima museum on the morning of 26<sup>th</sup> October 2000. The antenna was fixed to the top of a ranging rod which was then attached to the south-west corner of the railing at the front of the museum. Measurements were collected at approximately 10 second intervals for a period of about three hours. The antenna was then moved to the south-east corner of the railing and a further three hour sequence of measurements was recorded. The observations at the western point were made at a time when the geometry of the visible satellite constellation was near-optimal, and are probably indicative of the best that can be achieved with a stand-alone single-frequency receiver. Those at the eastern point include a period of poor geometry and the re-establishment of position following a failure of the GPS receiver battery. They are probably more typical of average reception conditions. However, the introduction over the next few years of additional satellites to provide Wide Area Augmentation Systems (WAAS), primarily to support improved aircraft navigation, can be expected to bring typical performance into line with the better results seen here from the western point.

Although a single receiver can be now used to obtain the level of spatial accuracy required for archaeological surveys, it comes at the price of reduced measurement speed. It is also clear that “mission planning” software, which predicts the number of visible satellites and the quality of their geometry, still

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<sup>2</sup> For these operations, we used PC Arc/Info; all other processing took place under GRASS 4.1.

has an important role to play. However, the combination of extended point occupation times and the need to avoid periods of poor geometry, which may amount to one or two hours of the working day, hardly contribute to streamlining the fieldwork process. For our second and third types of measurements there remains a case for using differential techniques to improve accuracy without sacrificing speed.

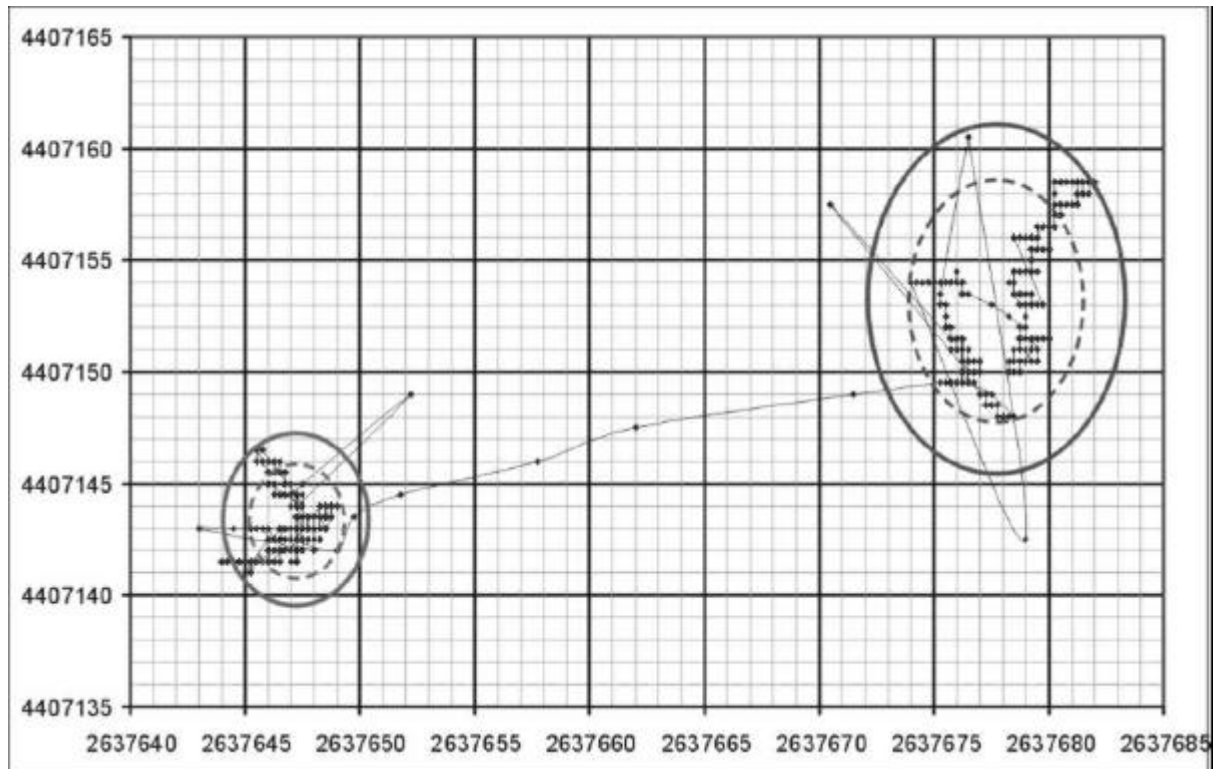


Figure 5 - GPS measurements of the two ends of the Timpone della Motta site museum balcony, illustrating the accuracy obtainable with a single receiver (Trimble SK8). Ellipses indicate 1 and 2 SD of location. Interval: 10 seconds, duration: 6 hours.

The accuracy of GPS measurements made by a single receiver can be significantly improved using differential methods (DGPS). In its simplest form, this involves using satellite-receiver distance measurements taken by another receiver at a known fixed location. Details of the orbital position of a satellite can be obtained as part of the satellite signal, so it is possible to calculate the difference between the measured and “correct” satellite-receiver distances. These differences can then be used to correct measurements made by a roving receiver. This simple technique effectively removes the measurement errors due to atmospheric effects on the propagation of satellite signals. With two receivers separated by only a few kilometres, accuracy can be improved to  $\pm 1\text{m}$  or better. More complex techniques involving signal carrier-phase measurements may be used to improve this to sub-metre levels. All this can be achieved using inexpensive single-frequency GPS receivers; greater accuracy requires the use of purpose-built and much more expensive dual-frequency ‘survey-quality’ equipment.

Real-time differential correction services are available in many areas. These include freely available signals from coastal beacon stations, intended for maritime use but often available at a considerable distance inland. Their main benefit is as a source of reliable correction data for inexpensive GPS receivers intended primarily for navigational use. Typically, the error in individual position fixes can be reduced to around  $\pm 3\text{m}$ , increasing with distance from the beacon station. Various commercial services are also available, but these usually broadcast encrypted signals for which payment of license fees and a special receiver and decoder are required.

If live correction is not required, much better results may be obtained by post-processing recorded measurements against full measurement data from a second receiver. In many parts of the world, there are stations operated as part of the International GPS Service (IGS, [igs.cb.jpl.nasa.gov](http://igs.cb.jpl.nasa.gov)) which make records available on a daily basis. For many areas, this is an invaluable source of highly accurate data. Unfortunately, the nearest observatory to the SIBA2000 survey area is at Matera, some 100 kilometres to the north. This distance is towards the upper limit of baseline distances for reliable corrections.

In view of the limited correction quality obtainable by post-processing against data from distant observatories, a further option would be to operate our own base station at a fixed location throughout the survey. This would require a dedicated computer and GPS receiver at the project base, recording continuously whilst survey teams were in the field. Given a maximum range to the edges of the extensive survey area of no more than 5 km and to the furthest point of the highland survey of about 15 km, position accuracy relative to the base station of between one and two metres could be expected by this method. In addition, long duration observations would help to significantly improve the absolute position of the base station by comparison with data from an observatory such as Matera.

Clearly, for those applications where the accuracy requirements are higher than what can be achieved with a single receiver, the last option would give the most satisfactory results. It is, of course, still a post-processing option so would not offer any improvement in the real-time positioning in the field but, as already mentioned, this does not appear to be a high priority because *FieldMap* provides sufficient accuracy for the fieldworkers' location needs. Should it become necessary, corrections could be broadcast from the base station and received at the rovers by using conventional wireless-modem transceivers.

## 2.5 SPATIAL ACCURACY AND THE PROBLEM OF IDENTITY

With the advent of accurate GPS location (and even before that with the increasing use of accurate field equipment) a peculiar problem has begun to haunt archaeologists: conflicts between field measurements and existing cartography. The position of topographical features as measured by GPS may not agree with their position as mapped on the most accurate available maps<sup>3</sup>. In the case of the SIBA2000 survey, this problem expressed itself in many conflicts between the GPS positions and the 1:10,000 scale topographic map; since the latter already had a bad reputation we 'resolved' the conflict by believing the GPS data to be the more accurate. On the other hand, some disagreements between paced distances on our field maps and GPS-measured distances could not be resolved at all because they were larger than could be explained by the standard GPS error. Using differential GPS or taking redundant readings suggest themselves as potential ways out of such conflicts. From this, and our problems in attempting to georeference the field maps, we learnt that field mapping methods based on estimates of distances and bearings are insufficiently precise in the kind of rolling terrain encountered in the Sibaritide foothills.

With respect to the sites mapped by the Quilici teams in the 1960s, the same problem was expressed in a more archaeologically relevant set of decisions. How much disagreement should we allow between the notional and measured locations of sites, before deciding that the two are *not* identical? Given the small scale of the published map data from which we had to work, it will not come as a surprise to learn that many Quilici sites were relocated up to 50m from their notional location. With larger disagreements it is no longer clear whether we have relocated an existing Quilici site, or have found a new one. While efforts continue to locate the Quilici's original 1:10,000 scaled field maps we may still hope that some of the remaining conflicts will be resolved.

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<sup>3</sup> This was noted, for example, when geophysical survey grids were very accurately positioned with the help of differential GPS at the buried Roman town of Wroxeter (Van Leusen 1998).

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### 3 FURTHER WORK

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Development of the dFA is ongoing; further work is needed to improve the functionality of both hardware and software components, and the user interfaces. The system should be able to deal with a range of fieldwork tasks under various field conditions, and should be to a large extent configurable by the user. In the following section we discuss plans and potential for further work on the functionality of the current dFA kit, on customising it with additional hardware and communication features for survey work, and on improvements to user and networking interfaces.

#### 3.1 ENHANCING CURRENT FUNCTIONALITY

The functionality of the system as tested during the SIBA2000 fieldwork should be improved by some fairly straightforward changes to both hardware and software components, as outlined below.

Firstly, current systems are not well adapted to typical Mediterranean field conditions. Although monochrome screens work well, colour displays are preferred for situations where multiple map layers are displayed. Unfortunately, most colour displays are dependent on backlighting and are difficult to read in direct sunlight. Manufacturers have been slow to realise that a mobile device might be used outdoors, but a solution may be found in some newer PDA models with partially reflective screens intended for outdoor use.

Data input is typically by an on-screen virtual keyboard or character or handwriting recognition software. Although the recognition systems are much improved when compared with those available on early handheld devices, these are still relatively slow processes, particularly for users who have not had considerable practice. The main interfaces of the *FieldMap* and *FieldNote* programs have been designed to minimise the amount of written input and, with large buttons and other controls, most interaction can be performed using a fingertip, making the pen almost redundant. This facility needs to be extended to the options screens, and we anticipate further development based on the Minimal Attention User Interface (MAUI) devised in earlier work (Pascoe *et al.* 1999). This employed large input controls that could be driven by the user's thumb, thus enabling one-handed control of the software. Simple use of voice actuation for selections from a constrained list of options is worth investigating as well. Recognition and automated transcription of voice input is not yet possible on these devices but, with rapid increases in computational power, may become available in the near future. In the meantime, we will investigate the use of the built-in voice recording capabilities of the PDA for adding voice notes as an alternative to text input.

Recording of geometric elements such as lines and polygons was a feature of earlier versions that was omitted from the new version because of development time constraints. Although the necessary data is recorded as part of the track log, restoring explicit user control of the geometry associated with a note is now a high priority.

Software should also be developed to facilitate conducting various types of 'gridded' surveys. The simplest option would be to record the locations of unit corners as they are being set out by the survey team, but more helpful alternatives should also be made available. For example, the system could be set to indicate the locations of unit corners at specified intervals and bearings from a given origin, or it could simply track the ground covered by teams as they work and warn them at specified intervals that a new unit is required. A major advantage of locating collection units in any of these ways, at least in rough and poorly controlled terrain, is that the spatial error is non-cumulative. Overall error can never be larger than that of an individual GPS point – about 5 to 10 m. A second advantage of the latter option is that the time consuming stage of setting up survey grids can be largely skipped, leading to greater efficiency.

A third area in which the functionality of the system may be improved is in the ease with which data can be exchanged between kits and with the project's base computer systems. Properly defined XML-

coded data formats will ensure that information can be exchanged and downloaded, stored and edited easily, and can be accessed by web servers and browsers (see section 3.3).

Lastly, a number of minor potential improvements to the functionality of the system were identified during the SIBA2000 experiments:

- Addition of several simple utility functions, to allow, among other things, on-screen measurement of distances and bearings using the pen
- The readability of the display may be further increased by the addition of line and area symbols for monochrome display (eg, dotted lines for grid edges, thick line for paths; dithering for images such as air photos), and by the use of transparency when displaying icons.

### 3.2 HARDWARE AND COMMUNICATIONS

If the paper recording trail is to be obviated altogether by the digital recording equipment proposed here, then one further step should be taken – the use of a barcode reader to link bags of finds to collection units. Handheld computers with attached barcode readers have been in use in archaeological excavation and survey since the mid-1980s, and the addition to the system of a barcode reader on a CompactFlash card is trivial.

A downside of the current system is that it can only record GPS locations of the kit itself, forcing the operator to walk along the features that are to be mapped. The mapping capabilities of the system would be clearly enhanced if it were possible to record the locations of distant features as well (eg, suitable areas for further work, caves seen in cliff faces). The time consuming and often strenuous task of following field boundaries could also be replaced by either of the following methods:

- by manual on-screen mapping as proposed in section 3.1, using a georeferenced large-scale topographic map as a reference; in this case the position of the features is estimated; or
- by attaching laser range-finder binoculars, which allow the measurement of distance and bearing. Commercially available models can be as accurate as  $\pm 2\text{m}$  at distances up to 2000 m.

As the functionality of the digital fieldwork assistant increases, more hardware components are added, leading to a shortage of ports. Many components require a serial connection so not all of them can be connected to the PDA at once without some form of intermediate switch; and even if they can, the additional cables and connectors make the system increasingly cumbersome. Even with a well-designed harness to keep these under control, there is an ever-present danger of catching cables on trees and other obstacles. We feel that the most practical solution to these problems lies in the adoption of wireless (radio) communications between system components. Ideally, each device would contain its own radio and would collaborate with the others to form a 'Piconet' or 'Body Area Network'. The long-awaited arrival of Bluetooth devices ([www.bluetooth.com](http://www.bluetooth.com)) which are intended to support short range (<10m) wireless networking may provide a solution.

An ever-present concern with mobile equipment is battery life. Battery technologies are improving but this is at least partly offset by increasing power demands as handheld computers become more powerful. The major limitation here is that most manufacturers design their systems for occasional and brief usage, whereas field computers are typically used more frequently and for longer periods. Many devices that are aimed at a consumer PDA market do not have adequate battery life for a full day's work in the field, particularly when heavy use is made of their serial interface to receive GPS data. Other similar machines

intended for industrial/commercial use are, however, equipped with higher capacity batteries that have proved equal to our demands.

The power requirements of GPS receivers have reduced considerably in the last few years as manufacturers strive to develop receivers that can be embedded in other equipment, such as PDAs and mobile phones. At present, a few receivers are available in PC card format, and smaller CompactFlash devices may appear in the near future. Whilst these have the advantage of reducing the number of cables used in the system, they rely on the PDA as a power source and therefore put an additional strain on its batteries. Whilst we intend to experiment with integrated components such as these, it will probably remain necessary to carry spare or external battery packs to support the combined load.

Communication for data exchange between handheld and desktop machines typically uses serial or wired Ethernet connections. For those devices capable of using PC cards, local communication over a range of about 150m is possible using conventional 'Wireless Ethernet' cards. As yet, however, no such card is available in the CompactFlash format more commonly supported by PDAs. Away from the team's base, mobile phones provide a suitable communication medium, provided that there is adequate network coverage in the survey area. In uncovered areas, other devices such as wireless modems might be used.

The main limitation of current mobile phone technology as a data transfer medium is cost. At the time of the SIBA2000 campaign, data calls on GSM digital network still required the pretence of analogue transmission and hence the use of a modem. As a result, the exchange of any amount of data, no matter how small, requires a lengthy negotiation phase as the modem attempts to establish a connection with an ISP. It is this rather than the low data rates (typically 9600bps) that constitutes the main limitation. *FieldNote* transfers often involve sending and receiving only a few hundred bytes, but long connection times mean that any transfer takes a minimum of about 70 seconds.

Since the SIBA2000 campaign, several telecom networks have begun to roll-out a GPRS service. Whilst still using the basic GSM technology, this provides a fully digital connection, similar to that of ISDN systems, albeit at a much lower data rate. The mobile phone can maintain an 'always-on' IP connection to a network server and charging is by data volume rather than usage time. Initial experiments with such a system in the UK suggest that this may become a viable communications medium for future field campaigns. Over the next few years, further developments are scheduled. The next major advance will be the so-called 'third generation' networks which will offer far higher data rates (up to 2Mbps) and the possibility of live multimedia and video links.

In parallel with infrastructure developments, a convergence of mobile phone and PDA technologies is under way. Eventually, the question of whether to add mobile communications to our field tools may become irrelevant as these will be part of the normal function of a PDA.

### 3.3 USER AND NETWORK INTERFACES

Extending the functionality of the PDA in all the directions suggested above will require some rethinking of its user interfaces, which will have to allow full configuration of task and display options and efficient ad hoc switching between tasks and displays. As more intelligent use of the system will require the simultaneous display of more different types of information and the availability of more options on a limited screen size, the design of intuitive and effective user interfaces will become essential.

A complex multi-component system will also require extensive configuration. Here we envisage that the design phase of a typical fieldwork project would include the preparation of configuration scripts which are uploaded onto each individual kit. An on-screen menu will then give access, firstly, to the list of available configurations (tasks such as 'create new grid' or 're-locate features'), and secondly, to a list of the configurable variables for that task (e.g., 'set grid size' or 'set alert distance'). The configuration data



can also specify which options will be available as on-screen buttons and/or as voice actuated options. Given that the system already contains components for handling data exchange in XML format, and that XML techniques for managing software configuration are becoming widespread elsewhere (see, for example, Austin *et al.* this volume), it is likely that this approach will be used to provide these configuration scripts.

At present, we see on-line communications between field crews as something of a luxury, but it has the potential to significantly improve the reliability of the system. If newly recorded data is rapidly mirrored on a remote server, we can overcome the ever-present fear of losses arising from device failures in the field. There may also be benefits in making preliminary environmental and archaeological maps available to crews as they are produced. As the costs of use and features offered by the mobile networks become more favourable, we anticipate exploring ways in which such connectivity might be exploited, particularly as the field teams are already carrying mobile phones for voice communications.

Work is also under way to provide a mechanism for automatically generating a web interface to notes, maps and photographs recorded in the field. This has the obvious benefit of making the field data accessible in a widely used form but, with on-line field communications, it would enable all participants in the field, at the campaign base, and at their home institutions to have direct, near real-time, access to the progress of the campaign. This opens up the possibility of 'remote' specialists taking part in the field work, for example providing determinations of enigmatic finds.

Further development of the desktop data management tools developed for the current and earlier versions of the *FieldNote* system is required. At present, these tools support conversion to and from appropriate GIS data formats and simple display and editing of data collected in the field. A revised version of the desktop component should include facilities for managing the configuration scripts discussed above. We envisage that responsibility for the dFA will become part of the Data Manager's task, and that procedures for the acquisition and distribution of data on dFA's will need to be fully integrated with the broader survey design.

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#### 4 CONCLUSIONS

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The experiments described here have confirmed the potential of the dFA system for both speeding up field recording procedures and reducing the number and size of errors made during the recording process. The system's potential for easing navigation and the sharing of information during surveys has not been fully explored, but our experience in (re-)locating archaeological sites mapped in the 1960's indicates that it will also prove useful in that area.

With the limited enhancements to functionality discussed in section 3.1, and the further improvements to the standard accuracy discussed in section 2.4, the system can profitably be used in any type of archaeological survey. With full technical and procedural integration of a professional version of the kit into fieldwork methodology, along the lines suggested in sections 3.2 and 3.3, dFAs will begin to transform fieldwork practise. This will require further extensive testing of system components, software, and field procedures.

In recent years, the use of professional GPS surveying equipment in archaeological fieldwork has become much more popular (cf. De Wulf *et al.* 2000a,b), and some teams are adapting commercially available products in order to obtain GIS-like capabilities in combination with GPS (Johnson & Wilson n.d.). These high-powered approaches, while providing very high accuracy and versatility, require considerable

expense and highly skilled personnel, and cannot provide a true field information system<sup>4</sup>. The advantages of the digital Field Assistant system described here over such alternative approaches can be summarised as follows:

- Inexpensive - it is possible to fully equip a fifteen to twenty person team for the price of one typical professional survey kit;
- Immediate feedback - the data collected in the field are made available for use straightaway in a process contributing to and enhancing the available pre-loaded data, rather than being taken away for later processing and use. They can also be made context-aware, presenting themselves actively rather than passively as in field GIS;
- Portability and unobtrusiveness - the equipment weighs very little, will fit in your trouser or vest pockets, and requires very little training. It is designed to avoid distracting the user from the tasks at hand;
- Utility - the equipment, as envisaged, performs typical and frequently occurring archaeological fieldwork tasks such as setting out grids, mapping collection units and points of interest, and recording finds information.

With respect to the GPS component of the system, the availability of a good location device is a crucial feature in the recent shift in emphasis of archaeological survey work away from the well-mapped and well-controlled coastal zones of Italy, to the more rugged and less well-mapped inland zones. For archaeological applications where the accuracy requirements are higher than what can be achieved with a single receiver, the addition of a GPS base station for differential correction would give the most satisfactory results. Post-processing, of course, would not offer any improvement in real-time positioning in the field but so far we have not identified any reason why this should be a high priority. Should it become necessary, corrections could be broadcast from the base station and received at the rovers by using conventional wireless-modems.

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<sup>4</sup> ESRI offer the field mapping system ArcPad (which runs under Windows CE); Trimble offer the Pro XRS system with Asset Surveyor and Pathfinder Office software for use on notebook computers. This will view and edit pre-loaded maps and interface to ArcView for subsequent query, analysis and presentation. Total cost for this system, used by the Australian Paliochora-Kythera Project to map survey units and landscape/archaeological features and to upload and correct the data in ArcView at the end of each day, is \$12K. De Wulf et al. (2000a,b) investigated the use of survey quality GPS in an archaeological topographical survey of the Thorikos region in Greece, concluding that it is more than twice as efficient as a total station (EDM) survey but also twice as expensive at the highest accuracy class; moreover, the processing, quality control, and interpretation of GPS measurements required a higher degree of skill than was needed with a total station.

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# THE RPC FIELD SURVEYS, 1998 – 2000

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## 1 INTRODUCTION

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The aim of this chapter is to gather together the significant results, both archaeological and methodological, obtained through the RPC project surveys conducted in the period 1998-2000. The surveys conducted by the RPC project have all been aimed at a better understanding of the spatio-temporal distribution of archaeological materials within the three study regions, and have generally been targeted at marginal landscape units in order to compensate for the fact that previous research has mostly been concentrated on urban settlements and their immediate surroundings<sup>1</sup>.

The 1998-9 fieldwork near Ninfa in the Lepine footslopes originally aimed to map Republican rural villa sites in an area adjacent to that of the earlier Norba survey (King 1995) in an effort to enhance an earlier topographic survey by Vittucci (1968), but following the discovery of a large number of Archaic sites its aims were broadened to include sites of protohistoric date. The 1998-9 fieldwork near the Fogliano lagoon aimed to establish to what extent the coastal landscape of ancient beach ridges was indeed 'marginal' with respect to contemporaneous developments (centralisation, urbanisation) in the Alban hills area, as argued by Attema (1993). Whereas the latter area and its fringes showed a clear development towards urban forms from the late Iron Age onwards, no such development had been visible elsewhere in the Pontine region. The 1999 fieldwork in the Salento Murge near the town of Ostuni was likewise aimed at studying an area thought to be geographically and economically marginal to the developments ongoing in the Salento Isthmus zone, studied intensively by researchers at AIVU since 1980. No rural surveys had yet taken place in this landscape of LBA and IA centralised settlements and scattered Hellenistic and Roman farm sites. The 2000 fieldwork east of the town of Lauropoli in the footslopes of the Pollino range was rather different from previous campaigns, in that it expressly aimed to test aspects of the distribution of known sites established by Quilici in the 1960s (De Rossi *et al.* 1969). Specifically, our aims were to test whether the large-scale patterning of mainly Hellenistic-Roman scatters which Quilici correlated to a hypothetical infrastructure was not due to the manner in which he conducted his survey; and to establish the nature of the small-scale variation in the archaeological record in between the sites discovered by Quilici.

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<sup>1</sup> The Ninfa field survey was planned and conducted as part of the Pontine Region Project, precursor to the RPC project at the GIA, which aimed to map the Republican villa landscape in the immediate neighborhood of the early towns of Segni, Lanuvio, and Sezze. The preliminary report reproduced here in chapter 9 therefore contains no references to the extensive Italian literature which is available on the 'formazione delle città' in this area. Starting with the 1998 campaign near Fogliano, however, field surveys in marginal landscapes of the Pontine region, the Salento Isthmus, and the Sibaritide were integrated with the existing research programs at the GIA and the AIVU. The surveys in the Fogliano area served to complement the long-term excavations conducted by Prof. Kleibrink at the Archaic center of Satricum; the Ostuni survey complemented the intensive diachronic research conducted by Prof. Yntema in the Brindisino since the early 1980's; and the Sibaritide survey was part of an ongoing program of surveys in the surroundings of the protohistoric settlement and cult place at Francavilla Marittima, excavated by Prof. Kleibrink since 1991.

## 1.2 BACKGROUND

Interest in the theory and method of field walking surveys, famously introduced into Italy in 1956 by Ward-Perkins, peaked in the late 1970's and 1980's, as can be seen from such edited volumes as those of the Society of Antiquaries one-day seminar on archaeological field survey in Britain and abroad (1983, Macready & Thompson 1985), the 1986 Theoretical Archaeology Group conference in London (Schofield 1991), the 1988 conference "La struttura agricola romana: il contributo della ricognizione archeologica" organised by the British School at Rome (Barker & Lloyd 1991), the 1989 conference on archaeological landscapes in Eastern England (Leicester, Parker Pearson & Schadla-Hall 1994) and the 1981 colloquium on archaeological surveying in the Mediterranean area (Athens; Keller & Rupp 1983). Monographs in this area included those by Shennan (1985) on collection and analysis experiments and Ebert (1992) on distributional archaeology. Numerous less significant conferences have been held on the subject, and a count of journal articles would certainly run to more than one thousand.

After what seems to have been a considerable lull due to delays in publication, another two important volumes of proceedings on the subject of surveying and plough-soil assemblages were recently published (Bintliff et al. 2000; Francovich & Patterson 1999); these were based, respectively, on an academic session at the 1996 EAA conference in Riga (Latvia) and on a 1995 symposium organised by the POPULUS European network. An important recent monograph was Boismier's (1997, appearing in the British series of the BAR) PhD thesis on tillage-induced pattern formation. Further reviews and discussions conducted in the context of a conference and workshops organised by the RPC Project team in 1999 will become available shortly (RPC forthcoming). In no particular order of importance, the significant trends arising from these studies are:

- geopedological research has become a required part of regional projects, not only in order to map one of the most important factors in past land use, but also to map geomorphological bias in the survey results (erosion, accretion). The OST99 survey demonstrates that some landscapes can be seriously affected by soil movement and restructuring.
- The increased use, since the middle 1980s, of field digital equipment, DBMS, and GIS as a data management tool
- The 'maturation' of survey as compared to other forms of research - increased complexity of organisation, concern for (supra-) regional comparison, leading to calls for standardisation. Cherry's (1983) work still aimed to show how important survey was; Cambi & Terrenato, in their introduction to landscape archaeology (1994:151-8), write that much work is still needed before agreement on basic procedures for survey is reached, and that the problem of visibility had only recently been recognised, but nowadays many surveyors are well aware of these issues and have begun to be concerned to be able to compare results.
- The increasing importance of 'off-site' archaeology and more intensive collection methods. The general tendency has been for surveys to become increasingly intensive, both in regard of the distance between walkers and of the amount and type of material recorded, collected, and described. Schiffer and Wells (1982) tabulated some typical crew spacings of the '80s; Cherry (1983) tabulated the number of sites produced by survey projects over the previous three decades. Although theoretically rooted in the early 1970's, this tendency towards intensification only resulted in the advocacy of non- or off-site survey by Mediterranean archaeologists from the early 1990s onwards.

## 1.3 APPROACHES

The choice of the area to be surveyed was based on physiographical criteria, in some cases modified by pragmatic and political considerations. The Ninfa survey area needed to be adjacent to the Norba area surveyed earlier, and was defined essentially on geological grounds by the steep limestone slopes of the Lepine mountains on one side, and by the tuff ridges of the Alban massif on the other. The Fogliano

survey area was again defined geomorphologically, this time by the landscape of lagoons and ancient beach ridges that forms the coast of the Pontine plain and is bounded on the landward side by the clayey deposits of the Latina level. The Ostuni survey targeted two areas, one located within the Murge upland, the other just below the Murge scarp on which an LBA settlement was known to be located. The SIBA2000 survey targeted a transect through the fluvio-marine terraces which were thought to expose most of the detectable physiographic and archaeological variation occurring in the northern half of the Sibaritide region, but here the choice of area was also limited by the concession obtained from the archaeological superintendency for Calabria. In all cases, current land use at the time of the surveys to some extent directed our choice of general area – a sufficient amount of accessible tilled land had to be available – , and precluded surveying in a considerable number of agricultural fields within those areas.

The general approach used during all the surveys was that of intensive rural (or ‘off-site’) field-walking aimed at total coverage within the survey area. Methods evolved from those previously used by Attema (which in turn derive from methods developed by the Agro Pontino Survey project, Voorrips et al. 1991) and quickly became more intensive when it was found that significant small-scale variation occurred in the archaeological record in between the easily recognisable classical sites. Because it was intended that GIS be used for the management and visualization of the survey results, the collection of finds and recording of variables was organised in geographically defined units rather than archaeologically meaningful units such as sites; the former units decreased in size from agricultural fields (Ninfa survey) to hectare-sized (Fogliano survey) and eventually quarter-hectare sized (50 by 50 meters) in the Ostuni and SIBA2000 surveys.

The intensity of the surveys was also increased by the decision to collect all archaeological materials on the transects walked by each team, as it was recognised that individual team members could not be expected to classify and count all materials correctly in the field. Since the typical distance between walkers was 6 to 10 meters, approximately 20% of the ground surface of each unit was inspected and approximately 20% of surface material was collected. Primary finds processing took place at the survey base under the direction of team members qualified to classify the material on the basis of fabric and ware group; more detailed secondary classifications based on form were carried out later on (sometimes after the field campaign) by appropriate specialists.

These approaches entailed a lowered ‘productivity’ of the surveys as compared with less intensive surveys conducted earlier. The overall speed of the surveys was reduced to just over 1 hectare per person per day. Various experiments were conducted in an effort to increase the efficiency of the surveys, firstly by reducing the number of variables to be recorded for each unit (these could be derived from digitised map layers in the GIS at a later stage), secondly by reducing the number of hardcopy forms needed for the paper trail of units and finds prior to their entry into computer databases (see Appendix to this chapter), and thirdly by skipping hardcopy forms altogether and recording unit and finds data digitally using portable equipment in the field (see chapter 7).

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## 2 RESULTS

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To a remarkable extent, the RPC surveys succeeded in uncovering evidence for the existence of pre-Roman indigenous settlement, which previous research had either ignored or been unable to detect because of the low visibility of the archaeological materials involved. Hypotheses about the marginal role of these landscapes with respect to the large-scale processes of centralisation, urbanisation, and colonisation have had to be modified not only by the direct results of the surveys, but also by our increased awareness of the biases introduced by the geopedological and land-use history of the study areas.

## 2.1 PONTINE REGION

The Ninfa survey proved that the Lepine footslopes between Cori and Norba were thinly settled from the later Iron Age onwards, with a large increase in the number of settlements occurring in the Archaic. Because the assignment of pottery and tile to the post-Archaic period is not yet secure, the fact that almost all Republican rural villa scatters proved to include Archaic and post-Archaic material cannot be used to argue for an essential continuity of settlement in this area; rather, it is likely that the increasing likelihood of raids forced some of the inhabitants to retreat to central and defended settlements elsewhere. The Roman Republican villas were established on previously used Archaic settlement locations in the area sometime after the late 4<sup>th</sup> century BC pacification, as part of the Roman ‘colonisation’ of the Pontine region.

The Fogliano survey uncovered a protohistoric landscape in some respects very similar to that of the Lepine footslopes. A relatively small number of ?BA and IA settlements was attested, and these may have been located in promontory-like landscape units in order to take advantage of cooling breezes and clear views across the small valleys that dissect the beach ridges – whether with a view to hunting the wildlife that would have concentrated there, or to grazing their cattle, is uncertain. The number of sites increases steadily throughout the Archaic and post-Archaic periods but no nucleation occurs; it is only in the late Republican period that the area appears to have been ‘discovered’ by the Romans, and a rural village grows up at the site of present Borgo Grappa, possibly in connection with industrial villas exploiting fish farming along the coast.

Both these surveys show a remarkable cessation of occupation following the early Roman Imperial period; it is not clear whether this must be explained by a depopulation of the Pontine plain or by a concentration of the population in large villae and defended burghs such as those attested for the later Middle Ages. It is thought that the economic significance of the Pontine plain, as a supplier of grain, olive oil, and other products to the Roman market, was much reduced when the Empire acquired more suitable lands.

## 2.2 SALENTO ISTHMUS

The Ostuni ’99 survey resulted, first and foremost, in the discovery that both the areas surveyed contained a completely unexpected and large number of MBA ceramic scatters, one of which was nearly 6 ha in size. The same material was also found in abundance in the coastal plain during a later (unpublished) campaign by Burgers, and poses interesting problems of interpretation – for now, a period of shifting cultivation is proposed to explain the widespread occurrence of the undiagnostic coarse impasto. In fact, finds dating to the MBA were in absolute majority because both areas contained only a few classical (hellenistic-Roman) sites. No LBA and only a few possible IA finds were made, but for these periods the settlement system is known to have been strongly nucleated on hilltops on average about 12 kms apart. The absence of Archaic and Classical finds indicates that this nucleated pattern continued to dominate until the area was incorporated into the Greek colonial and, later, Roman Imperial sphere. For these latter periods, there is a remarkably regular (although thin) pattern of farms present in both the Murge uplands and the coastal plain, which presumably formed part of the rural hinterland of the town of Ostuni. As in the previously discussed surveys, no material dating to the high or late Empire was found, and only a few late antique sherds.

## 2.3 SIBARITIDE

The SIBA2000 survey, preliminary analysis of which is for the first time reported here in chapter 12, brought no large surprises to the survey teams in that the results were sufficiently similar to those of the excellent extensive regional surveys conducted in the 1960’s by Lorenzo Quilici and his team in advance of the excavations at Sybaris. Our survey was aimed at establishing whether the patterns, densities, and nature of the archaeological record reported by Quilici would be upheld in an intensive survey of a representative section of his research area; the quality of his work is evident from the fact that we

must make only minor corrections to it. Our work confirms that most of the archaeological record in the foothill zone consists of poor, and poorly datable, Hellenistic (occasionally Roman) farms; it also showed that the virtual absence of 'rural' protohistoric materials is real (although perhaps partly caused by very low visibility), and again points to a nucleated hilltop settlement pattern – several of which are known to lie just outside our survey area. Again, no late Imperial or Byzantine wares were found, but these periods will be the subject of a separate research programme in the future.

In both the Ostuni '99 and the SIBA2000 campaigns we found ample evidence for the occurrence of significant local bias factors. In the calcareous area around Ostuni deep soils are so rare, that where they occur they are often dug away and redeposited elsewhere on the owners' estate, or even sold for use by other farmers; the 'shortfall' is made up with large chunks of broken-up limestone which are then covered up with a thin layer of soil. Such destructive work was evident in many places from the bright red color of the subsoil as it lay on the surface, with obvious consequences for the archaeological record. In the Sibaritide, agricultural improvement again caused a bias in the survey, because in many areas the plough had ripped up and disintegrated chunks of the underlying conglomerate rock. Being full of pieces of pebbles of many colors and bits of conglomerate cement, it was extremely difficult to discern any but the most obtrusive archaeological materials in the ploughsoil – possibly contributing to the dearth of reported non-classical material.

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### 3 DISCUSSION

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#### 3.1 FINDS COLLECTION AND PROCESSING

As a point of principle, and because the survey teams consisted of a mixture of experienced and unexperienced walkers, the policy of the RPC surveys has been to collect all non-natural material observed in the transect, and not to make any decisions individually about discarding any particular class of material. Because the surveys took place in marginal rural areas, this strategy only broke down occasionally as high density scatters of Roman tile and dolium fragments were encountered; in these cases, smaller representative and diagnostic samples were taken. In addition, team leaders were responsible for setting a slow pace that allows proper scanning of the surface. It was found that even under these conditions, great quantitative as well as qualitative differences between individual collections remained. The general effect of these was throughout to de-emphasise the presence of coarse, earth-coloured and fragmented pre- and protohistoric ceramics and lithics, while emphasising the larger, brighter, and more obviously artificial (in other words, the classical) finds. This problem could not be addressed within the context of the RPC surveys but is flagged up here as one that needs much more attention if collections are to be representative of the surface record. Among the examples cited in the individual survey reports are the well-known phenomenon of the lithic specialist picking up almost all of the lithics (Ninfa 98), and highly motivated individuals being the only ones to detect barely visible protohistoric wares (Fogliano 98, SIBA2000).

Ceramic finds for all the above-mentioned surveys were processed either by, or under the direct supervision of, Peter Attema, and use a system of classification based primarily on fabrics and ware groups. Specialists were called in to classify the lithics which were collected more or less as a by-product (but no less systematically), and those ceramics which allowed closer dating and form description. Where a typology of the local ceramics had already been produced, as in the Pontine Region, this allowed finds to be assigned to categories with a fairly restricted period of use (typically a century or two), although there are still considerable uncertainties associated with some classes and periods. Examples include the highly worn protohistoric impasto body sherds of the Fogliano survey, which may be ascribed to the Bronze Age or Iron Age, the Roman coarse and depurated kitchen wares which last from the Republican into the Imperial period, and various late Republican or Imperial tile categories.



### 3.2 DATA PROCESSING

In addition to the question of what data to record in a survey, there is also the question of how to record and process it prior to analysis and interpretation. In general, the recording practise during the RPC survey campaigns 1998-2000 documents my attempts to progressively exclude the informal recording of information and to preclude the recording of ambiguous information – the aim being to ensure that all forms would be comparable, while at the same time reducing recording and transcription error and inputting all form data into an RDBMS as quickly as possible. While the starting point in the Ninfa 98 survey was provided by the paper forms that had been in use in earlier survey campaigns by Attema, these had to be substantially altered to make use of the fact that many topographic variables such as slope class, relief class, and soil type no longer had to be estimated in the field but could be derived afterward from appropriate GIS data layers. A second major alteration consisted in relinquishing the individual transect as a recording unit, and replacing it with an areal unit surveyed by a team of walkers.

Since it was intended for the survey data to be linked to digital maps in a GIS and to be analysed in this form, further changes became necessary in the system of identifiers being used for collection units ('blocks' and 'sites') and collections ('bags'), and in the numeric encoding of variables that were to play a role in the process of correcting for biases. Finally, it was found that the physical movement of (bags of) finds through the various stages of cleaning, classification, and storage could only be kept relatively free of errors if the forms were designed to be passed along with the finds to the next responsible person in line.

In the end, the SIBA2000 survey teams worked with only two different paper forms: one for recording information about collection units, the other for information about collections (i.e. the contents of single bags). The former is sufficiently flexible to allow both the recording of a typical off-site unit and of a 'site'; the latter 'bag' form accompanies the bag from the moment it is created in the field through the processing, and information is added to it at every stage. Finally, only one transcription step is needed when the form data are entered into a digital database. These forms and the accompanying user notes, which represent the latest (2000) stage in the ongoing development of satisfactory field administration procedures, are included here as an appendix.

It must be admitted here that, although the survey teams and directors were happy with this system, it is by no means perfect, and relies on thorough instruction and discipline of all those involved in using them. Inevitably, errors and omissions creep in as the day wears on and people get hot and tired, so it remains as important as ever to reduce as much as possible the demands made by the forms in the field, while at the same time ensuring the integrity of the data entered on them. It is evident that these tasks can, in principle, be better performed by *digital* forms than by paper forms, and in our last campaigns we have therefore begun to experiment with the use of handheld field computers or *PDA's* (see chapter 7). These have the advantage that they can present only the relevant fields to the user, can prompt them to fill these fields out, make it easier to do so by offering option lists, and reject illegal values; they can also be 'context aware' by automatically providing information such as the current time, date, temperature, name of administrator, and location (through an attached GPS); finally, they have the advantage that the information in them can be downloaded rather than transcribed into the RDBMS. An area still to be explored is that of using such handhelds not only for the recording of alphanumeric unit attributes, but also for the digital mapping of the boundaries of collection units or even the individual transects walked by the surveyors, obviating the need for the time consuming practise of laying out measured collection units in the field. Shortwave radio or satellite phone communications could be used for the purposes of creating an instant backup of the data thus acquired on the expedition's computer system.

Once the data are safely within the database, preliminary quantitative processing can produce such descriptive information as the counts and weights of classes or combinations of classes per collection unit, which can be transformed into densities and displayed in map form once the boundaries and identities of the collection units have been entered into the GIS. Since the recording and correction of biases plays such an important role in my research, I must here go into some detail regarding the

correction procedures used. The method developed for the RPC surveys corrects for three factors – area of collection unit, percent coverage, and estimated total visibility.

Since we used relatively small collection units (typically of 0.25 ha), even relatively minor errors in mapping their boundaries could potentially have a large effect on the calculation of finds densities, causing spurious highs and lows to appear in our density maps. We therefore had to take great care in noting and excluding such features as verges, paths, and gardens intruding on our units, which do not appear even on the most detailed and up-to-date topographic maps. When I compared the actual total area surveyed in the Ostuni '99 campaign as calculated on the basis of our detailed field maps with the apparent area as derived from field boundaries on the 1:10,000 scale topographic map, the latter turned out to overestimate by as much as 15% the average surface area of any unit. This was in a relatively well-mapped region of Italy, and indicates that in more poorly mapped areas, or where maps of coarser scale are being used, this source of error can become even more significant. In the SIBA2000 survey I found that the actual arable part of some agricultural fields (i.e., the area open to survey) may be less than half the area contained within its mapped boundaries, because the maps do not show the scrub which usually takes up all the steeper parts of the landscape. Thus, one cannot rely on sketch maps but needs to estimate, or better measure, the actual area surveyed.

Since the area open to survey was typically walked by us at an interwalker distance of between 6 and 10m, depending on the type of land use encountered, the correction must take into account the percentage area observed (percent coverage). We therefore recorded this factor whenever it deviated from our standard 10m. In order to calculate the percent covered per unit and normalise this to its equivalent of 100%, I estimated the effective width of the 'swath' observed on a typical transect to be 2m. This is perhaps a slight over-estimate but since the same swath width was used in all surveys no errors result from it. Thus, in a typical case, the percent coverage would be  $2 / 10$  is 20%, and the correction factor would be its inverse, or 5.

A similar procedure was used to correct for estimated total visibility, although here the objectivity of our methods for estimating both the size of the bias factors and their effect on finds recovery may be questioned (see chapter 5 on bias modelling for details). Three areas for future research have been identified here: firstly, the need to establish objective measurement scales for bias factors, next, the need to distinguish the effects these bias factors can have on the recovery of different classes of archaeological materials; and thirdly, the need to avoid multiplying out of proportion random variations in low density finds data – the 'low numbers' problem.

Using this method, the raw counts per finds category are normalised into a continuous variable (densities per hectare), assuming total coverage and optimal visibility, and displayed as GIS raster map layers for interpretation. At this point they can be compared both with other data layers in the GIS (generally holding environmental variables), and with qualitative archaeological data regarding finds and sites observed during the campaign and in earlier compilations. Although this work could (and perhaps should) be done during the field campaign itself so as to be able to help 'steer' the work away from trouble, our relatively low-budget campaigns did not allow us to do so, and all GIS processing and most database processing was done at the Groningen Institute of Archaeology after the campaigns ended.

### 3.3 INTERPRETATION: (RE-) CONSTRUCTING SETTLEMENT AND LAND USE HISTORIES

Although each of the RPC surveys has helped to answer the immediate questions posed about each region, it is to be hoped that their impact will be wider than that. Bit by bit, field surveys are contributing to a database that should allow us to begin to see similarities and differences through space and time. The scope of typical field survey data may be limited by its generally low diagnosticity and temporal resolution, and its interpretation further bedeviled by a host of post-depositional biases, but broad patterns in space and time tend to emerge quite well from surveys, and their main use is therefore in qualifying the 'stories' told of the long-term history of settlement and land use within regions. Thus, they lead away from the generalising 'stories' of centralisation, urbanisation, and colonisation processes, towards the particular

history of the region or even landscape within a region. Yet because of the low quality of the data much depends on the comparison between data sets collected in the different regions and landscapes, and therefore on the comparability of the methods by which these data have been collected. The beach ridge landscape around Fogliano, and the colluvial slopes of the Lepine margin, can only be called ‘marginal landscapes’ in the protohistoric and Archaic periods if some aspect of the survey results – whether this simply be the quantity of finds or of sites, or qualitative indicators of urbanisation – , can be shown to demonstrate this. As will be shown in chapter 13, the necessary comparisons between different data sets lacking the elementary precondition of standardization in definitions and recording methods makes this an extraordinarily difficult task. At the very least, our research question should now become: *from the perspective of which system (in what sense) should these landscape units be called marginal?*

Conversely, it is not clear that survey data have much bearing on the ethnicity of the protagonists. Can Roman colonisers in the Pontine Region be distinguished from their Latin allies and sometime enemies? Are the majority of the Hellenistic farmers in the Sibaritide likely to have been of indigenous descent or from the pan-Hellene colony? The material culture of these rural areas is just too poor, and in some ways too standardised, to distinguish the two purely on the basis of data gathered by fieldwalking survey. Questions of ethnicity, cultural affinity, etc., can only be studied through excavated evidence of cultural practise.

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#### 4 CONCLUSION

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The RPC fieldwork has contributed to the aim of ‘elucidating the complex nature of archaeological reality’ as expressed in chapter 1, by showing that marginal landscape units can have their own settlement and land use dynamics, sometimes in line with general regional trends but sometimes independent as well, and that the archaeological record is indeed severely biased in favour of the classical landscape and of ‘high culture’. While aimed at understanding the nature of ‘marginal’ areas within the study regions, it has also been important in providing a sense of the landscape which cannot be obtained from studying maps and literature alone. The same is true of an appreciation of the nature and significance of the biases introduced by geopedological processes, historical and present land use and land cover, and the history of archaeological research in each study area.

Further work will be directed at the intensified exploration of highland economies as begun in the SIBA2000 campaign, with the attendant development of appropriate methods and techniques to increase surveying efficiency and quality of the data collected.

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**APPENDIX: SIBA2000 FIELD FORMS AND USER NOTES**


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**UNIT FORM**

A UNIT can be any geographically defined collection unit (such as an agricultural field, measured grids, a site, or a “string square”); the UNIT form is used to record information about the UNIT itself, and about the archaeological samples taken from it. Large-scale landscape characteristics (such as land use/land cover and geomorphology) are no longer recorded for each UNIT individually, but are mapped separately on copies of 1:10,000 scale topographic maps. If the UNIT is a standard nonsite area, only those characteristics particular to the UNIT (soil colour, evidence of working, etc.) must still be recorded in the NOTES box and on the reverse of the UNIT form where necessary. If the UNIT is a ‘site’ (however defined), the mandatory additional characteristics to be recorded are a) the location of the core and b) at least one contour line for the halo, with density in finds/m<sup>2</sup>. Recording of the conditions affecting the recovery of material from the UNIT has been streamlined so that a five-point scale must now be ticked for each of six factors. There must be prior agreement on the meaning of the scale.

A SAMPLE is defined as any set of finds put together in one finds bag. An RPC standard sample consists of all non-recent objects found along 10 m interval lines (for a swath width of 2 m, this gives a standard 20% coverage). Additional, non-standard, samples may be collected for a variety of reasons; four non-standard RPC sample types are recognised:

- Grab sample (Gs) – an unsystematic collection of ‘typical’ artefacts aimed at obtaining a quick impression of the surface material in the UNIT, usually made when circumstances do not permit the collection of a better sample;
- Diagnostic sample (Ds) – a systematic collection of artefacts selected for their diagnostic value, usually made in order to obtain a closer dating in cases where the Standard sample was not sufficiently diagnostic, or where the overall finds density is very high;
- String square sample (Sq) – a total collection of artefacts within a 4 by 4 m area marked out with a specially prepared rope, usually made on-site in order to obtain accurate finds densities and to ensure that unobtrusive finds categories are not overlooked;
- Total sample (Ts) – a total collection of all artefacts in the UNIT; usually made in the case of small and low-density scatters.

Each UNIT form has space for recording three samples, so an additional UNIT form will be needed if more than three samples are taken from the same UNIT. To avoid any confusion between standard samples taken on different visits to the same UNIT, samples must always be recorded straightaway (so the bag number will tell you which sample was taken first); as an additional safeguard, you can include ‘2<sup>nd</sup> visit’ etc. in the Notes section of each sample record.

At a minimum, the ticket in each bag (written in waterproof marker) should have the UNIT, BAG, and Sample ID numbers filled out. The bag weight and contents information is included to provide additional control against loss during processing. The bag itself should also have (written on the outside in waterproof marker) the UNIT, BAG, and Sample ID numbers.

The page number box on the UNIT form is filled out at the end of the campaign in order to facilitate annotation of, and referral to, UNITs.

## BAG FORM

Finds bags containing SAMPLEs, after preliminary recording on the UNIT form, are brought back to the survey base for processing at the end of each day. BAG forms are written out in the field whenever finds bags are produced, and are passed to the finds processing supervisor along with the bags themselves. The purpose of the BAG form is to record, in summary form, the contents of a single finds bag, and to provide the necessary control during all stages of processing. The form is A5-sized and contains information about a single bag, allowing the forms to be stored in the order of the UNIT/BAG ID number. The form is not intended for the recording of specialist processing involving individual objects. Each BAG is identified by its combination of UNIT and BAG numbers, eg 0136-02, which must also appear on the ticket included in the bag and, for security, written in indelible marker on the outside of the bag.

Four stages of finds processing are recorded on the BAG form, facilitating the identification and tracing of bags that go missing at any stage:

- From Field (date) – records the date on which the bag was brought back from the field and became available for preprocessing.
- Washed/Dried (date) – records the date on which the washed and dried finds were put back into their bag, and became available for processing.
- Processed (date, person) – records the date on which and the person by whom the finds were classified, counted and weighed. Non-artefacts and recent artefacts are thrown away at this stage; broad find categories (lithics, protohistoric to archaic ceramics, classical to post-antique ceramics) are bagged separately each with a copy of the original ticket (see below) and put into crates for storage.
- Entered into PC (date, person) – records the date on which and the person by whom the processing information were transferred into the project RDBMS. The data entered is subsequently checked for errors and omissions by a second person.

The description of the finds during the processing stage follows a classification system which may vary depending on the region where the survey takes place. The number of sherds larger than 1 cm<sup>2</sup> within each class is recorded, as well as the total weight per class so that average sherd size can be calculated. Both the condition of the material (weathering, patination, abrasion, rounding) and the occurrence of diagnostic features is noted on the form.

The writable plastic ticket included with each bag contains spaces for:

- (compulsory) UNIT (4 chars) and BAG (2 chars) numbers; Find category code; Estimated Weight (4 chars)
- (optionally) Date; Sample type (Sq, Ts, Gs, or Ds) and ID (2 chars); Site y/n.

Information regarding the find categories and estimated weight is included on the ticket as a precaution against the loss or omission of these same data on the UNIT form, and to allow the identification of the bag in cases where the BAG ID has been recorded incorrectly or incompletely. The GIA address is included for reference.









- <sup>n</sup> Amount of vegetation cover obscuring the soil, from 1 none to 5 very much
- <sup>o</sup> Final visibility factor (estimate of all other factors combined), from 1 very low to 5 optimal
- <sup>p</sup> The bag itself gets numbered with the UNIT #, the BAG #, and the SAMPLE ID
- <sup>q</sup> In the case of a standard sample this is 2 divided by the interwalker distance (assuming a swath of 2 meters), eg  $2/10 = 20\%$
- <sup>r</sup> Only if % coverage is not filled out. Ds = Diagnostic sample; Gs = Grab sample; Sq = StringSquare sample; Ts = Transect sample
- <sup>s</sup> If two diagnostic samples were taken, write DS 2 / 2.
- <sup>t</sup> In grams, estimated; this serves as a control during finds processing
- <sup>u</sup> Flint and/or obsidian
- <sup>v</sup> Add categories as required
- <sup>w</sup> For example: Includes material from a diffuse scatter of PARCH ceramics, see UNIT 136.
- <sup>x</sup> Initials required
- <sup>y</sup> Format DD/MM
- <sup>z</sup> Format DD/MM
- <sup>aa</sup> 3 digit Unit ID, from ticket in bag
- <sup>bb</sup> 2 digit Bag ID, from ticket in bag
- <sup>cc</sup> Mark this box if BAG is from a Site.
- <sup>dd</sup> date (DD/MM) that bag was brought in from the field; must be filled out by team administrator
- <sup>ee</sup> date (DD/MM) that finds were dried; must be filled out by supervisor of washing team
- <sup>ff</sup> date (DD/MM) that finds were determined; must be filled out by processing supervisor
- <sup>gg</sup> Initials of person processing the finds
- <sup>hh</sup> Box number may be added later if finds are sent to a specialist first
- <sup>ii</sup> Weight should always be recorded, since it provides a better basis for comparing proportions of different materials than do the counts
- <sup>jj</sup> Condition of the finds (eg, abraded, fresh breaks, surface treatment), numeric scale to be determined
- <sup>kk</sup> For example, regarding condition of finds, wares, dating, etc
- <sup>ll</sup> For example, “all finds recent & thrown away”, “finds lost during processing”

# ARCHAIC SETTLEMENT AND EARLY ROMAN COLONISATION OF THE LEPINE FOOTHILLS\*

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## 1 INTRODUCTION

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The protohistoric and early Roman settlement history of the Pontine Region were most recently studied by Attema (1993, 1996, in prep.). The current view is that nucleated settlement seems to have originated in the Iron Age around the Alban lake (with nuclei such as Ardea, Lanuvium, and Velletri), and to have developed slightly later on the higher ground around the Pontine plain proper (with sites such as Satricum, Cisterna di Latina, and Caracupa/Valvisciolo). Many of the Archaic nucleated settlements in the latter area disappear however sometime during the later 6<sup>th</sup> century (the late Archaic), and seemed to be replaced after 500 BC (the post-Archaic) by small dispersed settlement in the volcanic tuff hills only (Attema 1993:122).

For the colluvial plain deposits in contrast, Attema reports that Iron Age and Archaic materials are very poorly represented and no discrete protohistoric sites were identified at all in the Cori survey transect, although protohistoric pottery was found among the predominantly Roman finds, indicating continuity of some sites (Attema 1993:117-8). A field walking survey south of Sermoneta again yielded very little early material for the plain, where conditions must have been generally unfavourable for settlement. Again, in a similar survey near Sezze, finds from the Iron Age and early Archaic were absent (Attema in prep.). Whereas colluviation may well be implicated in decreasing the visibility of archaeological remains in the plains, we would not expect this to have such an impact on the western slopes of the Lepine mountains. Since 1993, several field walking survey campaigns have been conducted on these slopes in order to establish whether this view is correct.

The regional chronology for the current study departs from the generally accepted chronology (see fig. 9.2) in substituting a post-Archaic period (roughly 500 - 350 BC) for the early Roman Republican period, as archaeological indicators for the Republican colonising movement (colonies, villas, amphora-like forms, black glaze) appear in the area only after 350 BC. Other important aspects of the regional chronology are the shift from Late Iron Age orientalisising pottery styles (7<sup>th</sup> century) to Archaic red pottery, and the shift (around 500-490 BC) from the latter to the post-Archaic, which is visible in the increased production of pale and orange firing pottery and tiles made from more highly purified clay and the introduction of more substantial building styles (with heavier roof tiles). It should be noted here that, in the absence of excavations, site dating in most cases does not permit us to distinguish whether a site was occupied in the post-Archaic, early Republic, or both.

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\* This chapter was previously published in *Assemblage*, online journal of the graduate students of the Archaeological Institute at the University of Sheffield, at <http://www.shef.ac.uk/~assem/4/>. The fieldwork was conducted as part of a wider project by the Groningen Institute of Archaeology, aiming to map the Republican villa landscape in the immediate neighborhood of the Roman colonies of Cora, Norba, and Sezze.

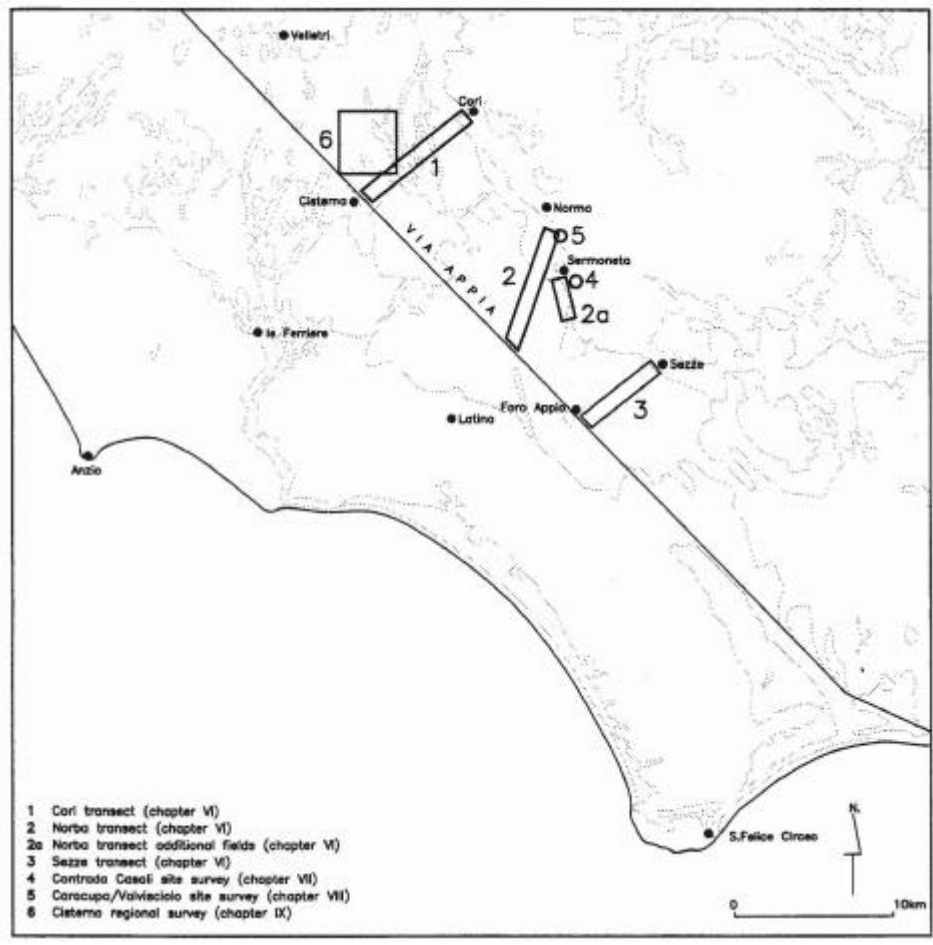


Figure 1: Map of the Pontine Region, with survey areas, from Attema 1993, fig. 2.



Figure 2: Chronological chart of central Italy, after Nijboer 1998, fig. 1. See especially the column labelled 'Latial chronology'.

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## 2 THE LOWER LEPINE SLOPES

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According to the established view, it appears there was very little settlement activity on the Lepine slopes until the later 4<sup>th</sup> century, when a system of Roman Republican villas, related to the new colonies of Cora, Norba, and Setia appeared (cf. Attema 1993:233ff). This villa system apparently represents a clean break with what went before, not just because of the change in building technique and pottery styles and techniques, but also because large-scale olive tree and vine culture began to be practised. The period 500-350 BC apparently brought an abrupt end to the evolution of the Archaic landscape - most likely due to the troubles associated with the Volsci wars – and was an archaeological ‘dark age’.

### 2.1 EARLIER SURVEYS

A topographic survey conducted in the early ‘60s in the Cori and Artena map sheet area (some 10 by 15 km) by Paola Vittucci Brandizzi was published in the *Forma Italiae* series (Vittucci 1968). Little further work was done until the late ‘80s when, in the course of the Pontine Region Project at Groningen University, field walking surveys were conducted in adjoining parts of the Lepine footslopes near Norba, Cori, Sermoneta and Sezze, and at the Archaic proto-urban site of Valvisciolo (see Figure 9.1). This work was reported on by Attema (1993). The most recent work, leading up to the 1998 survey near Ninfa, was done near Sezze (Attema 1994 in prep.) and Norba (King 1995). The goal of these two surveys was to locate and assess sites belonging to a hypothetical colonial system of Roman Republican villas, as suggested by Attema (1993:233ff and fig. 148; see Figure 9.4). Generally these sites are easily detectable in the landscape not only because of concentrations of pottery and tile, but also because their platform retaining walls and associated cisterns, constructed in polygonal dry stone and -later- cemented work, have withstood the ravages of time until very recently. For those same reasons these villas also figure prominently in the earlier topographic and desk-based survey by Vittucci. A summary of the results is presented here.

Table 1 – Descriptions of Vittucci sites in the Ninfa area.

Site ID	Description
33	villa, wall in opus caementicium, many pieces of tile and amphora especially to the south of the wall, and reticulate bricks
34	terracing in 2 <sup>nd</sup> polygonal style
35	terracing in 2 <sup>nd</sup> polygonal style
45	cisterna in opus caementicium and wall in 2 <sup>nd</sup> polygonal style. Other similar structures are supposed to have existed nearby but may have been overbuilt. Some remains of coarse ‘grossolana’ sherds in the area
46	villa platform ca. 4m high in 2 <sup>nd</sup> polygonal style and terracing below it. Covered entrance to platform. Some ceramics and tile found. Lead pipe reportedly found nearby in 1915 but later lost
47	terracing, polygonal walls, ca. 65m of a longer stretch that was recently destroyed remaining
48	tile, marble architectural remains, remains of tombe a cappuccina. Site recently disturbed due to viticulture
49	top and bottom walls of pedemontana in polygonal work
50	villa rustica (cisterna in tuff blocks, terracing in 3 <sup>rd</sup> polygonal style), around it numerous tile, imbrex and vase fragments
51	cisterna in opus caementicium, some remains of polygonal style terracing below
52	top and bottom walls of pedemontana, ca 6m wide, just below the modern path
53	long stretch of pedemontana walls, curving in order to cross a small fosso
59	villa (3-sided polygonal wall in 3 <sup>rd</sup> style, small cisterna in opus caementicium), ca 20 by 5 by 2.5m. Numerous limestone architectural fragments reported; reticulate wall reportedly found during construction of nearby house

Vittucci's (1968) map and description of sites in the Cori-Norba area relies heavily on the compilation of contemporary archaeological records and a follow-up on reports by local inhabitants. It is therefore no surprise that she reports no prehistoric activity at all, and instead concentrates on mapping Roman rural villa architectural (cisternae, platform retaining walls, field terracing) and infrastructural (the *pedemontana* road, about which more later on) evidence. The table below gives her descriptions, with Site ID referring to the numbers in Figure 9.3.

The Lepine footslopes just south and southeast of Norba were surveyed by Attema and his team on two occasions, first as part of the 1987 Norba transect survey (see Figure 1) and again in 1995 in order to further map possible Roman sites along the *pedemontana*. Attema noted that, as in the Vittucci survey, "Roman scatters [are] in all cases related to architectural remains, either polygonal masonry, opus caementicium finished with opus (semi) reticulatum or a combination of both. The latter are an indication of continued use of the site from early Republican times into the late Republican and early Imperial period." For the protohistoric period however, the evidence he gathered indicated that settlement began in the later Iron Age and intensified in the Archaic with both a proto-urban nucleus (Valvisciolo) and a dense distribution of smaller sites developing. Most of the Republican villas and other Roman sites seem to have developed out of these earlier Archaic settlements and none of the sites appears to be occupied after the early Empire.

Attema also noted that sites identified as Roman villas are distributed fairly regularly at distances of about 1 km along the lower slope deposits, suggesting the possibility of a 'villa colonisation' of the landscape, directed from the colonial towns. One Republican villa was unusual in that it is situated much further upslope inside the Valvisciolo gap; Attema suggests this could indicate that there was some level of hierarchical organisation to the rural villa system, and this site could be an example of a 'top-level' villa.

## 2.2 THE DOGANELLA DI NINFA SURVEY

In April 1998 a new team led by Attema conducted a further survey survey of the lower Lepine slopes, this time in the Doganello di Ninfa area which directly adjoins the area surveyed in 1995. This survey area, of about 5 km by 750 m and dominated by the Monte Arrestino massif (862m asl), is bounded by the *Canale delle Acque Alte (Canale Mussolini)* and *Fosso del Cavone* on the west and north sides, by the steep uncultivated slopes and cliffs of the Lepine hills, by the area surveyed in the 1995 campaign below Norba and by the Cori gap in the north (see Figure 9.3). Nowadays it consists mostly of large and small fields with olive trees, with smaller areas devoted to fruit trees, viticulture, and grazing. The slopes are cut in two or three places by (nearly) dry gullies, and drainage at the foot of the slope is NW-SE because of the elongated tuff hill geomorphology there. The area is dotted with small farming cabins and, increasingly, with modern houses. The two main rubble-metalled tracks running through the area perpendicular to the slopes, and many minor paths too, are in heavy use and we saw much evidence of fields being worked with machinery in order to remove stones. This included the removal of terrace walls and remains of Roman architecture. Increasingly, the steeper slopes are also cleared, ploughed and enclosed.

The team systematically surveyed a total of 27 fields, and discovered or reconfirmed the presence of 20 sites. Figure 3 shows the locations of these fields and sites on a topographical background. Although the stated purpose of the survey was to map further parts of the Roman system of platform villas, associated with olive culture and the strategic colonies of Setia and Norba and connected by the *pedemontana* road, most of the Ninfa area proved to be rich in Archaic finds, with Roman Republican sites (often without any platform walls) generally occurring in the same locations. This confirmed that the results of the 1995 survey should not be seen as exceptional and that the Romans could not be seen as colonisers in the sense that they brought a previously marginally used landscape under cultivation. Instead, a fairly dense and possibly differentiated Archaic settlement pattern seems to be present, which will force a partial re-adjustment of current views regarding the settlement history of the area.

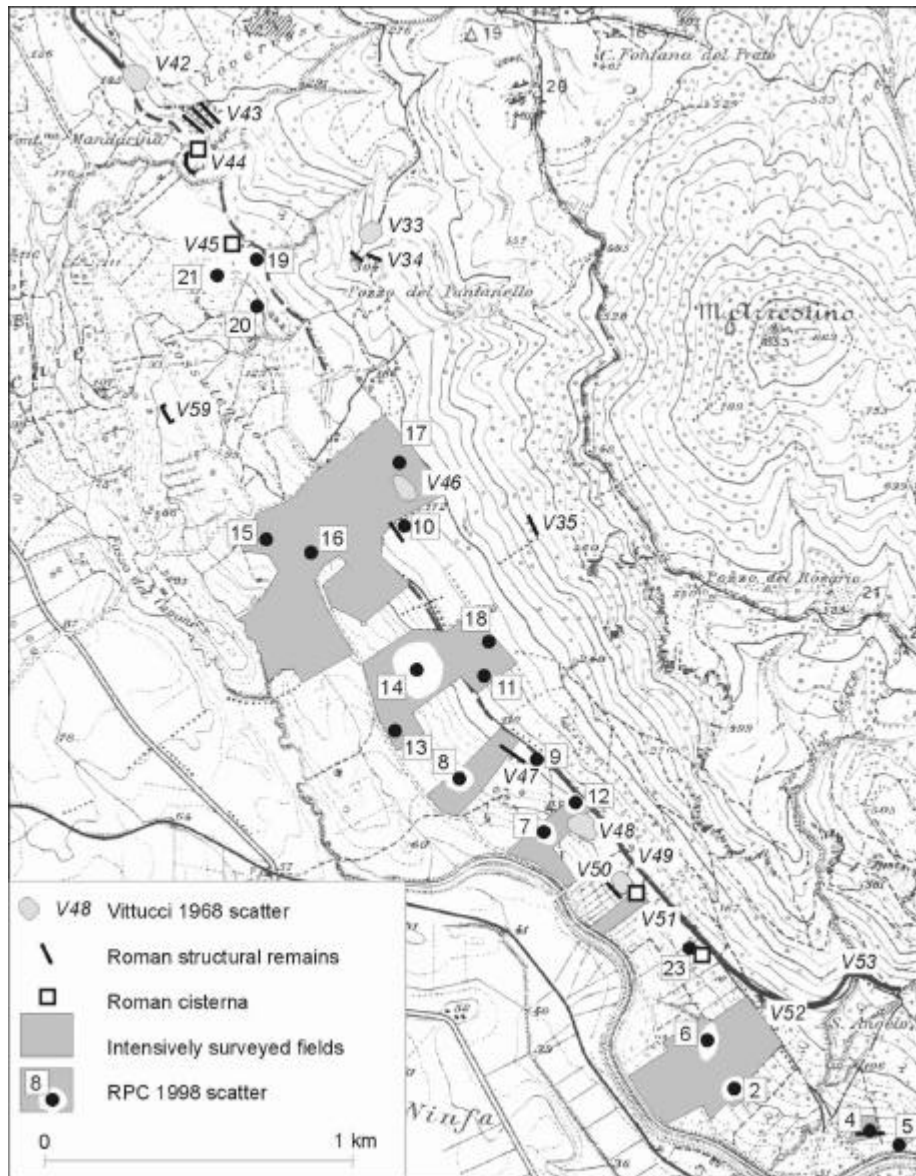


Figure 3: 1:25,000 scale topographic map of the Doganella di Ninfa survey area. Fields surveyed by the RPC in green; new Archaic and/or Roman Republican sites are represented by small red dots with site ID's in red; black numbers highlighted in red are sites identified by Vittucci (1968). Just left of center is the larger site S14 that hints at the potential complexity of the Archaic settlement system.

Table 2 - preliminary site identifications resulting from the Ninfa98 survey.

Site ID	Description
S2	diffuse scatter, early Archaic
S4	Archaic farm to Republican platform villa, some IA material present
S5	small scatter of Archaic sherds
S6	Archaic to Republican farm
S7	Archaic to Republican farm, some IA material present
S8	Archaic to Republican farm
S9	Archaic farm to Republican platform villa, some IA material present
S10	Archaic farm to Republican platform villa
S11	diffuse scatter, Archaic
S12	IA ceramic scatter, no precise date available yet
S13	tomb 'a cuppucina', Republican
S14	Archaic to Republican hamlet
S15	Archaic to Republican farm
S16	small scatter of Archaic and post-Archaic sherds
S17	scatter of Archaic and post-Archaic sherds
S18	Archaic and Republican ceramic scatter
S20	Archaic to Republican farm
S21	Archaic to Republican farm

### 2.3 SETTLEMENT HISTORY

Ceramic finds were classified according to fabric, ware, and form. Although many of the pottery and tile types found cannot be dated very closely, it is possible here to present a first rough chronological description of the settlement history of the Ninfa slopes.

The earliest datable material from the area is a red firing impasto from the early Iron Age, which occurs as offsite material on a possibly levelled tuff ridge near the Lepine slopes proper. No material from the middle IA was found. The late IA (phases IVA and IVB, dated about 730-630 BC and 630-580 BC respectively) is represented by the presence, in phase IVA, of common red slip ware occurring in very low numbers in the southern half of the study area and, in phase IVB, of a coarse red firing fabric with FeMn (manganese) temper at many locations. It would seem, then, that LIA sites occur about every kilometre, with single occasional finds in between. The regular if not very dense distribution suggests that, as in the 1995 survey area, we may trace the beginnings of the exploitation and settlement of the Lepine footslopes in the Ninfa area to this period, and especially to the IVB phase.

The Archaic period (580-490 BC) is represented in the study area by coarse red firing pottery with augite temper, occurring in thick (dolum) and thin (olla) forms. The latter may also date to the post-Archaic, but as the distribution pattern and even the densities at which both forms occur are very similar this has no effect on the settlement history of the area. The crude red augite tempered pottery in fact occurs at all sites and fields surveyed and therefore indicates that a strong intensification of settlement and land use with respect to the previous period took place (even after correcting for the fact that the Archaic period is twice as long as LIA phase IVB).

The post-Archaic period (490 - 350 BC, following Attema 1993) is less well recognised in the finds but must be represented by pale and orange firing augite tempered crude pottery (mostly tile), and by orange firing coarse ware. We find such materials occurring in fairly high numbers, probably as off-site material, in most of the area. Nearly all of the Archaic sites also contain a lot of these post-Archaic ceramics, which suggest that there may have been a continuation of previous land use patterns. This is also supported by the fact that the lion's share of the post-Archaic materials concerns the highly visible tile, whereas the orange coarse ware occurs in comparable densities to the Archaic coarse ware. We therefore must assume that the only differences between the two periods are an increased use of tile for roofing

and a shift in pottery production technology to a more controlled process resulting in lighter coloured products consisting of a more highly purified clay matrix and augite temper. Presumably the shift in roofing construction is indicative of a more general Latial change in building construction. The lack of more dramatic visible changes in the archaeological record for this period of historically attested Volscian inroads is remarkable.

The Roman middle and late Republican periods (350 – 50 BC) are represented in the finds by a growing diversity of pottery technology (depurated, reduced, and hard wares) and styles, by the use of lava temper in tiles, and by the introduction of fine wares such as black glaze. These materials occur at all of the larger sites occupied in the previous post-Archaic period, but a detailed look shows that there were changes in emphasis nonetheless - some sites seem to have been abandoned while others show a sharp reduction or growth in the number of finds. Also, the period we are dealing with has a 'stratigraphic advantage' with respect to, and is more than twice as long as, the post-Archaic, and absolute numbers of finds must be interpreted with this in mind. It would seem, then, that we must interpret the finds from the Republican period to indicate certainly not a growth in density of occupation - rather a concentration of settlement onto a lesser number of larger farm sites. In partial support of Attema's (1993) suggestion that this period saw the establishment of a system of rural platform villas, we indeed found such platforms in at least five of the sites.

Again echoing the results of the 1995 survey, we found very little evidence for the continued use of the area into the Empire, other than the occurrence of small pieces of Terra Sigillata and African Red Slip ware in some of the Republican sites. Coupled with the fact that we could not identify any full Imperial or early Medieval sites, this argues for the assumption that the area was essentially abandoned by the early Empire. However, with Barker (1996:67) we should exercise caution for the later period: "The failure of many field surveys to locate early medieval settlement effectively is [] the predictable outcome of a combination of negative factors: a much sparser population, a nucleated settlement system, greater use of perishable materials in buildings, and of poorly made pottery that is much less precisely dated than Roman ceramics."

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### 3 DISCUSSION

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In total, the Doganella di Ninfa survey uncovered 16 new site locations, ranging from a single probable 'tomba a cappuccine' to an Archaic and Republican hamlet, and from the early Iron Age to the late Republic. No sites dating definitely to the Empire or to the Middle Ages were found. Perhaps most importantly, it turns out that the whole of the western Lepine slopes between about 60 and 150 metres high appears to have been intensively used in the Archaic and post-Archaic periods.

#### 3.1 SETTLEMENT PATTERNS

##### THE ARCHAIC SETTLEMENT SYSTEM

There is now some evidence for three levels of settlement among the Archaic sites in the western Lepine slopes. In between the 'top' level represented by the single large proto-urban site of Caracupa/Valvisciolo and the 'bottom' level of the multitude of small and scattered single-family farmsteads, site S14 represents a middle level of aggregated settlement consisting of a few households without any evidence of centralised or 'proto-urban' function – a hamlet.

This system was decapitated with the abandonment of Caracupa/Valvisciolo at the end of the Archaic. It may be that the incipient urbanisation of the Pontine region, referred to in the introduction, was reversed by the end of the Archaic as circumstances became less favourable through sporadic warfare, and the inhabitants resettled into smaller and more easily defended sites on the Lepine scarp. It would have been



the latter that were targeted for the early (i.e., early 5<sup>th</sup> century) Roman colonisation reported by the early historians.

## CONTINUITY IN THE POST-ARCHAIC?

The existence and nature of any Roman colonisation in the wester Lepine slopes is to a large extent predicated on the presence or absence of a post-Archaic ‘gap’ in the settlement history of the area – the period called a ‘dark age’ by Attema (1993:17). But if there was no settlement continuity, and the area had been more or less deserted for five or six generations, then how is it possible that the republican farms are all located on Archaic settlement sites? Certainly dispersed post-Archaic settlement existed in the Cisterna di Latina area and there is no reason to deny it to the footslopes. We must therefore assume that there was settlement continuity throughout the post-Archaic, and therefore we must ask what was the nature of the change from slight buildings and thick augite tempered pottery in the Archaic, to tile-roofed platform buildings with cisterns and amphora and fine pottery in the Republic. Was the indigenous population moved away to make place for the new settlers, whose farms were constructed according to some colonial base plan? Or have the changes visible in the archaeological record occurred over a longer period, allowing indigenous farmers to take on certain Latin (and later, Roman) habits? Certainly the very fact that ceramic dating becomes very uncertain during these centuries points to the lack of recognisable development, and therefore to a disruption to normal production and cultural exchange, that we may ascribe to the Volsci wars.

## THE REPUBLICAN ‘COLONIAL’ VILLA SYSTEM

Roman style ‘urbanisation’ only begins in the middle of the 4<sup>th</sup> century with the establishment of formal *coloniae* at Cora, Norba, Circeo, Terracina, and Setia. But the establishment of these colonies did not take place in a vacuum. Control over the landscape and its inhabitants also took the form of a rural colonisation of which we can most reliably trace the villas. A morphological characteristic linking both parts of this system is the use of polygonal dry stone walls; physically they are linked by the *via pedemontana* and other tracks. The recent surveys seem to indicate that these villas were not as closely tied to the colonies in a spatial sense as was thought around 1992; rather they seem to occupy all of the available calcareous soils on the Lepine margin (see figure 9.4). It is possible that closer dating of these villas may show how the villa system expanded from initial settlement areas around the colonies, to eventually fill the landscape.

Among the villas found during the survey, Attema’s villa hypothesis (Attema 1993:233ff) suggests that we may be able to distinguish three groups:

- firstly, a group of platform villas built according to the same plan around the middle of the 4<sup>th</sup> century, and strung out approximately 1km apart along the pedemontana. The system might consist of as many as 20 villas between Cori and Sezze, and each may have a number of associated minor structures nearby;
- secondly, a much smaller group of ‘controlling’ platform villas, which can be distinguished by their commanding positions and much greater investment in platform architecture. This group would be contemporaneous with the first; and
- thirdly, a group of non-platform villas occurring in the lowland or lower Lepine slopes, and developing out of pre-existing Archaic farm sites, or alternatively, ‘filling in’ available space.

Evidence for the hierarchical organisation of the Roman Republican villa system is intriguing but the distinction between the three levels will need verification by excavation, which could uncover functional differences between them. The hypothesis that early platform villas were built in a communal colonial effort and are located at regular intervals of about 1 km could be further tested in future surveys and by a careful comparison of the dimensions and masonry styles of the platform architecture.

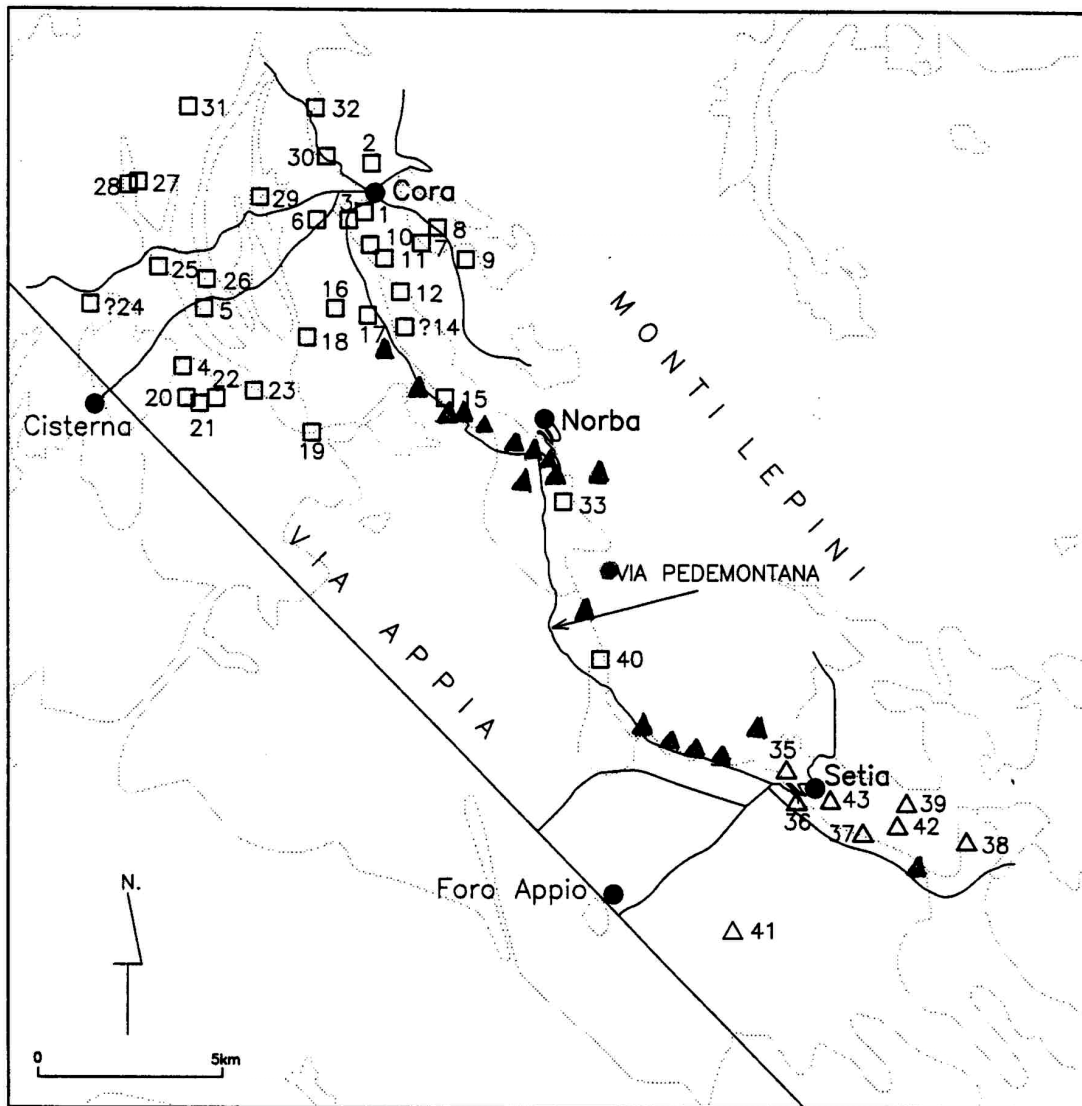


Figure 4: The Roman Republican 'colonial' villa system of the western Lepine slopes (adapted from Attema 1993, fig. 148). Before the recent surveys Republican villas appeared to be spatially tied to the colonies of Cora and Setia (open symbols); the newly located villas however (closed symbols), seem to occupy all of the available Lepine margin.

### 3.2 LOCATIONAL CHARACTERISTICS

#### BURIAL

Very little evidence for burial was found by any of the surveys in the area. The nearest known Archaic necropolis is that of Valvisciolo, and Republican necropoli are of course associated with the Roman colonies. Possible tombe 'a cappuccina' (cremation burials) were found in two locations some 1 km apart, but it seems reasonable to assume that burial took place normally at the edges of each individual settlement's core area. Many more graves are therefore likely to exist in the area, but they are very hard to detect from surface survey alone, as the remains of such burials could easily go unnoticed among the general off-site noise surrounding the Republican sites in the area. No evidence was found for the existence of a burial ground on the higher slopes of Monte Arrestino.

## SPACING AND COMMUNICATION

Although the *pedemontana* is generally thought of as a Roman construct, forming a system with the towns and villas built in the mid-4th century, it seems likely that its route and many lesser routes besides had been in constant use since at least the early Archaic - connecting the large proto-urban settlements while avoiding the difficult and unhealthy terrain below. There would certainly also have been communication lines with settlements (both Archaic and Republican) on the Lepine scarp, similar to or identical with paths that are still in use today.

It was suggested by King (1995:12) that sites are spaced at regular distances (approximately 500m judging from her map) along a road. Such a pattern could also be observed in the Ninfa area, with villa sites continuing from S to N along the presumed line of the *pedemontana*. The distance between large platform villas is consistently around 1000 meters here, but if we include the other sites producing Republican material the typical distance between sites again becomes 500 meters or less. One cannot imagine access to the road to have been of such great importance that sites had to be located very near it; all sites we found are within 400 meters of the *pedemontana* line anyway.

## HEIGHT AND SLOPE

The natural conditions in the area mean that, without modern farming machinery, only part of a typical slope could have been used for farming and olive culture. Archaic and Roman Republican sites are generally located between about 60 and 150 metres asl. Above this point the soil becomes too steep and stony to be used for anything but extensive grazing by, as is currently the case, goats and horses. At the lower end of the slope it is less clear that conditions are unsuitable for farming, but we may suggest two reasons not to situate farms lower than 50 metres asl - firstly, the view over the Pontine and Alban areas is dramatically reduced, and secondly, the heavy clay soil may not have been workable through the year.

Slope does seem to be a factor affecting many sites - there is a preference for flatter areas (which of course correlate with height) and often such areas appear to have been man made already in the Archaic. Platform villas also occur on steeper slopes and, in the case of villa Vittucci 46, significant walls had to be constructed to retain the villa platform (over 4 metres high). The occupants were rewarded with a magnificent view ranging all the way from the Monte Circeo and Monti Ausoni in the south to the Alban volcano in the north - a distance of more than 20 km both ways! It may be suggested that this villa was one of the 'controlling' group mentioned above.

## SOURCES OF WATER

Distance to surface water is not clearly a locational factor, although recent changes made to the landscape mean that this aspect must be further studied. Currently wells have water at about one meter below the surface, which means that early farmers were certainly not restricted to living near surface water. Unfortunately it is not possible to date any of the numerous wells in the area that are not obviously modern.

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# A MARGINAL LANDSCAPE: FIELD WORK ON THE BEACH RIDGE COMPLEX NEAR FOGLIANO (SOUTH LAZIO)\*

PETER ATTEMA, ESTHER VAN JOOLEN & MARTIJN VAN LEUSEN

**ABSTRACT:** This paper reports on the results of archaeological and geographical field work conducted in 1998 and 1999 by members of the Regional Pathways to Complexity project in the coastal landscape of South Lazio (Italy). The protohistoric (Bronze Age to Archaic) settlement history of this area is dominated by its marginal position with respect to the proto-urban settlements of the Alban hills and the Lepine margin, and in the historic period (post-Archaic to Roman Imperial) by the strategic and economic interests of Rome. A preliminary reconstruction of the dynamics of both the physical and the human landscape is given for both periods. The interpretation of the results of the field walking survey and the reconstruction of potential protohistoric and Roman land use are both informed by an analysis of recent changes in the physical environment – especially the Bonificà carried out in the 1920s.

**KEYWORDS:** Archaeological survey, land evaluation, central Italy, Pontine region, protohistory, Roman period

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## 1 INTRODUCTION

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### 1.1 MARGINAL LANDSCAPE UNITS IN THE RPC PROJECT

The Fogliano pedological and archaeological field work reported on here is part of the research program of the *Regional Pathways to Complexity* (RPC) project conducted jointly from 1997 to 2001 by the Groningen Institute of Archaeology and the Free University of Amsterdam. The RPC project studies landscape and settlement dynamics in three protohistoric Italian regions with the processes of centralisation, early urbanisation and colonisation as its main themes (Attema et al. 1998).

Whereas in all three regions much fieldwork has been carried out in the past decades to tackle these themes, such work has invariably neglected the marginal areas in the landscape. By ‘marginal’ we mean those landscape units that, on account of their environmental characteristics (low fertility, inaccessibility, and distance from core areas), were not especially favoured for permanent settlement during the proto- and early historic periods. In spite of their correspondingly less-than-impressive archaeology, we feel that these parts of the ancient landscape should not be excluded from a regional study. On the contrary, they should be considered integral parts of the ancient human landscape because they may have a specific role in the economic system, may constitute a potential zone of demographic expansion, or may function as an area of refuge.

Having been thinly settled in the past, and put to low intensity use, marginal areas pose particular methodological problems on account of the low density of surface material that constitutes the archaeological record. A total of four weeks of survey by the RPC team in the lagoonal environment near

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the lake of Fogliano in the Pontine Region in the summer of 1998 and the spring of 1999 were aimed at assessing the influence in this marginal landscape unit of the early urbanisation process (7<sup>th</sup> and 6<sup>th</sup> centuries BC) and of Roman expansion in the subsequent period (5<sup>th</sup> to 4<sup>th</sup> centuries BC and later). It was found that the area attracted substantial settlement only in an advanced stage of the Roman Republican and early Imperial periods, while featuring continuous but sparse human presence during all earlier periods. We tentatively link this late Republican and early Imperial settlement increase to a socio-economic development very specific to these coastal margins - the establishment of wealthy maritime villas that managed large marine fishponds, as well as a substantial pottery industry exploiting the high quality clay banks found along the coast and now exposed by the sea.

## 1.2 OUTLINE OF THE PHYSICAL AND HUMAN LANDSCAPE OF THE PONTINE REGION

In order to relate the findings of the archaeological surveys of the RPC project to the characteristics and dynamics of the contemporary landscape, physical geographical mappings are carried out in combination with the surveys. Such fieldwork took place in conjunction with the archaeological survey, in the area between Borgo Sabotino and Borgo Grappa, the coast, and the beach ridges of the Minturno level. The primary aim of this study was to check the detailed (scale 1:25,000) soil maps of this region by Kamermans et al. (1979) and Bouman and Rot (1982), and to compile these into one map. A subsidiary aim was to create a soil unit description according to the guidelines of the Food and Agriculture Organisation (1977), in order to do a land evaluation for agriculture from the late Bronze age till Roman times, reconstructing the potential suitability of a specific land use type for a specific physiographical unit. In this study only soil properties and characteristics relevant for early agricultural land use have been used, which is reflected in the criteria used in the legend. A final aim of the study was to reconstruct the landscape by examining the units, and especially the recent anthropogenic influences, which drastically changed this landscape.

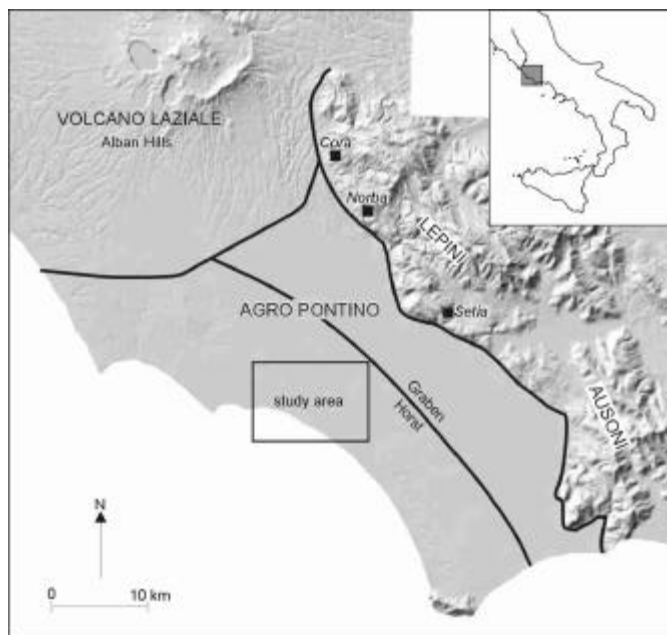


Figure 1: The location of the Fogliano field work area within the Pontine region. The four major physical geographical regions are outlined on a shaded elevation model.

The landscape of the Agro Pontino has been fully described by Sevink et al. (1982, 1984) and Kamermans (1991). In broad outline, it consists of four physical geographical units (see figure 1):

- 1) limestone mountains (Monti Lepini and Monti Ausoni), folded during the Middle and Late Miocene;
- 2) tuff hills originating from the Volcano Laziale which was active between 700,000 and 45,000 BP;

- 3) a graben formed in the Plio-Pleistocene as a result of vertical movements along NW-SE running fault lines, subsequently filled with fine textured and often organic sediments and draining toward the south-east; and
- 4) a horst system along the sea coast, consisting of four sandy clayey marine terraces with a local aeolian cover, developed as a consequence of world-wide sea level rises, although locally other factors played a role. From oldest to youngest the terraces are named Latina level, Minturno level, Borgo Ermada level and Terracina level (Sevink et al. 1984). This system as a whole drains to the south-west.

The Minturno level has been dated by fission track, K/Ar and amino acid racemization to about 125,000 years BP. During the next sea level rise in the early Würm (about 90,000 years BP) the Borgo Ermada level was formed (Kamermans et al. 1991). Only in the Holocene were the beach ridges of the Terracina level developed, incised later by rivers filling up the valleys with fluvial and marine sediments (Bouman and Rot 1982). All units have been locally covered by aeolian sands during dry phases from the Würm to the early Holocene. As part of the fight against the malarial mosquito the Lago di Fogliano was partly deepened and salted, partly filled in during the 1930s (J. Sevink, pers. comm.). Surplus sediment was also dumped around the lake and further inland, these units being classified as anthropogenic.

The settlement dynamics pertaining to the protohistorical and early historical period in the Fogliano survey area should be evaluated in the light of developments in the core area of Latium Vetus, i.e. the Alban hills including Rome and its environs (Attema 1993). The major developments in this area can conveniently be presented as three distinct settlement phases, each implying an exponential growth in agricultural, building, and industrial activities affecting ever more landscape units, including marginal areas such as Fogliano (see figure 1).

- 1) Centralisation of settlement during the Bronze age and early Iron age (ca. 1500 - 700 BC) featuring a very gradual infill of the volcanic landscape of the Alban hills and the core area around Rome, and marginal presence on the slopes of the limestone mountain range of the Monti Lepini;
- 2) Proto-urbanisation during the late Iron age and Archaic periods (ca. 700 - 400 BC), a process which saw the formation of early towns, and which included the growth of a rural landscape along the slopes of the Monti Lepini and along the ancient beach ridges into the Pontine region proper;
- 3) Romanisation of the proto-urban landscape and full colonisation of the Pontine plain (400 - 100 BC), a process which gradually also began to affect the more marginal areas, such as the beach ridges along the coast of which the Fogliano survey area forms a part. This phase also sees the growth of industrial activities.

Following this brief sketch of the regional context of our research, the remainder of this article will be used to describe the physical geographical units and their agricultural potential (section 2), to discuss the archaeological results and some problems in their interpretation (section 3), and, lastly, to consider how our research may influence our interpretation of the regional context (section 4).

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## 2 EVALUATING THE AGRICULTURAL POTENTIAL OF THE LANDSCAPE

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Evaluating the agricultural potential of the protohistoric and Roman landscape of Fogliano is a three-step process. First a physical geographical map of the area is made; then follows an assessment of any substantial changes the landscape may have undergone through natural and human agents; and finally an agricultural land evaluation is carried out. Figure 2 shows the physical geography of the study area as mapped by the RPC project. Table 1 summarises the process by which these units were constructed from two earlier partial mappings. In the following paragraphs each legend unit is briefly discussed and a preliminary land evaluation is given. A complete land evaluation of the Pontine region is being prepared by Van Joolen (in prep.)



## 2.1 DESCRIPTION OF THE UNITS

*Beach ridge unit.* The beach ridges of the Minturno level (M1) and those of the Borgo Ermada level (B1 to B6) can be classified into the same unit for land evaluation; despite the fact that elevation levels can differ significantly (respectively 13 m and 6 m asl), the texture, soils and drainage class are more or less the same. The ages of the different beach ridges are not relevant for the land evaluation, because in all units more or less the same soils have developed. However, since the older beach ridges had a longer period for soil development, they have a more clayey texture and more chromic properties (darker colouring).

*Lagoonal unit between beach ridges.* This unit consists of fluvial and / or lagoonal sediments. The unit is relatively narrow (less than 150 m). North of the Strada Litoranea the units B7 and B9 (deposits between and alongside the beach ridges, Kamermans et al.) and the units B4 (valley-units, Bouman and Rot) coincide. South of the Minturno beach ridge M1 the unit B9 (Kamermans et al.) coincides with M4 of Bouman and Rot. South of the Strada Litoranea the units B7 and B9 of Kamermans et al. coincide with unit B6 and T4 (Bouman and Rot). The aeolian unit B6 could not be differentiated from the beach ridge deposit B1; it lies in the same position as the B7 and B9 deposits and has the same texture. Unit T4 just west of the village of Fogliano could not be differentiated from the beach ridge unit B1, and is therefore classified alike.

*Level lagoonal unit.* Despite the fact that Bouman and Rot classify T7 as anthropogenic, it seems justified to consider T7 similar to T2, since it has the same position in the landscape and (probably) the same fluvial genesis.

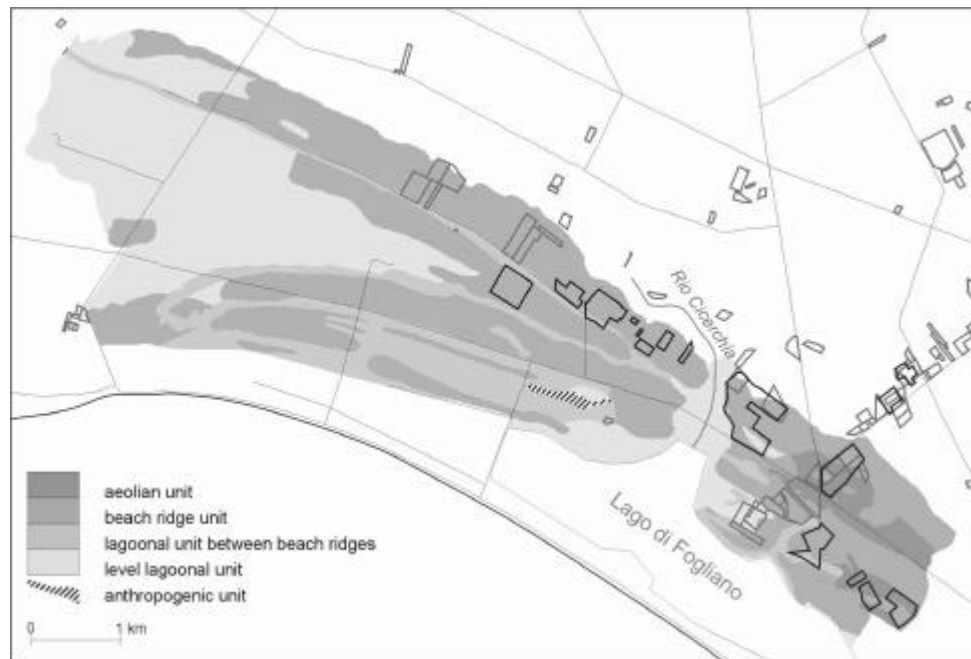


Figure 2: The physical geography of the Fogliano field work area. Fields outlined in bold were surveyed by the RPC project in 1998-9; those outlined in grey were surveyed by the Agro Pontino Survey project in the 1980s.

*Aeolian unit.* North of the western side of Lago di Fogliano the aeolian units (B6) of Bouman and Rot are classified as lagoonal between beach ridge deposits, because the texture (clayey loam) resembles that of the lagoonal deposits. North of the Strada Litoranea the aeolian deposits are classified as beach ridge unit.

*Anthropogenic unit.* All anthropogenic units of Bouman and Rot are classified as level lagoonal unit, except for the one north of Canale Allacciante at the western side of Lago di Fogliano, for which insufficient information was available. The anthropogenic unit B13 of Kamermans et al. is considered to be a beach ridge unit, because it forms a well drained elongated ridge in the landscape at an elevation of 10 to

11 m above sea level. On the map the other anthropogenic units from which the genesis could be reconstructed are hatched.

Units Kamermans et al. 1979	Units Bouman & Rot 1982	Units Van Joolen (this article)	Texture	Struc- ture	Soil classification (FAO 1977)	Drainage class	Elevation (m asl)	Slope class
B1 to B6; B13, M1	B1; B6; M1	Beach ridge unit	Sandy clay loam or sandy loam	N/A	Chromic, Orthic, Albic and Gleyic Luvisols	4 - 6	2 - 13	Gently sloping
T4; B7; B9;	T4; B4; M4	Lagoonal unit between beach ridges	Sandy loam or clay	Cracks	Chromic Vertisols, Gleyic and Orthic Luvisols	2	2 - 5	Almost flat
B8; B10 to B12	T2; T7; B2	Level lagoonal unit	Sandy clay or clay, sand on clay	Cracks	Solodic Planosols, Albic Luvisols, Pellic Vertisols, Fluvisols	1 - 2	5 - 10	Flat or almost flat
	B6	Aeolian unit	Fine, well- sorted sands	N/A	Eutric Cambisols, Gleyic, Orthic and Chromic Luvisols	4 - 5	Variable	Gently sloping
	T7	Anthropogenic unit	-	-	-	-	-	-

Table 1: Description of new legend units on the basis of the partial mappings by Kamermans et al. (1979) and Bouman and Rot (1982). N/A = Not Applicable; asl = above sea level. Drainage classes according to FAO (1977): class 1: poorly drained; Class 2: imperfectly drained; Class 3: moderately well drained; Class 4: well drained; Class 5: somewhat excessively drained; Class 6: excessively drained. Slope classes according to FAO (1977): 0 - 2% flat or almost flat; 2 - 6% gently sloping.

## 2.2 PRELIMINARY LAND EVALUATION

The method of land evaluation compares the soil requirements of different land utilisation types with the land qualities and characteristics of the described units, to determine their agricultural suitability. The results of our preliminary evaluation are given here.

*Beach ridge unit.* Because of the medium textured sediments and the drainage varying between well drained and excessively drained, the soils of this unit need fertilisation (by manuring) and if needed irrigation to cultivate crops. Such practices were not in widespread use in the Bronze age, but were used in Roman times (Spurr 1986). In the latter period millet (“can grow almost anywhere”, Spurr 1986), fodder crops, and vines were best adapted to these circumstances in a mixed farming rotation system.

*Lagoonal unit between the beach ridges.* Because of its clayey texture this unit may have been relatively difficult to cultivate. The deposits may have been suitable for small scale agriculture of wheat or grass for hay, together with dry and wet meadows. During the Bronze age the unit probably was not attractive because of the heavy texture and possibility of waterlogging and may have been only used for transhumant grazing of cattle, but in Roman times the biennial system of wheat cultivation followed by fallow was possible. It could also be used for long and short fallow and *pratium* (maintenance of dry and wet meadowland, Spurr 1986).

*Level lagoonal unit.* Because the presence of lagoonal sandy clay or clay at shallow depth (less than 45 cm), which acts as an impermeable layer, causes waterlogging and / or cracking of the soil, cultivation of crops is nearly impossible on this unit. It is only suitable for the cultivation of hay from dry or wet grasslands or as grazing lands for cattle. *Pascuum* (long fallow, Spurr 1986), *pratium*, short fallow, and transhumance may have been practised in both Bronze age and Roman times.

*Aeolian unit.* Because of the high fertility (fine, well sorted sands) these deposits are suitable for a wide variety of crops. The unit is flat or nearly so, and would have been suitable for cultivation of barley, millet and vine, perhaps with occasional irrigation in dry periods, in both the Bronze age and in Roman times. Usage of these soils for grassland would not have been logical. So cultivation practices such

as mixed farming of barley and vine in both periods would have been possible, also because of the easily workable soils for manual tools and light ploughs.

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### 3 THE ARCHAEOLOGICAL SURVEYS

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#### 3.1 METHODOLOGY

##### BIASES INHERENT IN THE ARCHAEOLOGICAL SURVEY

As always, a discussion of the results of a field walking survey must begin with an assessment of the factors that bias the samples that were taken. In the Fogliano area these may be grouped under the headings of visibility factors, post-depositional processes, and surveyor biases.

*Artefact visibility* was generally low to very low throughout the 1998 Fogliano survey, due to the dusty conditions and intense sunlight. Excepting in a very small number of cases, the fields had been dry for several weeks and had apparently been harrowed several times so that a 10 – 15 cm thick top layer of dust resulted. The direct sunlight also caused large differences in artefact visibility during the day, because of the variable angle of the sun above the horizon (altitude), its angle to our walking direction (azimuth), and the sharp shadows thrown by high crops and trees. A control survey conducted under better conditions in the spring of 1999 confirmed the importance of these visibility conditions, especially for pre- and protohistoric sites. It appears that even our intensive surveying could not consistently identify the Bronze and Iron Age material present in the study area in low numbers. With Archaic and post-Archaic ceramics the danger is slightly less because the sherds can be more easily distinguished (by size, color, and texture) from the soil matrix; and with Roman Republican and Imperial material visibility did not appear to be a factor at all. Artefact visibility bias has therefore mainly affected our observations of protohistoric ceramics.

A second factor affecting artefact collection are the *post-depositional processes*. Three centuries of Roman agricultural exploitation of the area during the late Republican and early Imperial period (200 BC – AD 100) constitute the first major post-depositional factor in the study area, significantly reducing our chances of finding pre-Roman ceramics. In addition to this, the *Bonifica Integrale* - the wholesale land reclamation of the Pontine plain brought about by the Italian government in the late 1920's and early 1930's – finally brought about the long wished-for transformation of the natural landscape of the Fogliano area into farming land. The characteristic landscape of beach ridges dissected by natural streams disappeared under the plough, and the lagoons of Fogliano and Dei Monaci were reduced in size and partly embanked. Interventions in the hydrography of the area had begun on a very small scale some 15 years earlier, as part of local private enterprises. Until then the size of the lagoons, having no natural outlets to the sea, was variable and depended on the water supply by rivers from the interior, such as the Rio Cicerchia (since regulated) and the Bracciolo (since filled in).

In many areas peaty and clayey soil was added to improve the less fertile sandy fields, while sandy soil may have been added both to improve workability and to raise the level of some of the lower-lying heavy clayey fields. Many other fields, especially those on ridges, may also have been levelled to make them more easily workable with modern farm machinery. Given the original relief of the area, marginal increases of the ground water level and of the water level in the lagoons will have resulted in significant decreases in accessibility, with marshes and lagoons closing in on the sandy ridges, as indicated by the presence of clayey deposits in between these ridges. This will have had great significance for the use of the smaller landscape units in antiquity. An analysis of the relief maps produced for the *Bonificá* of the 1920s is currently underway (Feiken & Van Leusen, forthcoming) and may in future allow us to correlate water level rises with the location of the archaeological sites in the protohistoric and Roman landscape. Taken together, these alterations may have significantly and non-randomly lowered artefact visibility in the area. However, no precise record of such activity was kept, and we therefore must rely on our own

observations and on the memories of the local peasants.

The third and last factor influencing artefact recovery are *inter-walker differences* in training and in visual acuity. To minimise the effect of these, walkers were instructed to recover *all* flint and ceramic objects encountered; but of course the differences in experience did express themselves in one walker preferentially finding flint, and another mainly red, black, and orange wares. Whilst differences between the surveyors generally did not affect the highly visible Roman Republican finds, the older protohistoric ceramics were often caked in sand and had approximately the same size as many of the natural sand clumps produced by the fine ploughing in the area; and so it was quite easy to miss individual shards and even small scatters.

Because of the importance of these three visibility factors, our analysis of the survey results must take them into account. Our field recording methods allowed us to do this with two factors (dust conditions and vegetation cover, and soil addition/levelling) but not with inter-walker differences. In addition, we attempted to control and quantify biases by re-surveying representative fields and by comparing our results to those obtained earlier by the Agro Pontino project (Voorrips et al. 1991).

All recovery factors identified in the Fogliano surveys have tended to bias results away from the protohistoric periods. The re-surveying of selected fields in the Fogliano survey area has indeed shown that the visibility of proto- and early historic sites is highly dependent on survey conditions, land use and weather conditions being the two most important factors. From our comparison of the results obtained on the ploughed but very dusty fields of August 1998 with those obtained on the recently planted but moist fields of April 1999, two major consequences follow for the interpretation of settlement history. Firstly, the find of even a single sherd of pre-Roman ceramics is likely to indicate the presence of a small site. Given that this single sherd is relative unlikely to be picked up even in an intensive systematic survey such as was used by the RPC project (with typically about 30% coverage), we must assume that our surveys can only identify some of the Bronze Age and Iron Age sites present; for Archaic and post-Archaic sites this danger is less great because the ceramics are not so similar to the soil matrix; whereas for the even more easily visible Roman Republican and early Imperial material, occurring at much higher densities, we may assume all sites present in the survey fields have been discovered. Unfortunately the much higher density of the later material also masks the presence of small and dispersed scatters of early ceramics; in such a case the latter are much less likely to receive the attention and follow-up that the same sherds would get when found in an otherwise sterile field.

Modern land management and agricultural practices have been another major factor influencing the recovery of artefacts from the Fogliano study area, and research attempting to map and quantify this factor is currently underway (Feiken & Van Leusen, forthcoming).

#### DEFINITION OF SITE AND OFF-SITE

The density at which we put the distinction between site and off-site material varies according to the type of material being analysed; in general, 'off-site density' can be taken to mean a density of less than 10 percent of the typical site density. For some materials that only occur in very low quantities and for which there are severe visibility problems, this can mean that a single ceramic find is interpreted as a probable site; at the other extreme, it can mean that high densities of Republican sherds occurring within 150 meters of a Republican site are classified as off-site material.

The main characteristic of the protohistoric off-site landscape as it appears from our survey is the extremely low finds density of 1-5 finds per hectare. A comparison with equivalent figures for the contemporary Alban Hills which are 30 kms away (ca. 50 finds per hectare), or even the Lepine margins at less than 20 kms distance (ca. 15 finds per hectare), reveals that human use of the coastal landscape must have been relatively marginal. In the late to post-Archaic period finds densities increase somewhat, and four distinct areas of use become apparent on the map. The non-use (or at least non-intensive use) of large parts of the landscape is evident from the percentage of fields with no finds from this period at all (80%).

Unit	Site ID	BA – EIA < 800 BC	MIA & LIA 800 – 600 BC	Archaic 600 – 500 BC	Post-Archaic 500 – 350 BC	Early & Mid Republican 350 – 200 BC	Late Republican & Early Imperial 200 BC – AD 100	Imperial > AD 100
<b>Minturno beach ridge</b>	225							
	202							
	201, 231							
	101							
	102							
<b>Aeolian / sandy body</b>	F227/3							
	219							
	227							
	226							
	005							
	211							
	214							
	210							
	205							
	217							
	215							
	216							
	103							
	105, 106, 107							
	104							
	208							
	218							
	204							
	212							
	213							
003								
002								
206								
207								
<b>Borgo Ermada beach ridge</b>	004							
	228							
	230							
	222							
	110							
	001							
	220							
109								

Figure 3: Summary results of the 1998 and 1999 Fogliano survey campaigns indicate the main trends in the development of settlement patterns from the LBA onwards in the three major landscape units. The width of the columns is proportional to the duration of each period. Light grey – presence of site uncertain.

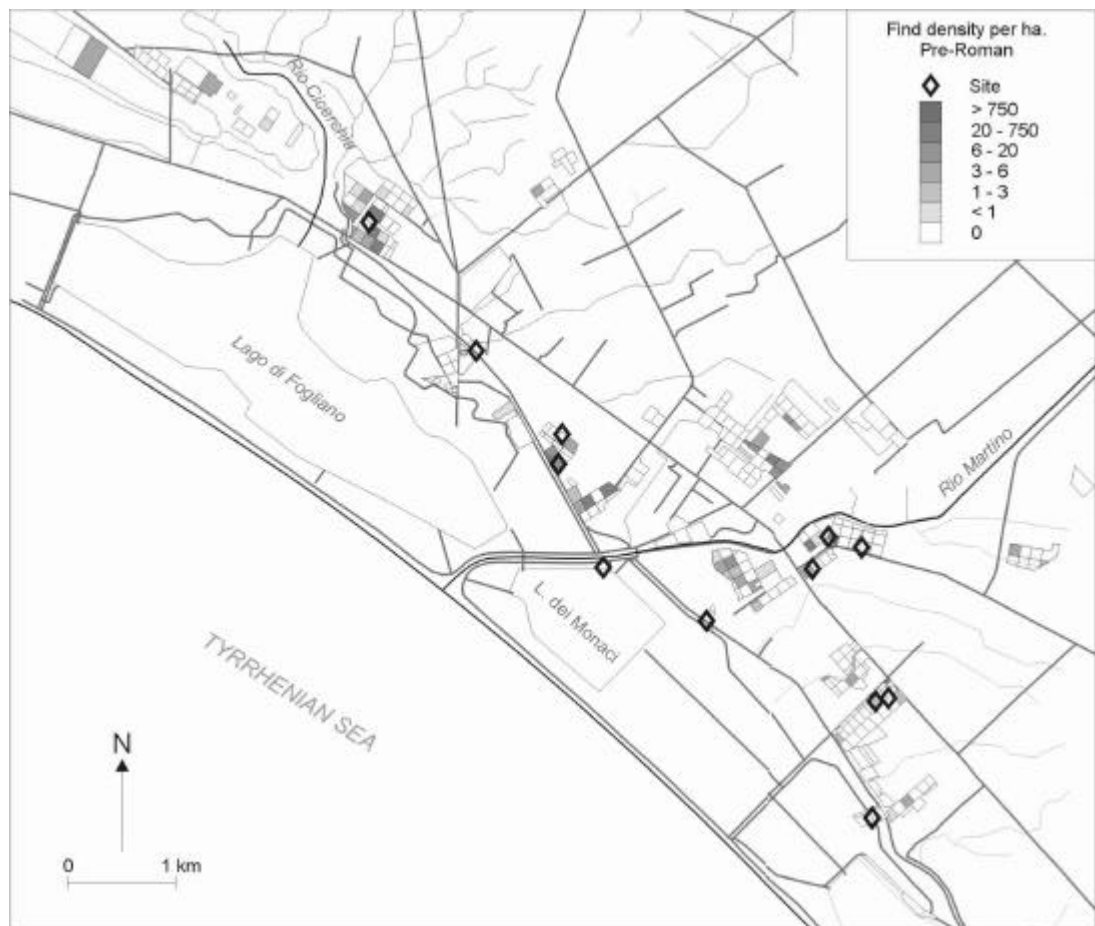
This can be contrasted with the situation developing throughout the middle and late Republic, in which more or less all the available land was taken up for settlement and agricultural or other use. This is reflected in the occurrence of small amounts of Roman Republican or early Imperial ceramics in nearly all of the fields surveyed by us.

### 3.2 SUMMARY RESULTS

Figure 2 shows the location of the fields that were surveyed by the RPC project and the earlier Agro Pontino project in the Fogliano area. For the purposes of our discussion of the results, the landscape is divided into units on the basis of its physical geographical characteristics as described in section 2, the aim being to show more clearly the continuity in occupation of the basic terrain units and the changes in occupation density over time. The Minturno level beach ridge is ca. 400 m wide with an average elevation of 13 m asl. The aeolian and sandy body connects with and overlies part of this ridge; it is several

kms deep and provides easily the most space for settlement and agriculture. The younger beach ridges, just inland from the lagoons and separated from the two other units by bands of clayey alluvial and/or lagoonal sediments, are less wide (about 150 m) and less high (maximum 9 m asl) than the older Minturno level beach ridge. Figure 3 sets out the main trends and chronology of settlement in these three units.

Traces of human occupation of the Fogliano area are present in an unbroken sequence from the Middle Palaeolithic onwards. The lithic material collected during the survey, which dates from the middle Palaeolithic to the Neolithic, will be the subject of a separate publication; discussion here will be restricted to the ceramic finds dating from the Bronze Age to the Roman Imperial period. The earliest ceramics, which are of a friable reddish brown fabric with sand temper, probably date to the Bronze Age/Early Iron Age (circa 1000 BC) and occur in at least two of the three landscape units; certainly all of the area was regularly used from the advanced Iron Age (ca. 800 BC) onwards, although precise dating of the material only becomes possible with the appearance of red slipped wares in the 7<sup>th</sup> century BC. A detailed fabric analysis of the protohistoric material will be carried out in the near future. Figure 3 shows that, by the Iron Age/Archaic transition (around 600 BC), essentially all of the coastal beach ridge and lagoonal



landscape

Figure 4: Density of pre-Roman (late Bronze Age to Archaic) ceramics in the Fogliano survey area.

was in use, with site numbers doubling and low levels of ceramics (1 - 5 sherds per hectare) occurring in almost all fields. Small sites are dotted across the elevated parts of the landscape every few hundred meters, avoiding only the clayey hinterland (see figure 4).

On the beach ridges, no major changes in this picture seem to have occurred, although a gradual incorporation of the area into the expanding Roman Republic did lead to changes in building style (tiled roofs) and in pottery consumption (wheel-thrown industrial pottery and fine wares) during the 5<sup>th</sup> and 4<sup>th</sup> centuries BC. The number of sites gradually rises until the early Imperial period. The picture is dramatically different for the aeolian and sandy body. Here, the relative lack of multiperiod settlements throughout protohistory seems to indicate the unconstrained nature of the terrain, and the number of sites doubles in the post-Archaic period. The early and middle Republican periods see a slight fall in the number of sites, but some are re-occupied when, in the late Republican period (from ca. 200 BC), a comparatively sudden five-fold increase in the number of sites reflects demographic growth perhaps brought about by an influx of labour from other areas. Although difficult to quantify, this period sees the growth of a rural village at Borgo Grappa, with isolated rural villas dotting the rest of the beach ridge landscape. This development may perhaps be understood in the context of the establishment of a production economy centring around the exploitation of the lagoons for fish farming, the importance of which is indicated by infrastructural works to regulate water levels and salinity (see section 4 for a more detailed discussion).

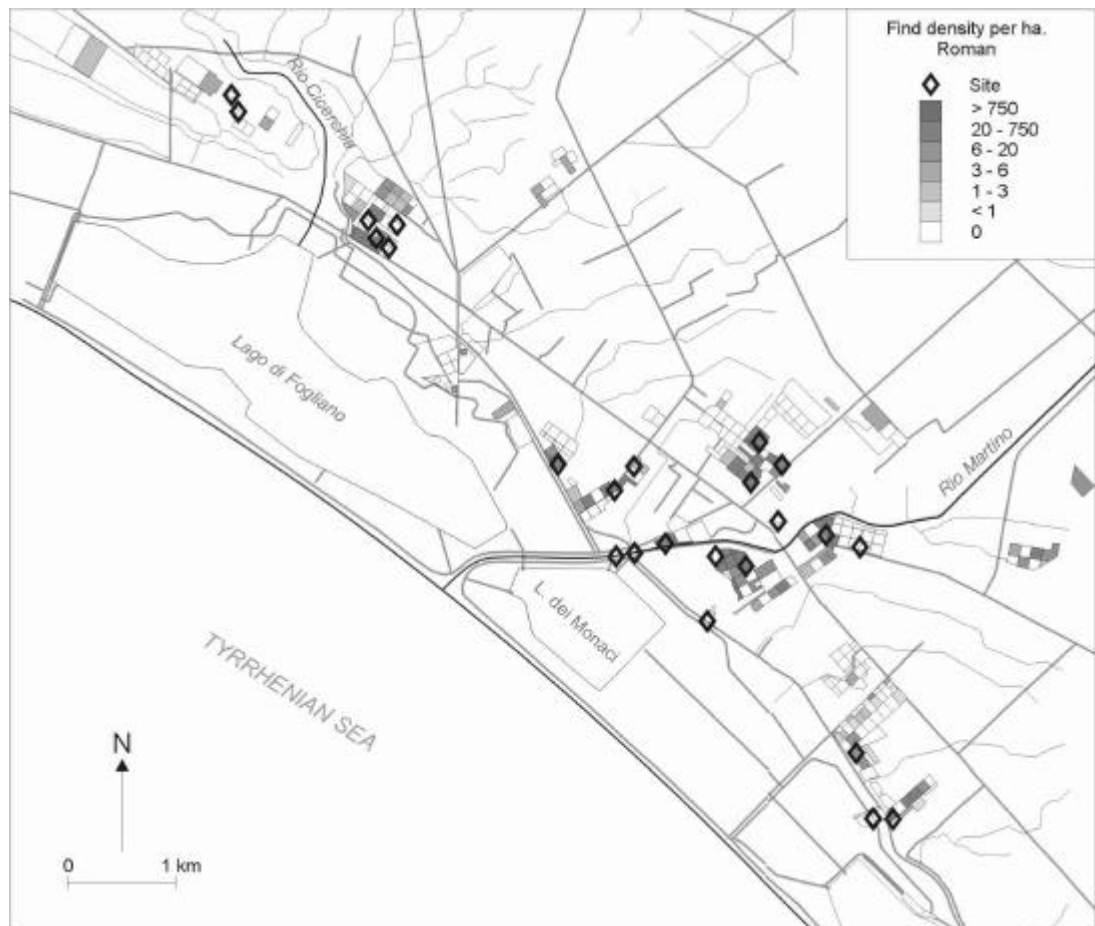


Figure 5: Density of Roman (post-Archaic to early Imperial) ceramics in the Fogliano survey area.

The late Republican flowering of the area lasted perhaps until the early 2<sup>nd</sup> century AD, after which period our surveys found very little evidence for continued occupation into the middle Empire. The virtual absence of finds from the late Empire and the post-Roman period might indicate that the area reverted to occasional and marginal uses, but an alternative hypothesis suggests that the population was concentrated into a small number of larger centres associated with Imperial villas, such as the one belonging to Alfeius Ceionius Julianus Camenius, mentioned in an inscription from Fogliano (Cecere 1989:22).

### 3.3 SITE INTERPRETATION

Whereas the finds assemblage at sites dating to the Roman period, with its building stone, roof tiles, and storage vessels, indicates fairly clearly that we are dealing with various types of (farm) building, such clarity cannot often be obtained at the pre-Roman sites. For one thing, no traces of roof tiles were found before the post-Archaic period; but even if the custom of tiling roofs had not yet reached the coastal landscape, one would expect settlement sites to possess at least some thick-walled vessels for storage purposes. One of the relevant results of the Fogliano survey was therefore the discovery of late Archaic ceramic scatters consisting of small to medium pottery shapes mostly intended for food preparation. In addition, nearly all of these sites occur as isolated scatters, that is, at locations that were not re-used for later Roman settlements. It is possible that these are the remains of ploughed-out graves, an idea supported by the fact that some of them occur in fields from which a considerable amount of topsoil is said to have been removed (F. Gardosi, pers. comm.). Such graves would be likely to date to the late and post-Archaic period (500 – 350 BC), when such burials are known to occur elsewhere. However, an alternative explanation seems more likely at this stage – namely, that the early inhabitants of the coastal areas lived in simple huts until well into the 4<sup>th</sup> century BC. This is in striking contrast to the proto-urban tendencies present in the core areas of south Lazio.

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## 4 DISCUSSION

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The following paragraphs offer a preliminary interpretation of the results described above, in the context of regional and supra-regional processes.

### 4.1 THE PROTOHISTORIC LANDSCAPE

For all of the protohistoric period from the Bronze age to the end of the Iron age, the archaeology of the Lago di Fogliano survey area suggests a non-hierarchical settlement organisation consisting of small settlements dotted over the landscape. Bronze age sites (supposing that our sandy fabrics are diagnostic for this period) are very small and few in number. In this respect the Lago di Fogliano survey confirms the results of the Agro Pontino surveys which recorded only six small sites with material dating to the second millennium BC for the whole of the Pontine plain. Of these only one was said to contain more than the usual few sherds (Voorrips et al. 1991:125). In his analysis of Bronze age settlement in South Lazio, Guidi (1986) notes that the Bronze age period in general is characterised by a preference for lakeside locations with, in its later phase, a more specific preference for the volcanic lakes situated inland. The substantial and rich Bronze age site known as the Villaggio delle Macine (village of the grinding stones), found submerged in the Alban crater lake, suggests that here indeed a process of centralisation had begun by the Middle Bronze age (17<sup>th</sup>/16<sup>th</sup> centuries BC; Chiarucci 1985). The site of Casale Nuovo along the Astura river with traces of metallurgy and the find of a Mycenaean IIIB shard indicates the development of trade routes connecting the coast to the mountainous hinterland (Angle and Gianni 1985). The beach ridge complex of which our study area forms a part appears as yet to have been excluded from these developments.

This must have remained so well into the Archaic period. Although human presence seems to have increased judging from the increase in the number of sites and the quantity of shards found per site, the finds assemblages do not contain roofing tiles or industrial-size storage vessels. In combination with the small size of the scatters this indicates that in the 6<sup>th</sup> century BC the beach ridge complex was still very much peripheral to the development of large proto-urban settlements and substantial rural infilling in the Alban hills (cf. Attema 1993:219 – 224). It therefore seems likely that during all of the protohistoric period the economic basis of life was intimately tied up with the exploitation of the lagoonal milieu, with subsistence farming taking place in the immediate vicinity of simple hut dwellings. This is confirmed by the agricultural evaluation, which indicates that, before technological advances made possible exploitation



of the heavier soils, only the aeolian deposits were suitable as arable; most of the remaining dry land would only be suitable for extensive use, e.g. as grazing lands.

It is interesting to note the parallel between this protohistoric settlement pattern in the beach ridge area, and that which can be deduced from maps that show a system of *lestre* (simple hut settlements and their yards) used by fishermen and transhumant pastoralists, dotting the beach ridge area as late as 1851 (Attema 1993:51 and fig. 13).

#### 4.2 THE ROMAN LANDSCAPE

As is shown by figure 3, the number of sites rises in all three topographical units from the Iron Age / Archaic transition onwards. Although the data are not very explicit yet on the post-Archaic period (5<sup>th</sup> / 4<sup>th</sup> centuries BC) pending closer ceramic dating of the survey material, there is no reason to believe that, except for the introduction of farm houses with tiled roofs and maybe a corresponding shift in the economy towards farming, substantial changes occurred in settlement intensity in the Lago di Fogliano area. The largest increase in site density – from 3 to 16 occupied sites – occurs in the main aeolian / other sandy body by the late Republican period, but it was argued in section 3 that this may be partially the result of visibility biases. The agricultural land evaluation does indicate that technological advances introduced by the Romans would have made both the beach ridge unit and the lagoonal unit between ridges suitable for arable use – multiplying the area available for such use – but at the same time more efficient farming practices would obviate the need for additional workers.

A substantial economic interest from outside the core area of Latium Vetus only took shape in the late Republican period and is probably to be connected with the establishment of large and luxurious villas along the coast, some of which exploited large artificial fishponds, and with industrial pottery production also along the coast near the mouth of the Astura river (Picarreta 1977). This interest was backed up by means of infrastructural works such as the Via Severiana, a Roman road that ran along the seaward or landward side of the lagoons (Egidi 1980), and by interventions in the hydrography of the area, such as the digging of the Martino canal (the Rio Martino). In his study of artificial fishponds in Roman Italy, James Higginbotham notes that in Roman Republican times (3<sup>rd</sup> and 2<sup>nd</sup> centuries) inland bodies of water were favoured for the farming of fish, but that at the beginning of the 1<sup>st</sup> century BC a change in taste occurred towards sea fish. It is from this period onwards that elaborate seaside fish ponds were constructed, a number of which are found along the coast between Nettuno and Circeo (Higginbotham 1997:4-5). It is against this background that we should evaluate the Roman site and off-site distribution found in the Fogliano survey.

The original hydrography of the Fogliano area would have been much different from its current state. This is illustrated by historical maps, and it is probable that the Romans were the first to make substantial changes in the landscape. The Martino canal, draining the graben, was supposedly already dug through the horst system in Roman times, thereby flowing into the coastal watershed area. It appears already on the earliest maps dating around 1600 AD. In between the Lago di Fogliano and the Lago dei Monaci the landscape changed gradually into marshland and rushes. Here the Rio Martino - coming from the Via Appia - dispersed, partly discharging into the Lago dei Monaci and unable to reach the sea. Cecere (1989:22) suggests that the Rio Martino may not primarily have been aimed at draining the Pontine marshes lying north of the Via Appia, but rather was meant to provide the lagoons with additional fresh water to improve conditions for fish farming in the Republican period. In any case, interventions in the hydrography of the coastal landscape go back to Roman times as was proven by the German archaeologist Elter (1884), who reports on an inscription found on a 1<sup>st</sup> century AD Roman villa terrain at San Donato immediately to the north of the Lago dei Monaci. This inscription attributes to one Phaenippus the carrying out of construction or maintenance at water management works built earlier in the area. Cecere suggests that these works are related to the Rio Martino canal itself and were intended to regulate the supply of fresh water to the lagoons.

Elter relates the archaeological remains found on both sides of the Rio Martino in the vicinity of present-day Borgo Grappa to a vast villa complex at San Donato that specialised in fish farming as well.

According to him this villa was continually enlarged between the 1<sup>st</sup> and 4<sup>th</sup> centuries AD. Although the latter identification is not certain (Egidi 1980 provides an alternative identification as the way station *Ad Turres Albas* on the Via Severiana), there seems sufficient reason to believe that the increase in settlement intensity during the late Republican and early Imperial period recorded in the Fogliano survey must be connected to the developments in the fish farming industry. Although the latter may have eventually been monopolised by the large maritime villas, the increased level of economic activity would have attracted others to set up as independent farmers in the area, or in a ‘service industry’ to the Roman villa owners.

### 4.3 CORRELATING THE PHYSICAL AND HUMAN LANDSCAPES

If we look at the most stable sites listed in figure 3, we see that the Minturno beach ridge and the aeolian landscape were probably occupied in all periods from the late Bronze Age to the high Empire, while on the younger beach ridges evidence for the very earliest and latest occupation phases is probably lacking only because of the stochastic nature of the survey.

In order to illustrate the interplay between the human and natural landscape of the Fogliano region, figure 6 shows the combined results of the agricultural land use potential mapping and the archaeological surveys for part of the study area. We will first discuss the diachronic changes in land use in relation to the changing agricultural potential of the units in this area, then follow with a discussion of the correlation between settlement location choice and the topography of the terrain.

As was stated above, the aeolian soil unit remains the best suited for agricultural use throughout the whole period, whereas the suitability of clayey landscape units such as the lagoonal unit between the beach ridges increases in the Roman period through soil improvement (adding sand) and technological change (using heavier ploughs). The suitability of the beach ridge unit itself also increases with the introduction of irrigation and manuring practices. It is only the level lagoonal unit which remains too clayey for intensive agricultural use in any period. We would therefore expect a much wider agricultural use of the landscape in the Roman period as compared to the protohistoric period, and the wide distribution of Roman sites and offsite ceramics confirms this. On the level lagoonal unit we expect to find no settlements of any period, and little if any original off-site material. Again this is largely confirmed by the results of the Agro Pontino Project surveys, which report the majority of fields in this unit to be aceramic, with indeterminate Roman finds occurring in one field where the unit borders on a beach ridge.

In addition to soils, the topography of the area also patterns the human landscape in a non-random way. Factors such as exposure to the weather, viewshed, accessibility, and access to natural resources (water, fish?) determine the precise location for settlement and other activities. We cannot hope to be able to link the location of individual settlements to environmental factors operating at such small scales, but we are nonetheless fortunate to possess detailed maps of the relief, hydrography, and general vegetation type of the Fogliano area during the late 1920’s. These allow us to reconstruct, to some extent, the potential of the landscape for travel, settlement, and various types of exploitation. Mesolithic to Archaic sites, for example, nearly all occur at dry elevated parts of the landscape that strategically overlook lagoonal or fluvial valleys, whereas the many late Republican settlements are preferentially located some distance away from such locations and rather seem to be centered on prime agricultural land. The effects of exposure and viewshed should be most clearly visible on the Minturno beach ridge, the south side of which receives much more sunlight and sea wind than the north side (the other ridges are probably too low for these factors to be significant). Although our own work indicates that sites dating from the Iron Age to the Roman period were indeed situated on the south-facing slope of this ridge, the Agro Pontino Project surveys found at least one late Iron Age site on its north slope.

The scope of field walking surveys does not allow us to extend our models of the correlation between the physical and human landscapes by including site function as a variable. Neither is the area large enough to allow quantitative analysis, but our analysis does illustrate in a qualitative sense how the history of settlement and land use in the Fogliano region may be understood by reference to the physical landscape.

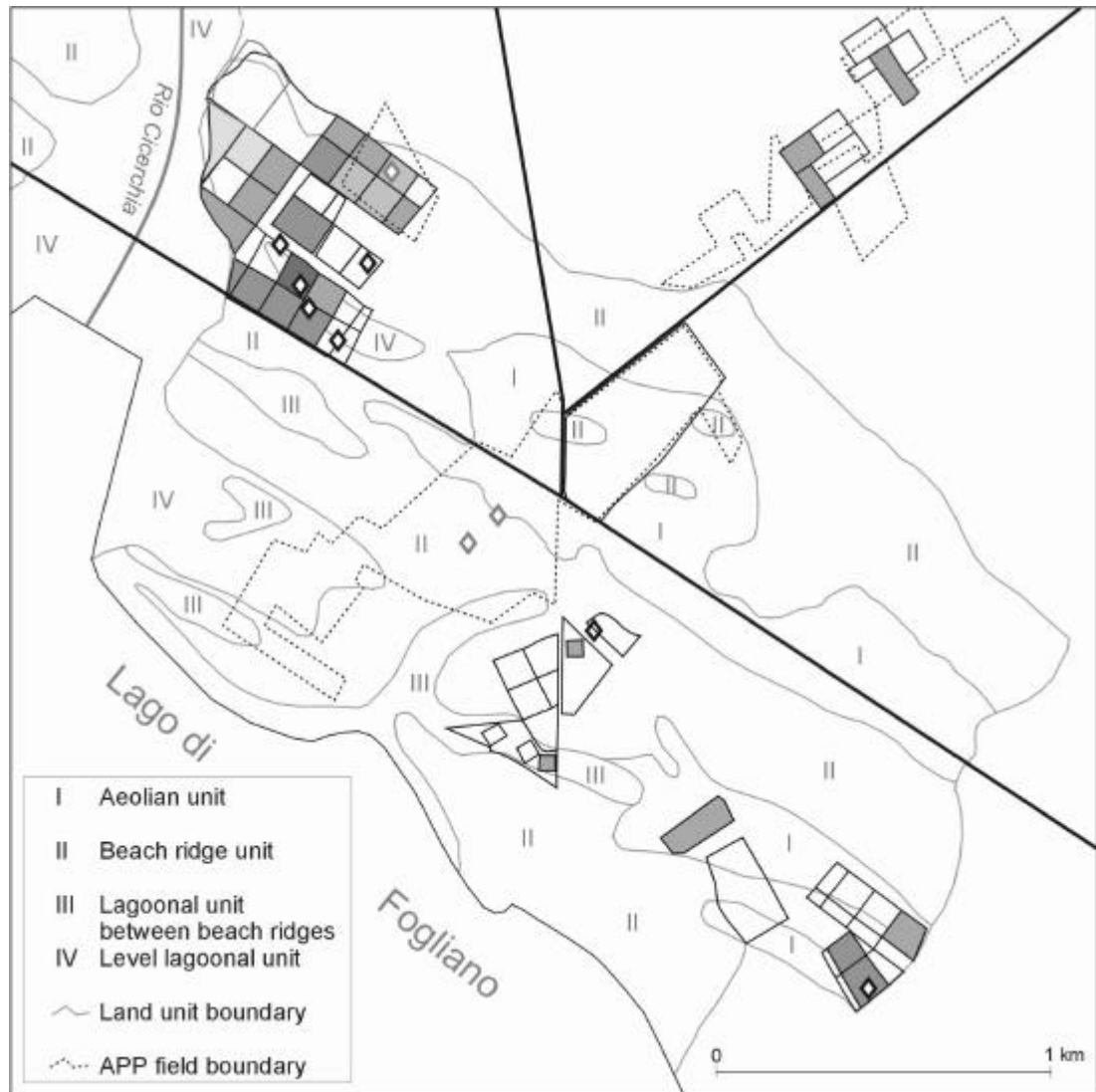


Figure 6: A detail of the Fogliano Survey area illustrates the value of the combined approach to the physical and human landscapes. Both off-site finds densities and sites of all ceramic periods are depicted against the background of the potential arable land use. For the legend to the finds densities, see Figure 5. Surveyed fields with continuous outline: RPC project; with dotted outline: Agro Pontino project.

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## 5 CONCLUSIONS

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The surveys of the RPC project in the Fogliano area have been very successful in establishing a basic settlement history that can probably be extrapolated to the whole Pontine coastal landscape. Continuity of occupation has now been proven from the 8<sup>th</sup> century BC down to the 3<sup>rd</sup> century AD, and among the protohistoric ceramic finds there may still be hidden a significant amount of Bronze Age and early Iron Age material. Further study of these fabrics will be undertaken in order to reliably recognise this material.

The RPC approach of combining geographical work with archaeological survey has proved important not only for a more detailed reconstruction of past land use than would otherwise have been possible, but

also because it has helped identify areas of anthropogenic disturbance. A more detailed formal land evaluation using the FAO system is in progress (Van Joolen in prep.).

Similarly, our emphasis on understanding the biases that occur during an intensive systematic field walking survey has prevented us from jumping to some unwarranted conclusions and has generally helped us in our interpretation of the results. We feel this aspect of our research is so important as to deserve further study - the Pontine landscape has been subject to so many recent changes, especially since the 1930s, that a more detailed reconstruction of its original geomorphology and hydrology is needed before the results of the archaeological surveys can be fully understood. We obtained elevation contour maps of the area as it was during the *Bonificá* of the 1920's, and by studying the differences between these and the modern relief we have mapped the main landscape changes and modeled the effects on the accessibility of the landscape of fluctuations in the ground and surface water levels (Feiken & Van Leusen, forthcoming).

The results of the Fogliano survey are best interpreted in the context of the developments in the wider region by relating them to processes of centralisation and early urbanisation in the core areas around the Alban massif and Rome. The development there during the Bronze Age, Iron Age and Archaic period (i.e. to the 6<sup>th</sup> century BC) of, first, centralised settlements and, later, peer polity city states is reflected by a similar, but late and stunted, development of marginal polities such as Caracupa / Valvisciolo on the Lepine footslopes and Cisterna di Latina on the south-eastern margin of the Alban massif. During the post-Archaic and Republican period the growing political, military and economic influence of Rome expressed itself archaeologically first in the establishment of colonies on the Lepine margin and, later, in the exploitation of the coastal landscape for fish farming, pottery production and leisure industry, and mixed farming on the colluvial slopes and (though much less so) along the Via Appia. The apparent dismantling of the Lepine olive culture and the near abandonment of settlement there and in the coastal area following the early Empire indicates that the Pontine region generally became economically marginalised as the Roman Empire moved its large-scale agriculture and industry elsewhere.

#### ACKNOWLEDGEMENTS

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# WALKING THE MURGE: INTERIM REPORT OF THE OSTUNI FIELD SURVEY (APULIA, SOUTHERN ITALY)\*

Gert-Jan Burgers, Martijn van Leusen, and Peter Attema

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## I INTRODUCTION

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### 1.1 COMPARATIVE SETTLEMENT ANALYSIS

Although studies of ancient landscapes have a long established tradition in mediterranean archaeology, one may observe in recent decades a definite break-through, encouraged in particular by the development of intensive field survey techniques. One of the merits of this trend is that it has allowed us to question traditional generalisations emphasizing uniformity in Graeco-Roman culture throughout the mediterranean basin. By stressing internal, and regionally specific, factors of change, the projects involved create the possibility of identifying variability in the dynamics of regional cultures and landscapes. However, the disadvantage of this approach is perhaps an overemphasis on regionally specific explanations. Whereas many regional data sets have become available in the last decennia, few attempts have yet been made to formulate new questions and syntheses on a supra-regional level (see notably Alcock 1994, Bintliff 1997). This is especially the case in Italy, notwithstanding the fact that the number of surveys here is comparatively large. To confront this issue, in 1997 three longstanding Dutch regional fieldwork projects joined forces to establish a new project aiming at a comparative analysis of centralization and early urbanization processes in three regional landscapes in Central and Southern Italy. This umbrella project was named *Regional Pathways to Complexity, Landscape and Settlement Dynamics in Early Italy* - RPC project for short. It is carried out by the Archaeological Institutes of the Vrije Universiteit at Amsterdam (AIVU) and Groningen University (GIA), and is subsidized by the Netherlands Organization for Scientific Research (NWO). The Italian regions investigated are, from south to north, the Sibaritide in Calabria on the Ionian sea, the Salento Isthmus in Apulia on the Adriatic, and the Pontine Region in Southern Lazio on the Tyrrhenian sea, south of Rome (see figure 1). The data proffered by the fieldwork projects carried out in these regions are analysed both within their specific internal social and environmental contexts, and in the context of the supraregional networks these regions were embedded in (see notably Attema *et al.* 1998a/b).

In order to fully understand variability within and between the regional contexts, we hold that it is imperative to investigate the total landscape of the regions concerned, i.e. all landscape units represented within them. Thus, in the context of the RPC project additional field surveys are carried out in those landscape units that have so far received little attention from archaeologists (see also Van Leusen 1998; Attema, van Joolen and van Leusen 2001). This report presents the results of one of these surveys, focused on the uplands of the Murge, the northern part of the Salento isthmus.

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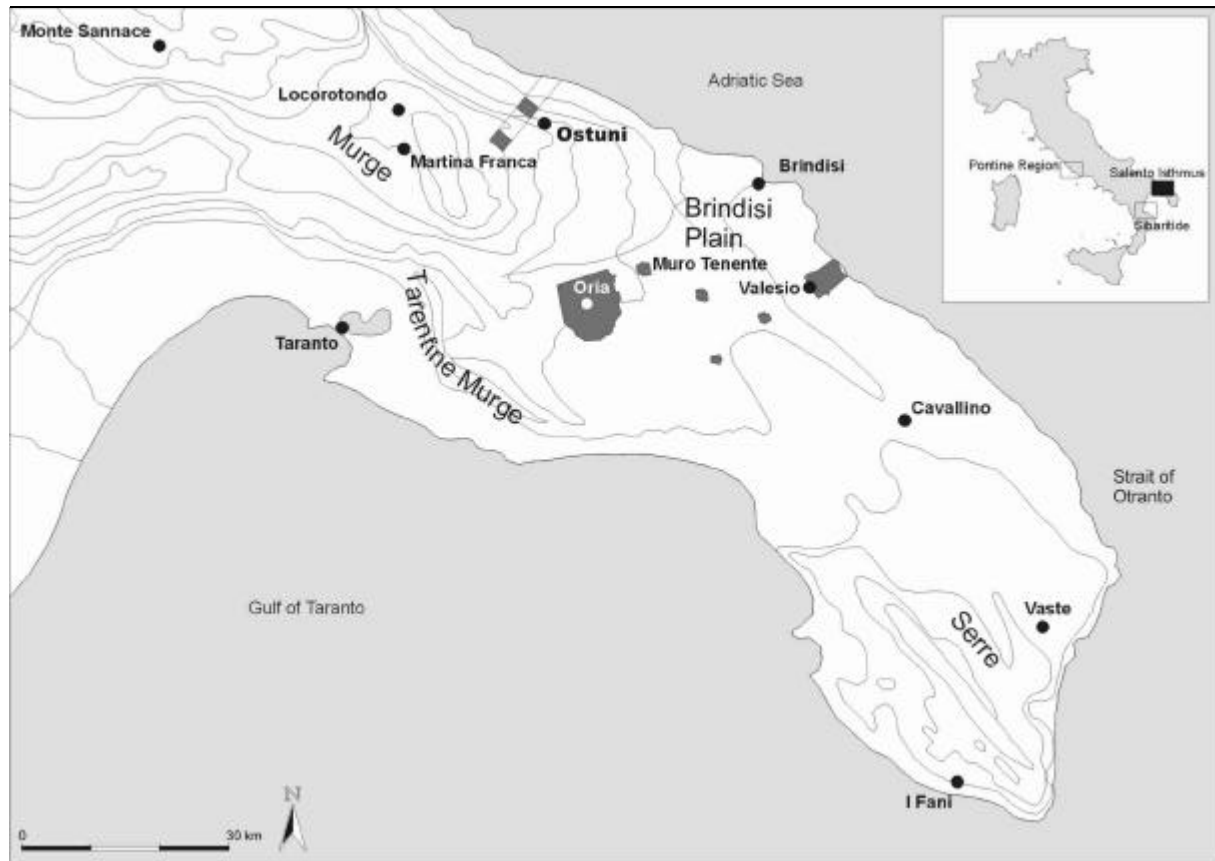


Figure 1: The Salento peninsula, with locations of major sites mentioned in the text. The shaded areas are those covered by the Ostuni'99 survey and by the previous surveys of the AIVU. Inset: Italy, with three RPC regions indicated.

## 1.2 AIMS OF DUTCH RESEARCH IN THE SALENTO ISTHMUS

The 'Salento Isthmus' is the common denomination of the stretch of land between Taranto and Brindisi, connecting the Salento peninsula to the rest of Italy (figure 1). Apart from the limestone plateau of the Murge in the north, the major landscape units in the region are the Taranto plain in the southwest and the larger Brindisi plain, or *piana messapica*, to the southeast. Since 1981 the AIVU has carried out a series of excavations and surveys in various rural and urban units throughout this region, but focusing in particular on the Brindisi district (figure 1)<sup>1</sup>. This fieldwork aimed to define the 1<sup>st</sup> millennium BC occupational history of the region and to analyse it in the light of three major supra-regional processes:

1. Processes of centralisation of settlement during the late Bronze Age and early Iron Age (ca. 1400-600 BC)
2. Early urbanisation, which in Salento is attested notably during the late Archaic and early Hellenistic periods (550-250 BC)
3. Romanisation of the early urban landscape, which proceeded after the Roman conquest of Salento in the first half of the third century BC.

<sup>1</sup> See notably van Alberda *et al.* 1999; Boersma 1990; 1995; Boersma *et al.* 1991; Boersma/Yntema 1987; Burgers 1998; Yntema 1993-1/2. Preliminary reports have been published annually in *Bulletin Antieke Beschaving* and *Taras, Notiziario delle attività di tutela*.

Accordingly, the general aim of the Ostuni surveys was to evaluate the settlement dynamics of the Murge landscape unit in the context of these three processes.

### 1.3 THE OSTUNI SURVEY

The Murge plateau is part of the Apulian karst. The landscape is marked by rolling hills and ridges, alternating with dolines and other forms of enclosed depressions characteristic of karsts. The altitude of the Murge averages about 420 meters above sea level. The plateau extends from the Bari district in the northwest to the Salento peninsula in the southeast. At its eastern edge, it drops abruptly towards the coastal plain bordering the Adriatic, whereas in the south it slopes more gradually towards the Gulf of Taranto. In the west it gradually merges into the Appennine mountain chain.

Intensive surveys in the Murge area have been limited to its western edge, at the Bradano trench between Apulia and Basilicata (Vinson 1972; Small 1991, 1998). Little detailed knowledge is available on the archaeology of the Salento part of the plateau, some 100 km to the east. This situation contrasts with that in the adjacent Brindisi plain, which mainly consists of fertile light arable and clayey soils. Here, intensive surveys by the AIVU have resulted in the identification of a densely and hierarchically settled landscape at least in Hellenistic and Roman times (see note 2). A major question regarding the Murge was therefore, to what degree the lack of data in this area reflected a lack of intensive, problem oriented research, or a

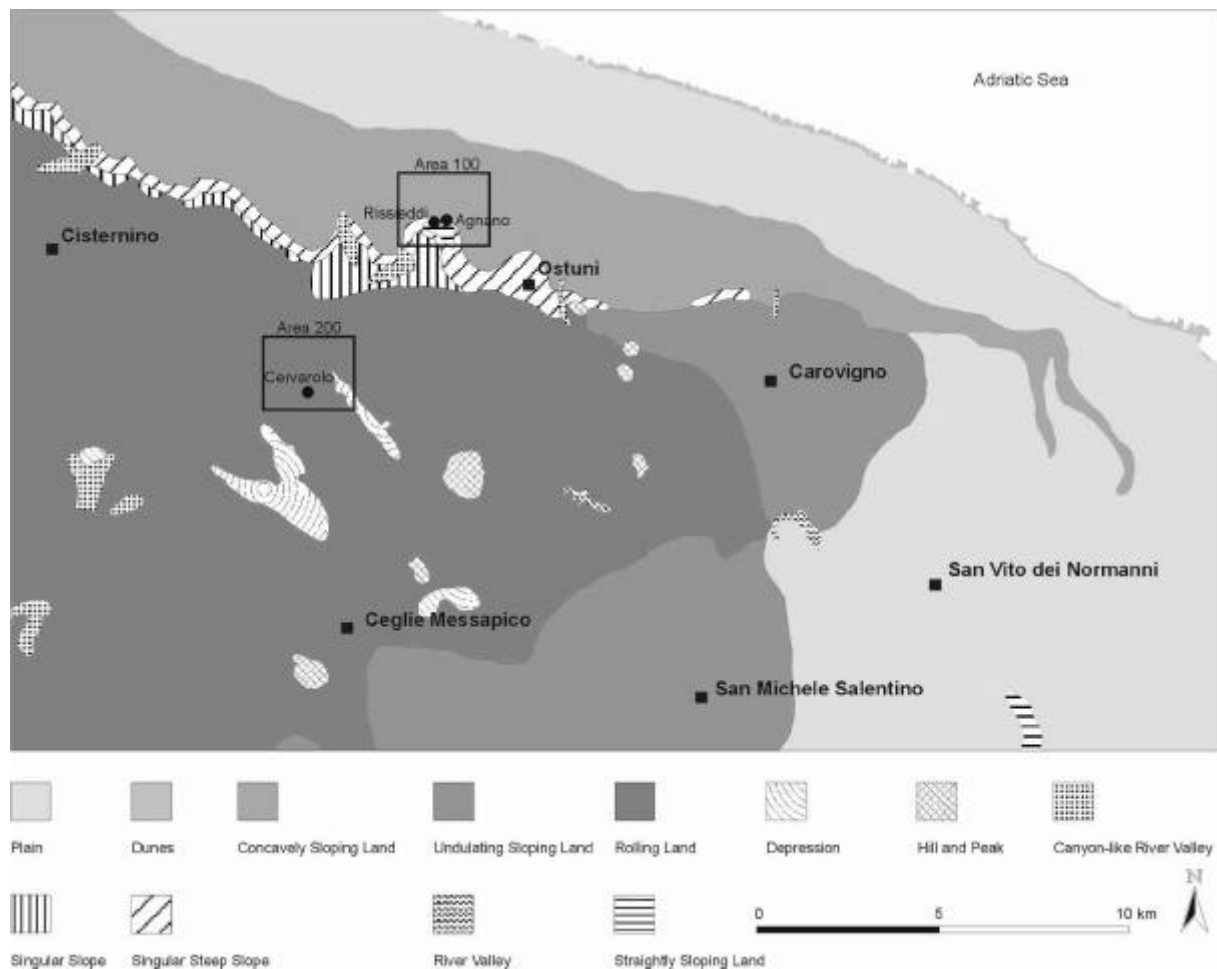


Figure 2: Geomorphological map of the larger part of the Salento Murge, with locations of major sites mentioned in the text and of the Ostuni'99 survey areas.



marginal human exploitation.

To confront this question, a survey was carried out in 1999 by staff and students from the two universities participating in the RPC project in two landscape units typical of this part of the Murge, located in the territory of the modern town of Ostuni (province of Brindisi; figure 1). To deal with the possibility, discussed above, that these areas were only marginally exploited, the survey method was specifically designed to document the low density and low visibility artefact scatters characteristic of low intensity settlement and land use. However, as we shall describe below, although we did in fact detect very diffuse and low density ceramic scatters within a general 'blanket' of off-site material, it has also become clear that such scatters do not constitute the norm in either of the two investigated landscape units. Both contain large and dense sites dating to the middle Bronze Age, and settlements from the Hellenistic and Roman periods were also discovered, suggesting an intensive human exploitation in these phases.

#### 1.4 METHODOLOGY

To investigate the possibility of differentiation in the human exploitation of the local landscape, 1.5 km<sup>2</sup> sample areas were located in two of the landscape units defined by the land evaluation (figure 2; see section 2). The first sample area ('Area 100') is situated near the cliff-like interface between the Murge and the coastal plain, just below the large Bronze Age site and cult cave at Masseria Risieddi; the second sample area ('Area 200') lies some six km inland, on the Murge plateau around the post-Medieval Masseria Cervarolo. Both areas were systematically surveyed in gridded units of 0.25 ha (50 by 50 m) at 10 m intervals (~ 20% coverage) by teams of student surveyors, and all non-recent objects were collected per unit. Further passes were employed in order to define, map, and sample any finds concentrations ('sites') encountered during the first pass. Samples from these further passes were generally taken in order to be able to quantify the density of material at various locations within a concentration, and in order to collect additional diagnostic material for dating. Both survey unit boundaries and finds density contours were mapped on 1:10,000 scale cadastral maps of the *Comune* of Ostuni for later digitisation. The finds collected during the survey were sorted, weighed and counted after washing and drying, then passed to lithic, protohistoric, and classical material specialists for more detailed classification; these data were then stored in a database system (MS-Access) attached to a GIS (GRASS) containing the digitised field maps.

#### POST-PROCESSING

The raw counts and weights resulting from the survey in themselves cannot easily be interpreted because the collection units themselves may vary in surface area, finds visibility, and surface percentage covered. The results are therefore presented here in the form of density distribution maps corrected for unit area and aggregate finds visibility (a correction for percent coverage was not needed in this case because this factor was kept invariant during the survey). Raw counts per unit were transformed into normalised densities (counts per hectare) by calculating the true surveyed area of each unit (excluding landscape features such as paths and verges, which can occupy a large part of the area of a unit) in the GIS, and dividing the raw counts by the recorded percent coverage and the true unit area in hectares. For example, if 6 impasto sherds were found in a unit of 0.25 hectares and 20% coverage, the normalised impasto density will become  $6 / 0.25 / 0.2 = 120$  per ha. Finally, the normalised finds densities were corrected for factors causing differences in finds visibility (and therefore biasing recovery rates). Although it is generally agreed that such a correction is necessary before the results of a survey can be properly interpreted, there is no such agreement on objective methods for recording visibility factors, nor for using these to correct uncorrected finds densities. A full discussion of these issues will be the subject of a separate publication (Van Leusen, in prep.); the method followed by us will be described here.

An aggregate visibility estimate on a 6-point ordinal scale, based on tillage, vegetation, weathering, and stoniness, was recorded by us in the field for each collection unit (figure 3). In order to quantify the effect of this visibility estimate, each of the points on the scale was assigned a percentage value based on our estimate of its relative significance (for example, high = 100%, normal = 90%, low = 50%, and very low = 25%). Following this, the algebraic correction for this recovery bias was applied in MS-Access by dividing the normalised finds densities by the aggregate surface visibility percentage. In the example used earlier, if

visibility had been 'normal', the corrected impasto density would be  $120 / 0.9 = 133$  per hectare. An unsolved problem with this approach, particularly when working with low raw counts and visibility percentages, is that the significance of random variations in finds density is exaggerated, while the diversity (in the statistical sense) of the finds assemblage is systematically underestimated. See, for example, the discussion in Orton (2000:172-6), and the discussion following Bintliff's recent re-evaluation of Boeotia survey data (Bintliff *et al.* 1999, 2000).



Figure 3: Aggregate surface visibility in the Ostuni survey areas (aggregate of ploughing conditions, vegetation cover, dust/rain, stoniness).

#### LAND EVALUATION AND LAND USE HISTORY

In order to relate the findings of the archaeological surveys of the RPC project to the characteristics and dynamics of the contemporary landscape, physical geographical mappings are being carried out in conjunction with the surveys. Such fieldwork also took place in conjunction with the Ostuni '99 archaeological survey (figure 2), with the aim of creating a soil unit description according to the guidelines of the Food and Agriculture Organisation (1977). Such a description was needed in order to do a land evaluation for agriculture from the late Bronze Age until the Roman period. The method of land evaluation compares the soil requirements of land utilisation types (e.g., of Roman arable farming) with the land qualities and land characteristics of the physiographic units defined during the physical geographical fieldwork, in order to determine their agricultural suitability. The results, to be published in full elsewhere, are here summarized in section 2.

While the land evaluation is intended to reveal correlations between the archaeological record and the past agricultural suitability of the land, the more recent history of land use within the survey areas has a directly observable impact on that record. Surface artefact recovery rates are of course biased by a host of factors besides those directly relevant to the density calculations discussed above. Those factors considered most relevant in the study area were recorded during the survey - the presence or absence of features indicating ongoing surface erosion (figure 4), the amount of recent or subrecent material on the surface (figure 5), and the condition of protohistoric sherds (see below, figure 10). The significance of each for the interpretation of the results of our survey will be briefly discussed below.

The presence of erosive features in the study area, including slope wash, small gullies, and patches of bedrock, indicates the instability of soils under current tillage, and is therefore an indication that soils including archaeological material may have been eroded at some areas and redeposited elsewhere. Evidently geomorphic processes might be responsible for distorting the recovered pattern, especially of protohistoric finds, but because erosive features were not consistently recorded for all collection units the resulting map (figure 4) must be seen as indicative and no formal analysis along lines similar to the Cecina survey (Terrenato 1996, Terrenato and Ammerman 1995) could take place. However, this factor does enter into our discussion of the interpretation of the protohistoric 'off-site' material in section 3.

Recent or subrecent material (a category which is composed mainly of glazed or very hard baked white ceramics, but also contains glass, rubber, metal and other materials) occurs throughout the study area and, even in low densities, is likely to distract walkers from noticing archaeologically more significant find types (figure 5). Where it occurs at higher densities, this factor is likely to have a significantly dampening influence on recorded finds densities. Figure 6 shows that the largest recorded density of (sub-)recent material was present in the southeastern part of Area 100, nearest the modern town of Ostuni, and it seems likely that refuse from the town was dumped in these nearby fields. The possibility that archaeological material, especially from the classical periods, might have been overlooked by the walkers in these fields led to a targeted resurvey, the results of which will be discussed in the appropriate section below.



Figure 4: Presence of erosive features in the Ostuni survey areas.



Figure 5: Corrected density distribution maps of recent finds in areas 100 and 200.

Some months after the original field work at Ostuni, the protohistoric impasto ceramics forming the bulk of the finds were studied in more detail by one of us. The aim of this study was to identify whether post-depositional disturbance had occurred among finds groups recorded as 'sites' in the field or, in other words, whether such find complexes were likely to have been found in situ or not. Sherd fragmentation and wear were taken as an indicator of land use intensity and sherd displacement, reflecting the degree to which the impasto has been affected by fluvial movement, frequent tilling and weathering. The main outcome of this study, discussed in more detail in section 3.2, is that there is no simple correlation between the density and the quality of the protohistoric material, casting doubt on the validity of site/off-site distinctions made in the field.

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**2 LANDSCAPE, SETTLEMENT AND AGRICULTURE**

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**2.1 EVALUATION OF THE PHYSICAL LANDSCAPE<sup>2</sup>**

From the Adriatic coast to the interior, the three major physiographic units identified during the land evaluation are the coastal plain, concavely sloping land, and rolling land on the Murge plateau (figure 2). The coastal plain is separated from the sea by a narrow line of dunes. The plain rises very gradually from 2 m asl behind the dunes to 70 m asl some 2-3 km inland, at which point it gives way to the concavely sloping land unit. At intervals of 1 to 2 km the coastal plain is incised by deep, canyon-like river valleys (*lame*) which originate in the Murge upland. The soils of the plain reach a thickness of 50 cm on average. Along the coast, the upper calcareous horizons are more coarsely textured than in the remainder of the unit, where they consist of sandy loam or sand. Most other soils consist of an upper horizon of brownish-red loam, with a second more fine-grained horizon underneath. The main crop cultivated in the plain is wheat, interspersed with olives on the higher parts.

The second landscape unit consists of a very wide concave slope at the base of the cliff-like edges that separate the lowland from the Murge plateau. The soils of this unit vary in thickness between 10 and 160 cm, consisting mostly of sandy to silty loams. Most commonly, an upper calcareous red A-horizon is followed by an even brighter red non-calcareous B-horizon. In thinner soils the B-horizon is absent and the A-horizon lies directly on top of the bedrock. Stoniness is rather high in this unit, and occasionally the bedrock even comes to the surface. Although wheat growing does occur in this unit in conjunction with olive culture, the latter dominates to such an extent that natural vegetation has almost completely disappeared.

Our third unit, the rolling land of the Murge plateau, largely consists of hills alternating with depressions, dry valleys and valley floors. The upper parts of the hills generally have thin soils, consisting of loamy clay, silty loam or loam. These soils all lie directly on the limestone bedrock, which here, too, frequently comes to the surface. The degree of erosion is high on these hills, which are planted mostly with almonds and occasionally with olive trees, plants that need only thin soils to survive. Accumulation takes place on the lower parts of the slopes and in the depressions and valleys. In the latter, soils are at least 150 cm thick and consist of clayey loam or loam. In contrast to the other units, drainage in these lower areas is relatively poor and they are mainly used for viticulture and horticulture.

For each of these units, the suitability for specific (pre-) historic land use types was determined on the basis of an evaluation of a range of land characteristics (Kamermans 1993; Foeken & Gietema 2000). According to this classification, the lowland units can both be defined as suitable for wheat growing, even without the use of ards. This also holds good for the lower parts of the slopes and the river valley floors on the Murge plateau. The major factors of influence here are the relative flatness, ample nutrient availability and workability. The agricultural potential of the river valley floors, with their relatively clayey texture, is likely to have improved with the introduction of a drainage system and of ploughing. Of all units in the study area, these valleys are least suited for olive growing and best suited for horticulture and viticulture, for which ample foothold is a major requirement. Because of their steepness, stoniness, thin soils and excessive drainage, the Murge hills were less attractive for wheat cultivation. However, they can be defined as (marginally) suitable for vine and olive growing, although the climate factor should not be underestimated (see above). Indeed, from the point of view of climate, the lowland units have much more to offer olive culture, and olive trees are nowadays found even on the lower slopes of the otherwise bare Murge cliff facing the coastal plain.

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<sup>2</sup> This summary is largely based on the preliminary physical geographical fieldwork conducted in parallel with our survey, and reported in Foeken and Gietema 2000.

## 2.2 SETTLEMENT AND LAND USE

A brief review of settlement hypotheses for the Salento part of the Murge must start with the work of Prof. Coppola at Rome and Lecce University, whose interest in cave, lithic and early ceramic sites provides us with a scatter of such sites (Coppola 1977; 1983; 1985). Coppola has dedicated most of his research to the archaeology of the caves, which were formed by two different processes in the limestone geology of the area. Percolation of rain water along angled bedding planes on the one hand has resulted in caves with entrances where such bedding planes intersect with the land surface; other caves were opened up by wave action along successive coastlines as the land was lifted up and the sea subsided in stages. Many of these caves were inhabited from the early Palaeolithic onwards – perhaps even by hominids<sup>3</sup>. Lithic sites were also found along *lame* (fossil river valleys) in the coastal plain.

In contrast to the relative abundance of known prehistoric sites in the Murge, information on occupation in protohistoric and historic phases was virtually lacking before the start of our survey. A few larger settlements dating to the Bronze and Iron Age were known to occur on the edges of the Murge, some 6 or 7 km from the present coastline, and another handful of Roman ‘villa’ sites were known for the entire area under consideration. This led to the hypothesis that the high Murge was, at most, marginally used before the Middle Ages. In the Middle Ages themselves, and for most of its more recent documented past, the Murge plateau was never intensively exploited or settled, being defined as *selva* (or forest - as opposed to the coastal plain, known as *marina*). Peasants of nearby villages enjoyed rights to put animals to pasture in the *selva*, to spend the night, cut wood, and to draw water from catchment basins (Galt 1991:69). From the 19<sup>th</sup> century onwards, these forests have gradually been reduced by large scale deforestation projects, and today only 5% of the region is still covered with woods or macchia, notably on the cliff-like edges mentioned earlier.

The 19<sup>th</sup> century saw a remarkable rural infill of the Salento Murge, with isolated farms (*trulli*) and hamlets (*jazžèlere*) appearing all over the plateau. This reclamation of previously marginally exploited lands, with roots in the later 18<sup>th</sup> century, can be intimately linked with the rise of viticulture at a time of increasing international demand for wine<sup>4</sup>. Vine growing became a major occupation of the peasants colonising the plateau. External markets also played an important role in the flourishing of olive culture in the coastal lowland, which has long been dominated by olive growing. As early as the 16<sup>th</sup> century the area was described as ‘a forest of olives’ (Galt 1991:71-72). By contrast, olive culture is a marginal phenomenon in the Murge because of its abundant winter precipitation and even the occasional snow storm. Frost damage is therefore an ever present danger making olive culture a risky business.

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## 3 RESULTS OF THE ARCHAEOLOGICAL SURVEY

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### 3.1 GENERAL OBSERVATIONS

Nearly 850 blocks (collection units), for a total area of 243 hectares, were surveyed during the Ostuni’99 campaign. Figure 6 shows the locations and approximate sizes of the 36 sites recorded in this area. Our survey method aimed explicitly at recovering marginal occupation, and its success is demonstrated by the fact that we did indeed identify even very small and diffuse scatters. After processing, 238 kg of ceramics remained, about evenly divided among three categories – impastos, depurated wares, and other pottery. Apart from a general thin lithic scatter, to be published in detail elsewhere, ceramic material datable to the Neolithic was found in only one spot, while nearly all of the landscape was found to be blanketed in

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<sup>3</sup> Concurrently with the Ostuni survey an excavation was carried out at a newly discovered cave at Ceglie Messapico by a team led by Prof. Coppola and Dr. Biagio Giaccio. If the geological *ante quem* date of 560,000 BP is correct, this cave was inhabited by Homo Erectus.

<sup>4</sup> The anthropologist Galt (1991) has dedicated a detailed ethno-historical account to this process, focusing on the interaction between landlord and peasant strategies in the territory of Locorotondo, some 25 km northwest of Ostuni.

Bronze Age coarse impasto ware. Equally as remarkable as the amount of Bronze Age ceramics found, is the almost absolute lack of Iron Age to Classical material: only a handful of (possibly) Iron Age sherds, and no Archaic or Classical material at all, were found. While sites from this period might in theory go unrecognized because of a lack of diagnostic fine wares and roof tiles, one would expect to find at least thick walled (impasto) storage wares.

Some of the most evident scatters of artefacts found during the Ostuni survey can be dated to the Hellenistic and Roman periods; their visibility is high because of the relatively large amounts of tiles and brightly coloured wares (eg, orange coarse ware, black gloss and ARS). Interpretable as farmstead and graveyard sites, in area 100 they occur on lightly sloping terrain not far from the edge of the Murge; while in area 200 they are situated fairly high up the slopes overlooking the larger valleys.

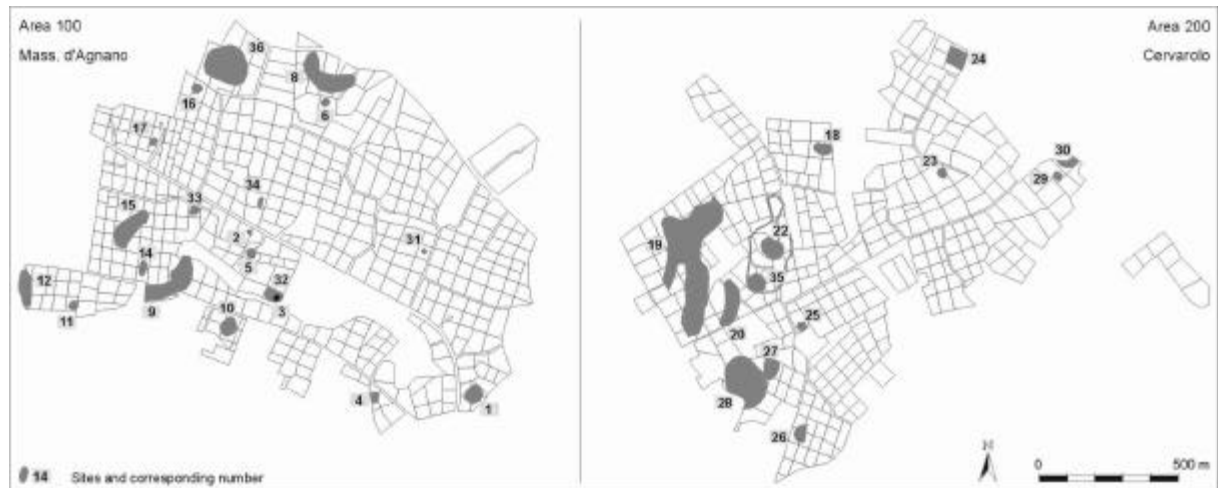


Figure 6: The gridded survey transects of the Ostuni'99 survey, with site areas shaded.

### 3.2 THE PROTOHISTORIC PERIOD

Figures 7 and 8 show the raw and corrected densities of protohistoric materials (almost exclusively coarse Bronze Age impasto ceramics) recorded during the first pass of the Ostuni survey. It may be observed that this material occurs over most of both areas, in densities varying from 1 to 570 per hectare (median density: 13). In Area 100 the relative absence of protohistoric material in the northeastern half may be partly related to the local topography, with a reduced use of the less accessible terrain directly below the Risieddi terrace, but it also seems likely that recovery rates were substantially lower here because of the presence of much recent material (above, figure 5). In Area 200, zones of low finds density appear not to be systematically correlated with land form, but we do suspect that high recent erosion and deposition rates may be involved. The large number of very small (diam 20 m) to small (diam 50 m) impasto sites is remarkable, and they seem to occur in all types of terrain including, on occasion, hilltops; however, the larger impasto sites tend to be situated on lower slopes and valley bottoms, in area 200 even clustering together in one valley<sup>5</sup>.

The macroscopic fabric of the impasto pottery group, very homogenous in area 200 but less so in area 100, is red firing and the paste contains quartz and/or flint and iron<sup>6</sup>; no shiny minerals were noted in the clay, nor does it appear to be very sandy. The pottery has not been subjected to microscopic analysis yet. A shiny layer caused by burnishing of the clay body was noted on a fairly large number of sherds from area 200, and appears as a separate layer onto an often friable core. The sherd surface is unevenly burnt and colours typically vary between red 2.5YR 5/8 and strong brown 7.5YR 5/6 to black. Sherd cores

<sup>5</sup> Given the occurrence of iron ore and slag we may have to presume that such sites are exceptional.

<sup>6</sup> Clay layers containing FeMn nodules are present in area 200.

consist of red and black layers or are totally black, indicating firing at a low temperature in an open fire. Many sherds do not have any surface treatment, though this may be partly due to post-depositional processes. This ‘standard’ impasto fabric is dated to the early part of the second millennium BC (*proto-Apenninico B*), implying that the settlement system producing it may have been in use for as brief a period as 100 to 150 years only (personal communication dott.ssa A. Cinquepalmi). Although diagnostic forms were barely present, and the general pattern of finds was more diffuse in area 100, reflecting its higher intensity of agricultural land use, the larger part of the impasto fabrics resemble those of area 200, and all may be assigned to the proto-Apennine B facies.



Figure 7: Raw density distribution maps of impasto finds in areas 100 and 200.



Figure 8: Corrected density distribution maps of impasto finds in areas 100 and 200.

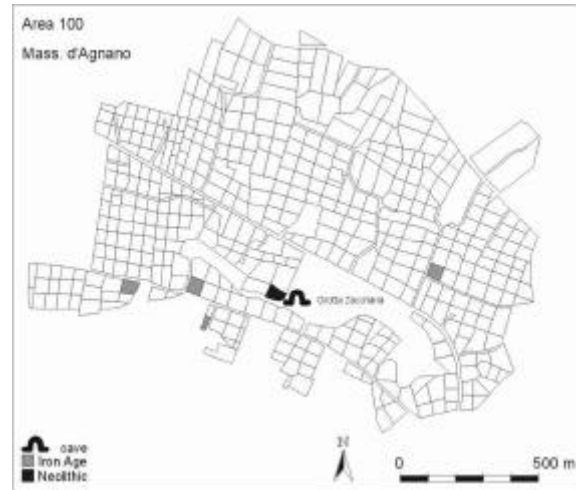


Figure 9: Presence of possible Neolithic and Iron age material in area 100, with location of the Zaccaria cave.

Area 100 seems not to have been quite abandoned in the preceding and following periods, however, because two sherds of a possibly Neolithic light brown burnished ware were found just below the Zaccaria cave site<sup>7</sup>, while sherds of a harder fired impasto with crushed limestone inclusions, indicative of Iron Age fabrics, were found in two other locations (figure 9)<sup>8</sup>.

Encircled densities in figures 7 and 8 indicate the areas of higher relative finds density ('sites') mapped in the field, details of which are listed in Table 1 (site reference numbers can be found in figure 6). While the site/off-site distinction could be maintained fairly easily for the classical periods, and the material was generally in good condition with no reason to suspect the presence of extensive manuring or plough scatters (see below), the variation in density and quality of the protohistoric material made us question the validity of our site/off-site distinction. An impasto quality study was therefore conducted, the results of which confirmed our suspicions: on the one hand, some 'protohistoric' sites (eg, site 4) turned out to consist partly or wholly of a (probably post-antique) very hard sandy impasto-like fabric, or to be contaminated by off-site plain coarse wares dating to the Hellenistic and/or Roman periods; on the other hand, groups of high quality protohistoric impasto sherds had gone unrecognised in the field.

The impasto quality study was carried out in order to determine whether post-depositional disturbance had occurred among the impasto finds groups. Focusing on variability in sherd fragmentation and wear, four classes were defined: 1) completely rolled, 2) worn and with rounded edges, 3) worn, but still recognizable as (body) sherds, and 4) sherds with surface treatment and form characteristics preserved.

<sup>7</sup> The Zaccaria and S. Maria d'Agnano caves were both occupied from the paleolithic onwards; among the finds reported in Coppola (1983:24, 251-2) are sherds of various types of Neolithic impasto.

<sup>8</sup> Coppola (1983:252) suggests that a few Iron Age sherds found at the entrance of the S. Maria d'Agnano cave are derived from the Masseria Risieddi site located at the top of the Murge cliff.





Figure 10: Summary of the distribution of the four impasto quality classes in areas 100 and 200. The numbers refer to the four classes mentioned in the text.

Table 1: Protohistoric sites (for locations, see figure 6)

#### Area 100

ID	Description
2	<b>Small (diam 5 m) and dense scatter</b> This scatter consists of both impasto pottery and flint. However, the impasto is not of site quality.
3	<b>Small (diam 5 m) and diffuse scatter; halo (radius 100 m)</b> This scatter contains 15 thin-walled impasto-like sherds of some 7mm thick, and 6 sherds of medium-walled impasto, some rather hard fired. However it also contains some late coarse ware (date uncertain). The scatter contains 10 certain pre/protohistoric impasto sherds (probably BA), which in itself does not warrant a site, but in conjunction with other finds from the surrounding area ('halo'; blocks 109-14 to 17) there is enough standard impasto of site quality. Diagnostic forms are hardly present: Block 109-14 contains a.o. a large knob? and rim of <i>tazza</i> ; 109-15 contains several large fragments and also a thin-walled impasto <i>tazza</i> .
8	Elongated scatter of impasto pottery; dense core 150 by 10 m, periphery 150 by 50 m The impasto within this scatter, of standard type, is very worn and not of site quality; it contains only a few clear body sherds. Some sherds appear to be fired harder than usual.
9	<b>Dense scatter, at least 250 m wide but could be larger toward S and W; top 10 m on Agnano terrace and continues another 50 m down terraced slope</b> This scatter contains much impasto material of standard type, but some 10% is in fact coarse ware or fabric X (see following sections). The impasto is generally very worn, but a small percentage is not worn and will have been ploughed up more or less <i>in situ</i> (e.g. in block 115-01). The scatter may have originally extended further to the south and west, on and along the edge of the Agnano terrace, but dense vegetation precluded survey. Site status is beyond doubt.
10	<b>Diffuse scatter, core diam 80 m, halo over 100 m wide</b> Much of the impasto in this scatter is very worn, except for blocks 118-15 and 118-A-DS-1 which have clearly site quality material.
11	<b>Diffuse scatter, diam 25 m</b> This impasto scatter was characterized in the field as 'not convincing' because many sherds were lying on the surface rather than in it. The quality of the material is good, but the density appears sufficiently low to regard this as off-site. The scatter is dissected by wide dry stone field boundaries.
12	<b>Diffuse scatter, 10 by 100 m</b> The elongated shape of this impasto scatter, and its location alongside a recently dug leat and field boundaries, indicates that the material may have been recently dug up. This might explain the material has site quality, but the number of finds is not impressive.
16	<b>Diffuse scatter, 15 by 25 m</b> This impasto scatter is located on both sides of a dry ditch, which may mean that the material was deposited when the ditch was dug. Since the material is very worn, it appears that this cannot have happened recently.

## Area 200

ID	Description
18	<b>small diffuse scatter</b> Contains only 7 fragments.
19	<b>Very large (500 by 200 m) diffuse scatter, with core area 100 by 100 m</b> This impasto scatter, of standard type, has a very complicated shape, with many internal variations in density. The highest quality material occupies both sides of a dry valley, with lower quality material extending in lobes along low ridges. However, the difference may be due to current building and landscaping activities going on in the former; 'nests' of high quality impasto in blocks 202-10 and -11 indicate that fresh material is still being ploughed up. The larger part of the material (95% or more) is between ca. 1 and 2 cm thick. The forms are jar- and bowl-like ( <i>olle</i> and <i>scodelle, ciotole</i> ); most of the simple band handles present among the material belong to this category of large pottery forms. No complex handles such as are known from the middle and later Bronze age were present. Only a few sherds of a black burnished thin-walled impasto were recorded that must have belonged to cups ( <i>tazze</i> ). Additional finds within this scatter include some Neolithic pottery and fragments of naturally occurring iron ore, possibly related to the iron slag found mainly in neighbouring field 211.
20	<b>Diffuse elongated scatter, 120 by 20 m</b> This scatter does not contain any diagnostic forms, and all sherds are medium-walled except for one <i>tazza</i> fragment in block 203-12. It is very similar in type and density of material to site 19.
23	<b>Diffuse scatter, diam 20 m</b> Located on a hill top.
25	<b>Diffuse scatter, diam 20 m, with 30 m radius halo to its N</b> This scatter initially contained only 7 impasto fragments, but a later revisit turned up an additional 21.
26	<b>Diffuse elongated scatter, 100 by 40 m</b> Blocks 13 and 16 to the east of this scatter were disturbed and therefore not surveyed.
27	<b>Diffuse scatter, diam 40 m</b>
28	<b>Scatter with dense (2-5 sherds/m<sup>2</sup>) core of 30 m diam, and diffuse halo</b> Almost all the material in this scatter is medium-walled, with 10 diagnostic sherds. However, the quality of preservation of material in neighbouring block 215-25 is higher.
30	<b>Dense scatter, diam at least 40 m</b> Located on hill top; the scatter may have continued toward the north into an unsurveyed field. Some thick-walled impasto bases were recorded, but no thin-walled impasto.
35	<b>Diffuse scatter, diam 50 m</b> Although the total number of sherds in this impasto scatter is only 11, it includes rather substantial sherds of thick walled impasto; more-over, it may have been partially masked by Hellenistic site 22.
36	<b>Diffuse scatter 100 by 100 m, with small core 25 by 50 m at southern end</b> The core of this scatter seems to be located in blocks 112-14 and 112-13, and contains some very large lumps of impasto, one teglia lug, and one thick base fragment. Probably the scatter originally extended further toward the south, but a recent walled garden and buildings prevented further survey in this area.

Figure 10 summarizes the results of this study by giving the highest class occurring within each recording unit; it can be seen that higher quality generally occurs on the high Murge whereas in area 100 much post-depositional wear and tear has occurred. That the latter play an important role in both areas is confirmed by the fragmentation of this material, due to frequent turning of the soil and long exposure to sun and rain: although some scatters still contain fragments measuring 6 by 6 cm or larger, 90 % of the material was fragmented to 4 by 4 cm or smaller. No recent fresh fractures were noted in the material from area 200, all sherds having been exposed at the surface for several cycles of tillage. No sherds were classified as class 1 (severely rolled), the bulk of the sherds being of class 2 (worn and fragmented by tilling and exposure). The quality of some of the finds, classified as class 3 (recognizable fragments) and 4 (sherds with surface treatment and form characteristics), indicates that new material is still being taken up into the ploughzone. The quality of the impasto sherds from area 100 was generally lower than that of area 200, and (parts of) many find groups were classified in class 1, meaning that the sherds have been severely affected by post-depositional processes. This is probably also reflected in the fact that many of the impasto sherds no longer seem to be related to clear scatters and were recorded as off-site material. Impasto finds classified in class 2 and 3, in contrast, are indicative of actual sites ploughed to the surface within the units where they were collected.

The protohistoric pattern emerging from the Ostuni99 survey poses interpretative problems relevant to

the ongoing general debate regarding the definition and practical implementation of site/non-site/off-site concepts. Following the tenets of distributional archaeology (Ebert 1992), we might have only recorded distributions of archaeological materials at the chosen spatial resolution of 50 by 50 m and coverage of 20%; in practice we recognised, and therefore wanted to record, patterning at higher resolutions - 'sites'. Typically, the observation of ADAB (abnormal density above background) for any of the materials occurring in the area would lead to the definition of a 'site' in the field, and a more detailed investigation would follow in order to define the distribution of materials within it and to recover diagnostic materials<sup>9</sup>. Of course, some density fluctuations (sites) might not be observed or defined in the field, whereas others, defined in the field, might subsequently lose their site status during finds processing and analysis.

In the light of this definition, the pattern of protohistoric material revealed by our survey presents us with considerable interpretative difficulties. Inasmuch as one would expect sites being ploughed up to exhibit both greater quantity and higher quality of material, it is noteworthy that areas of high quality impasto (figure 10) in many cases do *not* coincide with impasto scatters observed during the survey (figures 11 and 12). Two possible explanations for this phenomenon suggest themselves:

- a) areas of high quality impasto occur where they do because sites are present in the subsoil only there, and are being brought to the surface through general tillage. This is a weak explanation because it relies on the absence of evidence;
- b) areas of high quality impasto are indicative of underlying archaeological sites having been ploughed up *recently*; conversely, areas of medium or low quality impasto represent similar sites that were ploughed up earlier or more often. One example of this is site 2, recorded as a recognizable scatter in the field, but consisting of material 'not of site quality'. This explanation would imply that areas of high quality impasto vary from year to year depending on burial and tillage, and leads to the possibility that most of the landscape qualifies as a 'site'.

Neither manuring nor plough scatter can be invoked as an explanation for the occurrence of off-site material in this period, the former because it presupposes high-intensity land use, the latter because experimental work indicates that ploughing cannot disperse sherds very widely. Whilst material classified in class 1 (severely worn) may conceivably be redeposited by natural and man-made causes, in most cases the observed severe fragmentation and wear will be due to the long and intensive cultivation of the olive groves where the survey took place, and cannot be taken to indicate 'off-site' uses<sup>10</sup>. Thus we are forced back to the position that the generally occurring low densities of worn protohistoric finds must represent a palimpsest of occasional but recurrent, low intensity, social activities.

The 'aging' of surface archaeological material through repeated tillage presents us with a problem: should high quality material be treated any differently from lower quality material that shows no evidence for rolling? The issue is further complicated by the occurrence of localised soil disturbance and movement in the course of building work and agricultural improvement, of which there was much evidence in the region. The occurrence of high quality archaeological material may signal that such work has recently taken place. If we have evidence that a scatter resulted from ditch-digging nearby or from variations in the tillage of a deep valley soil, what does that say about the size/shape of the underlying site? Thus, while concepts of site and off-site are practical in field situations, and are needed in order to compare our results with those of other surveys in the region and elsewhere in Italy, the two approaches are not well integrated from a methodological perspective. It is unlikely that these issues can be resolved without further fieldwork, especially a programme of test excavations directed at understanding the range of relations between subsoil and ploughsoil archaeology.

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<sup>9</sup> Conversely, the term 'off-site' was applied to the occurrence of materials in 'background' densities (the B in ADAB).

<sup>10</sup> As examples of the former, doubts were recorded in the field about the originality of a number of sites (nos. 11, 12, 16, 21). In addition, Coppola (pers. comm.) suggests that much of the material currently present on the Agnano terrace may be secondarily deposited from the cave sanctuary area of S. Maria d'Agnano itself.

### 3.3 THE HELLENISTIC AND ROMAN PERIODS

The raw and corrected density distribution maps of Hellenistic material recovered by our survey (figures 11 and 12) are similar to those presenting the protohistoric material in one sense: the material in area 100 appears to be much more scattered and fragmented than it is in area 200, where two clearly separate scatters (nos. 22 and 24) were identified in the field. In area 100 a targeted re-survey of units which had yielded some scraps of classical fine wares was needed in order to turn up a sufficient amount of additional material to allow us to define scatter cores. The resulting pattern may still be somewhat biased by the preponderance of recent and subrecent material in parts of area 100 (see figure 5), which would have prevented the relatively inexperienced student walkers from reliably recording similar-looking classical material. Sites 14 and 15 are within 200 m of each other, and may be parts of the same settlement; the similarity in the location of the three Murge sites, all on the upper part of slopes with a commanding view of the valley beneath, is remarkable.



Figure 11: Raw density distribution maps of early Hellenistic finds in areas 100 and 200.



Figure 12: Corrected density distribution maps of early Hellenistic finds in areas 100 and 200.

Comparison of figures 11/12 and 13/14 shows that there is a large measure of continuity in the pattern of settlement from the Hellenistic to the Roman Imperial period, although the density of finds from the Roman period is higher. In this phase, in area 100, sites 14 and 15 are still paired and 14 is now more clearly part of the halo surrounding 15; the small site 5 now appears to belong with a similar partner site

32, which is situated in a sheltered location just beneath the Agnano terrace and the Zaccaria cave site. Unfortunately the terrain directly to its south-east was quarried for limestone. Table 2 provides descriptions of the Hellenistic and Roman sites.



Figure 13: Raw density distribution maps of Roman Imperial finds in areas 100 and 200.



Figure 14: Corrected density distribution maps of Roman Imperial finds in areas 100 and 200.

### 3.4 POST-ANTIQUÉ TO RECENT

Although recent and subrecent material was only recorded by us because it is a significant factor in biasing the recovery rate of other material groups, we did hope to identify Byzantine and Medieval material despite not having an appropriate specialist on our team. As it turned out, the only probably post-antique material we could identify turned up as a result of the impasto quality study; as yet unidentified, it was termed 'fabric X'. The fabric is sandy, and is fired very hard; it appears to be used for both tiles (typically between 1.8 – 2.0 cm thick) and pots; its predominant colour is reddish yellow 7.5YR 7/8-6/8. Figure 15 and Table 3 provide an overview of the distribution of this material. Clearly, most of the material forms two scatters, located on opposing edges of the Agnano terrace; a few sherds in the northern part of the surveyed area indicate that a third site may be nearby. Further work is needed to identify and date this

fabric.

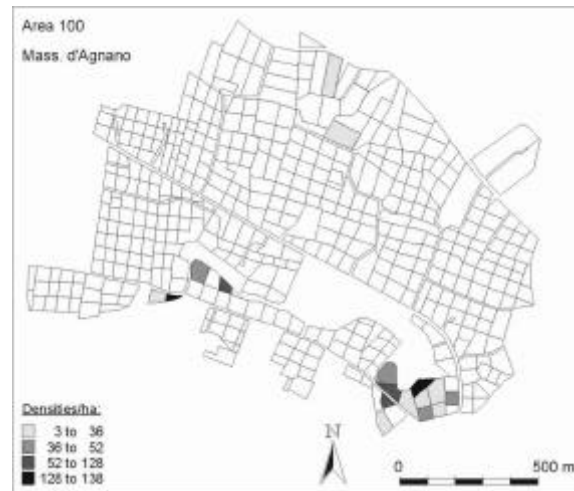


Figure 15: Corrected density distribution map of impasto sherds with fabric 'X' (per ha) in area 100.

Table 2: Hellenistic and Roman sites (for locations, see figure 6)

#### Area 100

ID	Description
1	<b>Diffuse scatter of Hellenistic pottery, diam 50 m</b> Scatter consists of fine wares (Apulian Black Gloss, late Republican Grey Ware), coarse and plain wares and amphora (Corinthian A). Amount of tiles very low. Near to the core of the site a Gnathia sherd was found, indicative of an early Hellenistic burial.
5	<b>Small and diffuse scatter of Hellenistic and Roman Imperial tile and pottery, diam 10 m</b> Located on terraced slope, this scatter contains mostly tiles, and only one fine ware sherd (Italian sigillata).
14	<b>Diffuse scatter of Hellenistic and Roman Imperial tile and pottery, 50 by 20 m</b> The long axis of this scatter is located along a field boundary. The pottery consists notably of fine slip wares (mainly Apulian Black Gloss, Red Slip wares), amphoras and coarse – kitchen wares. The major phases are the early Hellenistic and the middle to late Roman Imperial periods (to well within the 6 <sup>th</sup> century AD; witness the presence of Byzantine/Palestine amphoras)
15	<b>Dense scatter of Hellenistic and Roman Imperial tile and pottery, core 50 x 30 m</b> This scatter has a considerable halo and contains large amounts of diagnostic ceramics. The pottery consists notably of fine slip wares (Apulian Black Gloss, Italian Sigillata, Red Slip wares), amphoras and coarse – kitchen wares. The major phases are the early Hellenistic and the Roman Imperial periods (to well within the 6 <sup>th</sup> century AD; witness the presence of Byzantine/Palestine amphoras). The presence of Apulian Red Figured sherds is indicative of an early Hellenistic graveyard.
17	<b>Dense scatter of tile and pottery, 50 x 15 m; overall density not known</b> The long axis of this scatter is located along a field boundary; it probably represents a Hellenistic farmstead since multiple Apulian Black Gloss were found.
32	<b>Diffuse scatter of Roman pottery and tile, diam 25 m</b> Few diagnostic ceramics, datable to the 2 <sup>nd</sup> /3 <sup>rd</sup> century AD (African Red Slip and San Foca).

**Area 200**

ID	Description
22	<b>Dense scatter of Hellenistic and Roman pottery and roof tiles; core diam 75 m, with 50 m halo (up to 100 m downslope)</b> Fine wares include Apulian Black Gloss, late Republican Grey Ware, Italian sigillata and early African Red Slip wares; probable Roman building blocks were re-used in terraces. Same material possibly re-used during recent soil additions higher up on same spur (Block 9). The scatter can be interpreted as the nucleus of a hilltop farm that was continuously occupied from the early Hellenistic period to within the 2 <sup>nd</sup> century AD.
24	<b>Diffuse scatter of ancient pottery and tile, 50 by 50 m</b> The scatter is located along a field boundary. In 1999 only undiagnostic material was found here. In 2000, a revisit to the surrounding area revealed the existence of an extensive and dense Hellenistic-Roman site in the fields bordering the scatter to the north. In view of this, the scatter can be argued to constitute the periphery or halo of that site. The material still has to be analysed in detail.
29	<b>Dense scatter of ancient tiles and pottery, diam 20 m</b> The material is not very diagnostic and has, as yet, not been analysed.

Table 3: Post-antique sites (for locations, see figure 6)

**Area 100**

ID	Description
4	<b>Dense scatter of fabric 'X', 25 by 10 m</b> A large percentage of the sherds from this scatter belong to tiles of which in some cases the rims were preserved, but thinner potsherds were also recorded. The quality of the sherds is high (class 3) and the scatter appears to be homogeneous. We probably deal here with a post-antique structure in local fabric, although the siting on a steep terraced hillside is strange. Provenance of finds unclear; could be from site on edge of Agnano terrace.
9	<b>Dense scatter, at least 250 m wide but could be larger toward S and W</b> The top 10 m of this scatter, containing some 10% coarse ware or fabric X, are located on the edge of the Agnano terrace; it continues another 50 m down the terraced slope
31	<b>Diffuse scatter, diam 10 m</b> Turns out to be all post-antique material.

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## 4 DISCUSSION

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As stated in section 1, the primary survey data presented in the previous section are analysed in the context of the three major (supra-) regional developments – centralisation, early urbanisation, and Roman colonisation – introduced in section 1.2. Below, the outcome of this analysis will be presented chronologically.

### 4.1 CENTRALISATION OF SETTLEMENT IN THE LATE BRONZE AGE AND EARLY IRON AGE

The detail of the survey method used in the Murge proved successful in locating even small, low density and low visibility middle Bronze Age (18<sup>th</sup> – 15<sup>th</sup> centuries BC) artefact scatters. In both survey areas a large number of such ephemeral scatters was found alongside a series of larger and more dense concentrations, suggestive of an extensive human exploitation of both up- and lowland areas in this phase of the Bronze Age (figure 12). With regard to locational preferences, one may observe that the major Bronze Age scatters in area 200 cluster on the lower terraces at the interface between hill slopes and valley floors. A similar pattern is attested near the contemporaneous large Bronze Age site of Masseria Carestia, some 3 km to the east in the same landscape unit (personal communication d.ssa A. Cinquepalmi). This preference can be explained in reference to the classification of the lower parts of the slopes and the valley floors as suitable to palaeotechnic wheat farming, due to their relative flatness, nutrient availability and workability. The same holds true for the concavely sloping land and the lowland plain proper, where middle Bronze Age sites abound as well. Whereas the sheer abundance of middle Bronze Age material in

all areas makes it likely that the settlements were not all permanently occupied contemporaneously (explanations should be sought in the context of group mobility related to the practice of shifting cultivation, necessitated by the short term fallowing system practised in the Bronze Age), the homogeneity of the material argues for a relatively short period of use. Unfortunately, due to the undiagnostic nature of the finds we cannot assign this settlement period to any particular phase within the MBA.

The highly dispersed middle Bronze Age pattern established by our survey contrasts with that of the late Bronze Age (LBA; 14<sup>th</sup> - 12<sup>th</sup> centuries BC). In the survey areas no definite LBA material was found. However, this does not mean that the Murge area was abandoned in this phase. Whereas in the Salento region as a whole, LBA sites are mainly concentrated along the coast line, in the Murge they are also found at the top of the steep slopes at the interface of the coastal area and the upland. A good example is offered by the site of Rissieddi, which stretches out on one of the promontories along this edge, immediately north of area 100 (see figure 2). Now largely built over, until recently sections of a stone fortification circuit could be observed to enclose a densely occupied area of some 2-3 ha (Coppola 1983:208-213). The Rissieddi promontory visually dominates the surrounding landscape, as do similar LBA sites in the Murge. On the basis of the available data one can conclude that, by the LBA, a strongly centralized settlement pattern had emerged, contrasting with the highly diffused one of the MBA.

Much less is known about the final Bronze Age and initial Iron Age (11<sup>th</sup> - 9<sup>th</sup> centuries BC; the 'Dark Ages'). For the Salento peninsula as a whole, the known sites are still situated predominantly on the coast. After the collapse of the Mycenaean world no imports from that region reach Salento, suggesting that overseas, and perhaps even interregional, networks had collapsed. Coastal communities were probably autarchic, while the interior may only have been exploited for extensive pastoralism, if at all (Burgers 1998:173-174). This pattern was gradually transformed in the course of the 8<sup>th</sup> century BC. In the study area one may observe a shift in locational preferences in this phase, the Rissieddi plateau being abandoned in favour of a new settlement on the more accessible hilltop at Ostuni (see figure 2). Iron Age occupation at Ostuni is attested from the 8<sup>th</sup> century BC onwards (Coppola 1983:235-254). This is congruent with recent theories on settlement expansion and shifts in site locations in 8<sup>th</sup> century BC Salento in general (D'Andria 1991:405; Yntema 1993-1:161; Burgers 1998:186-191). The early Iron Age Salento is characterized by a gradual increase in site density, an expansion of already existing sites, and an occupation shift from coastal promontories to inland plains and hills, suggestive of an internal colonisation movement. In addition to Ostuni itself, a whole series of Murge sites illustrate this phenomenon, such as Locorotondo (figure 1; De Michele 1986), S. Pietro di Ceglie Messapico (figure 2; Fusco 1964; Coppola 1977:304), and Castello di S. Vito dei Normanni (figure 2; Cocchiario 1998; Semeraro 1998). Still, judging by the relatively large distances between these sites and by the absence of Iron Age artefacts in rural survey areas such as ours, most of the Murge is likely to have been exploited only marginally.

#### 4.2 EARLY URBANISATION AND RURAL INFILL

No direct evidence for the emergence of urban sites could of course be obtained from our rural surveys at Ostuni, so we must turn to previous research in order to put our results into perspective. Artefact scatters dating to the Archaic/Classical period (600 – 325 BC) were absent in the survey areas, suggesting that most of the high Murge was still not used intensively in these phases, and that settlement continued to concentrate in the same areas as in the previous Iron Age. Indeed, it may be hypothesized that the nucleated settlement pattern that emerged in the Salento Murge in the early Iron Age was consolidated in the Archaic/Classical period. Unfortunately, due to the scarcity of systematic investigations at major Murge sites such as Ostuni, Ceglie Messapico, and Martina Franca (see figure 1), no proto-urban intra-site studies are as yet available that would allow us to evaluate if these sites underwent changes similar to those detected at the southern lowland sites of Cavallino, Oria and Valesio (see figure 1)<sup>11</sup>. At Cavallino, excavations point to a trend towards the replacement of dispersed early Iron Age hut compounds by aggregate blocks of (partly) stone built houses with tile covered roofs, and traces of such houses have also

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<sup>11</sup> On Cavallino, see notably Pancrazzi 1979 and D'Andria 1991; on Oria, Andreassi 1981; Yntema 1993-1; on Valesio, Boersma/Yntema 1987.



been found at Valesio. At Cavallino, this reorganization of settlement space was shown to have been accentuated by, amongst others, the arrangement of clearly defined paved roads and public spaces, as well as by the construction of monumental stone defensive circuits surrounding the inhabited areas. Similar defenses have been traced at Oria and Mass. Fani (figure 1; Andreassi 1981; Descoedres/Robinson 1993).

The emergence of early urban features at these sites can be shown to coincide with a reorganization of religious space. This becomes particularly evident when the wider landscape is taken into consideration as well; whereas early Iron Age religious activities remain largely invisible in the archaeological record, for the Archaic/Classical phases one may observe a process of formalization of cult activities, notably in caves in the territories of the major settlements. Evidence for the occurrence of this process in our study area is provided by the cave sanctuary of the *Grotta di S. Maria d'Agnano*, just a little distance uphill from survey area 100 (see figure 2). The cave is located some four km north of Ostuni, and opens out onto a natural terrace overlooking the coastal plain, just below the cliff top harbouring the site of Rissieddi. Investigations carried out under the direction of Coppola have demonstrated that the cave became the scene of a formal cult dedicated to a female divinity from the 6<sup>th</sup> century onwards (Coppola 1983:249-252). Following the arguments we have put forward elsewhere regarding such sanctuaries (Burgers, forthcoming), we believe that this reorganisation not only involved a transformation in the perception of the landscape, but also a formalisation of territorial claims.

In view of the above, it is all the more remarkable that the results of our survey show that it was only in the early Hellenistic period (325 – 200 BC) that these territories attracted any substantial rural settlement. In area 100, following a pattern observed earlier at Oria (Yntema 1993-1), these sites appear to be located along a line running just beneath and parallel to the Murge edge, suggesting the existence of a *pedemontana* road (see figure 11). Unlike similar farms in the Oria and Valesio survey areas, some of these sites lack identifiable tile, which suggests that a much simpler construction method was used for farm buildings. In both survey areas these early Hellenistic sites are surrounded by low density 'halos' indicative of manuring, while in area 200 they occur on slopes that were largely avoided in the Bronze Age. It may be proposed that with fertilisation (and possibly irrigation), these slopes had been made suitable for agriculture. Considering the observed emphasis on polyculture in other parts of Salento from this time onwards, it is tempting to suggest that the slopes may have been taken into use for arboriculture in a manner analogous to the 19<sup>th</sup> century situation referred to in section 2<sup>12</sup>.

Although the latter hypothesis can not be proven as yet, these results may be called highly significant. The Salento Murge was thought to be an archaeologically marginal landscape even in the Hellenistic period until the sites and off-site material detected by our survey showed that the Murge in fact participated in the regional trend of agricultural expansion and intensification, established on the basis of the spread of early Hellenistic farmsteads in urban catchment survey areas on the Salento Isthmus (Burgers 1998:226-263). Considering that in the Murge the rural infill is also attested in the upland survey area 200, at 7-8 km from the nearest urban centers at Ceglie Messapico and Ostuni, one may suggest that this regional trend extended to the cultivation of even the most outlying, previously untilled, lands outside the urban catchment areas.

The agricultural transformation indicated by these results is linked to other major contemporaneous early Hellenistic developments. It can be argued to have supported a demographic increase and urban rearrangement of the larger settlements, which reached their maximum expansion in this period. Since we have only cemetery evidence from Murge sites, a parallel must be drawn with other Salento sites where systematic urban surveys point to a considerable expansion (Yntema 1993-2; Burgers 1998). Excavations at several of these sites likewise show the emergence of large nucleated *insulae* with a relatively regular layout (figure 1; Monte Sannace: Scarfi 1961; 1962; Vaste: D'Andria 1991; Muro Tenente: van Alberda *et al.* 1999). Besides these domestic quarters, specific urban spaces were arranged for public buildings, cult places, cemeteries, warehouses and for intensive horticulture. Fortification circuits were built to enclose

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<sup>12</sup> On the development of a polyculture system, see Burgers 1998:255-259.

entire settlement areas - as was the case at Ostuni and Ceglie Messapico in the Murge (D'Andria 1991:445; Coppola 1983:269-275). These urban transformations can be shown to have occurred simultaneously at sites throughout the Salento peninsula. Relating them to the rural infill of the landscape surrounding these major sites, one may observe the parallel emergence of pronounced local settlement hierarchies throughout the region (as discussed in more detail in Burgers 1998:226-263). On the basis of our survey, the Murge area can be considered one such micro-region, with isolated farmsteads even appearing on the rolling land of the high plateau.

It can be concluded that, with the rearrangement of the wider landscape, the Murge towns became central places serving extensive rural hinterlands in the early Hellenistic period. Indicative of this development is the variability in the ceramic repertoires of the rural sites detected in both survey areas - besides tiles and local coarse kitchen and plain wares, these include fine wares such as Apulian Black Gloss, Gnathia ware and Apulian Red Figure, suggesting articulation with a market system.

#### 4.3 THE ROMAN LANDSCAPE

Neither survey area in the Ostuni transect shows significant changes in the number or location of sites of the late Republican and Imperial periods, as compared to the early Hellenistic period. A basic continuity seems to exist for these phases, suggesting that the Murge landscape was not much affected when the centre of power in the region shifted towards the Brindisi plain as the direct hinterland of the Latin colony of *Brundisium* (see figure 1).

*Brundisium* was founded around the middle of the 3<sup>rd</sup> century BC as Rome's satellite in the newly conquered Salento peninsula. In the late Republican period it grew into one of the major Italian harbours for communication with the eastern Mediterranean, as well as into a regional centre for the overseas export of agricultural products, notably wine and olive oil. With the emergence of an export oriented market economy, there is evidence to suggest the formation of a regional landscape which was differentiated in various zones of profitability (Burgers 1998:265-292). Market oriented wine and olive oil production can be argued to have concentrated in the immediate hinterland of Brindisi, as well as along the major new transport axis of the Via Appia. As a consequence, the role of the former Hellenistic towns as central places in these areas lost much of its significance, which may be one of the major reasons for their decline.

Areas further removed from Brindisi and the Via Appia (including the Ostuni survey areas) must also have become economically peripheral, with subsistence farming likely to have prevailed in the late Republican period. The aforementioned lack of systematic research at towns in the Murge warns against drawing definite conclusions regarding their development in the Roman period. However, judging from the scarcity of Roman finds so far, they do seem to have contracted considerably. On the other hand, the rural landscape of neither the Murge upland nor the plain seems to have suffered similarly, as the Roman sites in the survey areas demonstrate, and the presence of considerable amounts of fine wares on these sites suggests that the area as a whole still had access to a wider market system.

This rural continuity also holds good for the Roman Imperial period, at least for the lowland survey area (area 100), for which African Red Slip wares are amply attested. There is even some evidence of site expansion - at site 15 Imperial Roman artefacts are distributed over a much wider area than the Hellenistic sherds. In comparison to the other Imperial scatters discovered here, this site clearly stands out not only in extent but also in the amounts of fine wares found. In view of this, it can be interpreted as the central part (with domestic unit) of a larger estate which also harboured a range of utilitarian outbuildings. A similar development has been observed in other Salento survey areas, where Roman Imperial sites also expand progressively (Boersma *et al.* 1991; Yntema 1993-1:215-226), and may be suggested to reflect a process of concentration of small, dispersed land holdings into larger, more centrally managed estates. If this was the case in the lowland around Ostuni, it is tempting to relate it to an expansion of olive culture in this area, which as we have seen above (section 2.2) is already described in historical documents of the 16<sup>th</sup> century as 'a forest of olive trees' and which remained so until the present day. Central estate management is a prerequisite for large scale olive culture. In this regard, one may also point to the

existence of the nearby Via Traiana, running all along the coast from the Bari district to Brindisi. Its course has been studied by Uggeri, who relates the ancient written sources mentioning the road to actual field observations (Uggeri 1983:228-264). The Via Traiana is likely to have considerably improved the accessibility of this part of the Murge, not least for the transport of agricultural products. In contrast, Imperial fine wares are less conspicuous in the upland Cervarolo zone. Other contemporary diagnostic wares lack as well, suggesting that the area was abandoned in the 2<sup>nd</sup> century AD and that the Murge upland now became peripheral to the wider region.

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## 5 CONCLUDING DISCUSSION

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From a methodological point of view, the Ostuni'99 survey has had some very interesting results. The three visibility bias factors discussed in section 1.4 indicate that the recent and subrecent land use history of the study area has had a significant influence on the results of our survey. The impasto sherd quality study reported in section 3 revealed a lacuna in our understanding of surface pottery distributions, relevant to the ongoing general site/off-site/non-site debate. While we may not be able to attach any secure interpretation to the occurrence of areas of higher sherd quality such as those mapped in figure 10, it is in our opinion a phenomenon worth looking into by means of a programme of test excavations. These concerns must be borne in mind when reading the analysis of the use of the landscape in each period.

Despite the unsolved problem of insecure dating of the Bronze Age impasto, the Ostuni survey conducted by the RPC project has considerably strengthened and widened the basis for generalisations on the occupational history of the Salento Murge. The sample areas investigated represent two of the major landscape units of this micro-region. Contrary to expectations, both have given up a relative abundance of surface material dating to the Bronze Age and the Hellenistic/Roman period. By applying a detailed survey method, focusing on the documentation of the density and distribution of artefacts rather than sites, it has become possible to assess accurately the variability in quality and quantity of this surface material in the light of both cultural and natural formation processes. Moreover, relating the results of the survey to those of the land evaluation, hypotheses on land use patterns could be more firmly grounded.

On the micro-regional scale of interpretation, one of the major conclusions that can be drawn on the basis of the surveys is that, in broad outline, both sample areas demonstrate parallel shifts in artefact densities and distributions from the Bronze Age to within the early Imperial period. Judging by the highly dispersed pattern of Middle Bronze Age scatters delineated in both survey areas, the Murge plateau and the lowland zone can be argued to have been extensively exploited during this phase. This rather mobile settlement system of the MBA contrasts strongly with that attested for the late Bronze Age, which is of the nucleated type. A similar nucleated pattern, now including the interior of the Murge, came into being in the course of the early Iron Age, when a number of large sites appeared on selected strategic positions. The latter pattern can be shown to have continued to well within the 4<sup>th</sup> century BC, a period in which, according to the survey results, the rural landscape surrounding the major Murge sites seems to have been exploited only marginally. Archaeological material dating to these centuries is restricted to the cave site of S. Maria d'Agnano, where the Archaic formalisation of cult activities can be argued to have supported territorial claims on the surrounding land.

Our survey indicates that it is only from the late 4<sup>th</sup> century BC that the rural landscape of both the coastal zone and the Murge plateau was actually claimed for settlement. In view of this, it can now be argued that the Salento Murge participated in the general south-Italian trend of agricultural expansion and intensification that accompanied ongoing urbanization. The recognition that this trend involved even areas on the high Murge, far from the immediate catchments of the major Murge towns, may illustrate the scale of the process.

For both survey areas, a basic continuity of occupation throughout the Roman Republican and Imperial periods can be deduced, with the possible exception of the late Imperial period in the upland area. This situation contrasts with that known from incidental discoveries at the major Murge sites, which seem to

have been largely abandoned in the late Republican period. If this may be taken to indicate that these sites lost their previous central market role, subsistence farming is likely to have come to prevail in the surrounding rural territories. As for the Imperial period, the expansion and intra-site differentiation of the largest site attested in the lowland survey area can be interpreted in the light of a concentration of land holdings in a more centrally managed estate focused on large scale olive growing.

In line with the central RPC project aim of comparative regional analysis, the settlement history outlined above is studied from a (supra-) regional perspective. The Salento region has most often been treated in the context of Hellenization studies, focusing on the demonstration of the diffusion of Greek culture among non-Greek populations in Southern Italy (cf. notably Whitehouse and Wilkins 1989). This diffusion is generally conceptualized as a unilinear process of increasing intensity, enhanced in particular by the installation of Greek colonies along the Ionic shores (notably Taras for the Salento Isthmus), and is thought sufficient proof of Greek cultural domination over their native neighbours. The recent upsurge of problem oriented fieldwork in southern Italy, and in the Salento peninsula in particular, allows us to qualify this strongly culture-historical, diffusionist paradigm. Cherishing a wide chronological and spatial scope, the fieldwork conducted by the RPC project offers the possibility of research into long-term, supra-regional settlement and landscape dynamics. From this perspective, the early Greek intrusions can be argued to have been not a dominant but rather a peripheral element in a region-wide process of internal colonisation, settlement expansion and corresponding shifts in territorial perspectives and claims (see above, section 4.1). This process, which can be shown to have started before the arrival of Greeks, is also attested in the Murge area, where a range of new sites emerged on strategic locations in the early Iron Age.

Similarly, it has now become possible to overcome the traditional emphasis on Greek *polis* formation for the subsequent centuries and to point to the existence of contemporary dynamic processes occurring in the native world, especially those of early urbanization and agricultural intensification. These processes involved, amongst others, the emergence of pronounced settlement hierarchies in micro-regions throughout the Salento Isthmus, and can be related to the formation of centralised socio-political power structures increasingly integrating previously segmented tribal units (Burgers 1998:195-263).

From the same diachronic and supraregional perspective the Roman landscape of the Murge must be interpreted in the context of the progressive incorporation of Salento into a developing state and market system dominated by Rome. This further enhanced political and economic centralisation, favouring notably the Latin colony of Brundisium and its immediate hinterland in the Brindisi plain. Although the Ostuni survey results indicate that neither the uplands nor the lowlands were abandoned until the later Imperial phases, the Salento Murge as a whole can be argued to have become increasingly peripheral from the late Republican period onwards.

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# REGIONAL ARCHAEOLOGICAL PATTERNS IN THE SIBARITIDE

PRELIMINARY RESULTS OF THE RPC FIELD SURVEY CAMPAIGN 2000<sup>\*</sup>

Martijn van Leusen and Peter Attema

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## 1 INTRODUCTION

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This article presents a preliminary report on the October, 2000 field walking survey campaign of the Regional Pathways to Complexity (RPC) project in the Sibaritide (northern Calabria, Italy), focusing on the study of spatial and chronological patterns in the archaeological record and their interpretation in terms of regional settlement history.

From 1991 onwards, the Groningen Department of Mediterranean Archaeology has conducted annual excavations at the hilltop sanctuary and settlement areas of Timpone Motta at Francavilla Marittima, with occasional limited field surveys in the immediate neighbourhood of that site. In 1997, the Sibaritide became one of three regions being studied in the context of the RPC project run jointly by the archaeology departments of the University of Groningen and the Free University of Amsterdam (both in the Netherlands)<sup>1</sup>. The central aim of the RPC project is to study regional processes of centralisation, urbanisation, and colonisation which have occurred from the Iron Age onwards, and especially to evaluate the relative importance of internal and external contributing factors to these processes. Among several approaches toward that aim is the detailed study of the relations between the regional landscape and its settlement history at various spatial and temporal scales. This approach utilises the concept of history developed by the *Annales* school in the 1930s, operationalised by Braudel after the second world war, and introduced more recently in archaeology (cf. Bintliff 1991). It requires the modelling of landscape characteristics within a GIS environment, and the application of careful 'source criticism' of the available archaeological data. Fieldwork, especially survey, has been used in an attempt to fill gaps and assess biases in these data.

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<sup>\*</sup> This chapter is currently in press, to appear in *Palaeohistoria* 42/43. The campaign was conducted as part of a collaboration project with the archaeological superintendency of Calabria. We would like to express our gratitude to the Soprintendente, Dr.ssa Silvana Luppino, for arranging the necessary permissions. Some aspects of the SIBA2000 field campaign, such as the highland reconnaissance survey and the experiments with context-aware portable digital field assistants, are not discussed here (see chapter 7).

<sup>1</sup> The RPC project (1997-2002) is part of the research program 'Landscape and settlement' of the Netherlands Foundation for Scientific Research NWO.

## 2 THE SIBARITIDE

The Sibaritide is an alluvial plain on the Gulf of Taranto (part of the Ionian Sea), bounded on the landward side by the Pollino massif (to the north) and the Sila mountain range (to the south). It is named after the ancient Greek colony of Sybaris, which lies in the approximate centre of its coastline. Since, on the one hand, its history of settlement and land use has been largely determined by the possibilities afforded by the physical and natural environment and, on the other, its archaeological record has been conditioned (through the medium of recent land use and land cover) by that same environment, a brief review of the geology, climate, and land use of the study area will be given here.

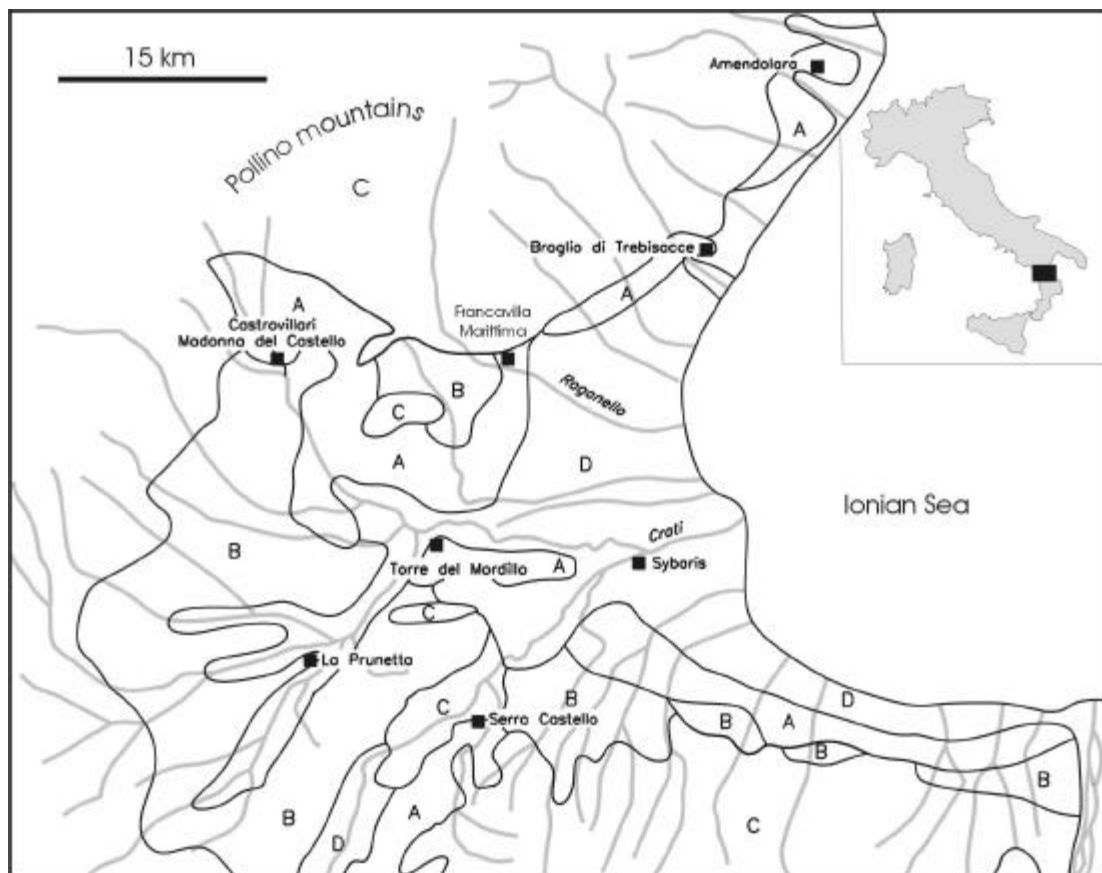


Figure 1 - Major landscape units of the Sibaritide. The coastal and alluvial plains (D) are surrounded by terraced (A) and non-terraced (B) marine and fluvial sands and conglomerates which merge into the lower slopes of the Pollino and Sila ranges (C)

## GEOLOGY

The Sibaritide is a roughly triangular coastal lowland, formed mainly in the Quaternary by the accumulation of erosion products from the Pollino mountain range to the north and the Sila mountains to the south. A series of stepped fossil coastlines, up to an altitude of several hundred meters above the present sea level, can be recognised in these loose sediments and conglomerates. Each is represented by a relatively steeply sloping 'cliff' and a weakly sloping (5%) fan-like 'terrace'. These stepped coastlines possibly were the result of the interplay of tectonic uplift of the area and changing sea levels due to



climate changes in the Quaternary. Fluvial erosion and deposition must have accompanied these changes in climate through changes in vegetation cover, river regime and sea level. As vegetation cover increased at the onset of the Holocene, the rate at which sediment was transported must have slowed down. However, the sedimentation rate in the coastal plain could still have been considerable in human terms, and the alluvial deposition of several meters of sediments could easily have changed local hydrogeography. Erosion in the hinterland and sedimentation in the coastal lowlands are ongoing processes, though now mostly as a consequence of violent winter storms. Their effects, however, have in historic times been minimised by regulatory works such as river bank reinforcements.

Given the very dynamic geology of the Sibaritide, in which for example the Greek colony at Sybaris lies below 6 to 8 meters of alluvial deposits, the archaeological record of the plain can only be interpreted with reference to palaeo-geographical reconstructions. However, the late Holocene deposits are generally too thick for a manual auguring programme to succeed, although the mechanical augerings taken in the course of the 1960s search for Sybaris demonstrate that a dedicated coring program is not impossible (Rainey & Lericci 1967)<sup>2</sup>. Turning to the mountainous inland parts of the Sibaritide, geomorphology and land use are such that surveys of large contiguous areas are impossible. These two zones are therefore generally unsuitable for survey, and the opportunistic study of available sections is the only low-budget option open to researchers. The location of our survey transect across the transitional zone, consisting mainly of the aforementioned marine and fluvial terraces of the Raganello river, was therefore largely determined by the geo-morphological structure of the region. However, as will be made clear below, there were other archaeological reasons to concentrate research in this zone as well.

The legend of the most recent detailed geological map of the area (CGC 1969) allows us to establish that there are four main formations in the study transect. From lowest to highest these are:

- 1) alluvial deposits held in place by vegetation or artificial works; morphologically, these consist of a single alluvial fan emanating from the Raganello valley;
- 2) yellow-red sands and pebbly sands associated with conglomerates consisting of well-cemented rounded pebbles; this formation includes clayey intercalations and, locally, banks of yellow-green clays and silts; morphologically the formation consists of three terrace levels. The formation is highly permeable but can resist erosion well locally, depending on the degree of cementation of the deposits;
- 3) grey-blue clays, often intercalated with sand lenses, and conglomerate sands. This formation occurs only in one area near Lauropoli, is easily eroded and is prone to slumping especially where sandy layers abound; the permeability of the deposits is generally low; and
- 4) well-cemented coarsely stratified conglomerates consisting of large calcareous pebbles and rounded sandstones, on occasion of pebbly or large-grained sands, locally with silty or clayey lenses. With a generally high permeability, the local sensitivity to erosion of this formation depends on its degree of cementation.

#### CLIMATE AND LAND USE / LAND COVER

A fairly detailed discussion of the current climate and land use of the Sibaritide can be found in D'Angelo and Oràzie Vallino (1994:785-92), who note that the climate of the terraces and foothills is more pleasant than that of the coastal plain, with more frequent rains because of the surrounding mountain, and less oppressive heat in the summer and autumn because of the wind and altitude. The highland is even more wet and cool, and is suitable for transhumance in summer. The larger part of the survey transect nowadays is given over to arable land and a mixture of old and new olive groves, the latter giving rise to extensive soil disturbance (deep ploughing, levelling) and cultivation of previously marginal zones

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<sup>2</sup> A recent manual auguring program in the plain, to depths of up to 7.5 m, has obtained absolute (radiocarbon) dates of up to 2100 BP for peaty layers, providing *post quem* dates for the more recent sedimentation phases (pers. Comm. Jan Delvigne).

(especially steep slopes). The arable is apparently used for grain crops and, in at least one recorded case, maize for which a previous vineyard had recently been uprooted. Other lesser types of land use in the survey zone include grassland, a rubbish dump, and small almond groves, but a considerable amount of land especially in and around the dry gullies is still unused and covered in the local thorny *macchia*. The prevalence of the latter increases with elevation, whilst the accessibility decreases. A marked contrast exists with the land utilisation types mapped in the early 1950s (CNR 1956a,b); at that time, less intensive forms of agriculture such as olive groves and grassland occurred over larger parts of the survey zone, at the expense of the arable (macchia appears not to have been mapped).

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### 3 RESEARCH HISTORY

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Following the discovery of Sybaris and its Hellenistic and Roman successor towns through the combined efforts of the University of Pennsylvania Museum and the Lerici foundation (Lerici 1960: 303-337, Rainey & Lerici 1967, Rainey 1969: 261-273), an approximately 21 by 24 km (500 km<sup>2</sup>) area<sup>3</sup> in the centre of the region was surveyed by a team under the direction of the young Lorenzo Quilici, who is now a senior professor at the University of Bologna. Quilici aimed both to provide a context for the excavations starting at Sybaris in 1969 and to record surface archaeology in advance of land development schemes funded by the Italian *Cassa per il Mezzogiorno* (De Rossi et al. 1969:147). In what follows we shall refer to this survey, for brevity's sake, as the 'Quilici survey', and to its results as the 'Quilici data set'. Following their desktop study of the records held by the Soprintendenza archeologica della Calabria, the study area was divided into three zones, each 'topographically' surveyed by one or two members of the team. In addition to revisiting and evaluating the known sites, many new sites and monuments were discovered as well. The results were recorded on a total of 858 forms and 23 sheets of the 1:10,000 map series published by the 'Cassa per il Mezzogiorno', but were considerably condensed for publication. The whereabouts of the original survey archive are currently unknown. The nearly 800 sites of archaeological interest collected from documented evidence or recorded in the field by this team still provide the bulk of the archaeological record for the region - later additions being of a piecemeal nature - and are therefore the primary subject of the study reported here (see figure 2).

Additional work on the protohistoric settlement history of the Sibaritide was published by the excavator of Broglio di Trebisacce, Renato Peroni, based on a series of surveys conducted since 1979 by the University of Rome in conjunction with the Superintendency for Calabria (Bergonzi et al. 1982; Peroni 1994; Peroni & Trucco 1994)<sup>4</sup>. By contrast, very little primary research has been done on either the classical and Hellenistic Greek period, or the subsequent late Republican and Imperial Roman period in the Sibaritide outside of Sybaris itself; here we must rely on the general literature regarding Magna Graecia and the Roman Empire. Since 1991, the Groningen Institute of Archaeology has been involved in excavations at the protohistoric/Archaic hilltop sanctuary of Timpone della Motta and its settlement (Attema et al. 1998). These excavations have given rise to largely unpublished preliminary and exploratory surveys in the immediate surroundings of the Timpone Motta, extending on occasion to neighbouring Monte Sellaro (Feiken & Weterings 1998) and further along the footslopes towards Broglio di Trebisacce (Haagsma 1996).

In 1994, Haagsma and Delvigne conducted unsystematic field checks on settlement sites identified by the Quilici survey between the Timpone Motta and Broglio (Haagsma & Delvigne, unpublished notes). These

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<sup>3</sup> The study area corresponds to the following (partial) sheets of the IGM 1:25,000 map series, 1958 edition: 221 II NE & SE, 222 III NO & SO, the eastern half of 221 II NO & SO, the north-eastern quadrant of 229 I NE, and just over the northern half of 229 I NO and 230 IV NO. This area is bounded by the following co-ordinates - North: 4410000; South: 4386000; East: 2650000; West: 2628000.

<sup>4</sup> Although this is not clearly stated in the published accounts, it appears that these surveys were largely limited to the *fascia collinara* (foothill zone), and were intended to locate protohistoric settlements similar to those at Amendolara, Francavilla Marittima, and Torre Mordillo.

revealed that the lowest-lying of the marine terraces were already settled in the Middle Bronze Age while the upper parts of the coastal plain were not; a Late Bronze Age site was found on the Timpa del Castello, a rocky outcrop above the present village of Francavilla Marittima<sup>5</sup>. Their survey yielded no identifiable Iron Age or Roman material, but did locate some of the 6<sup>th</sup> century BC Archaic impasto

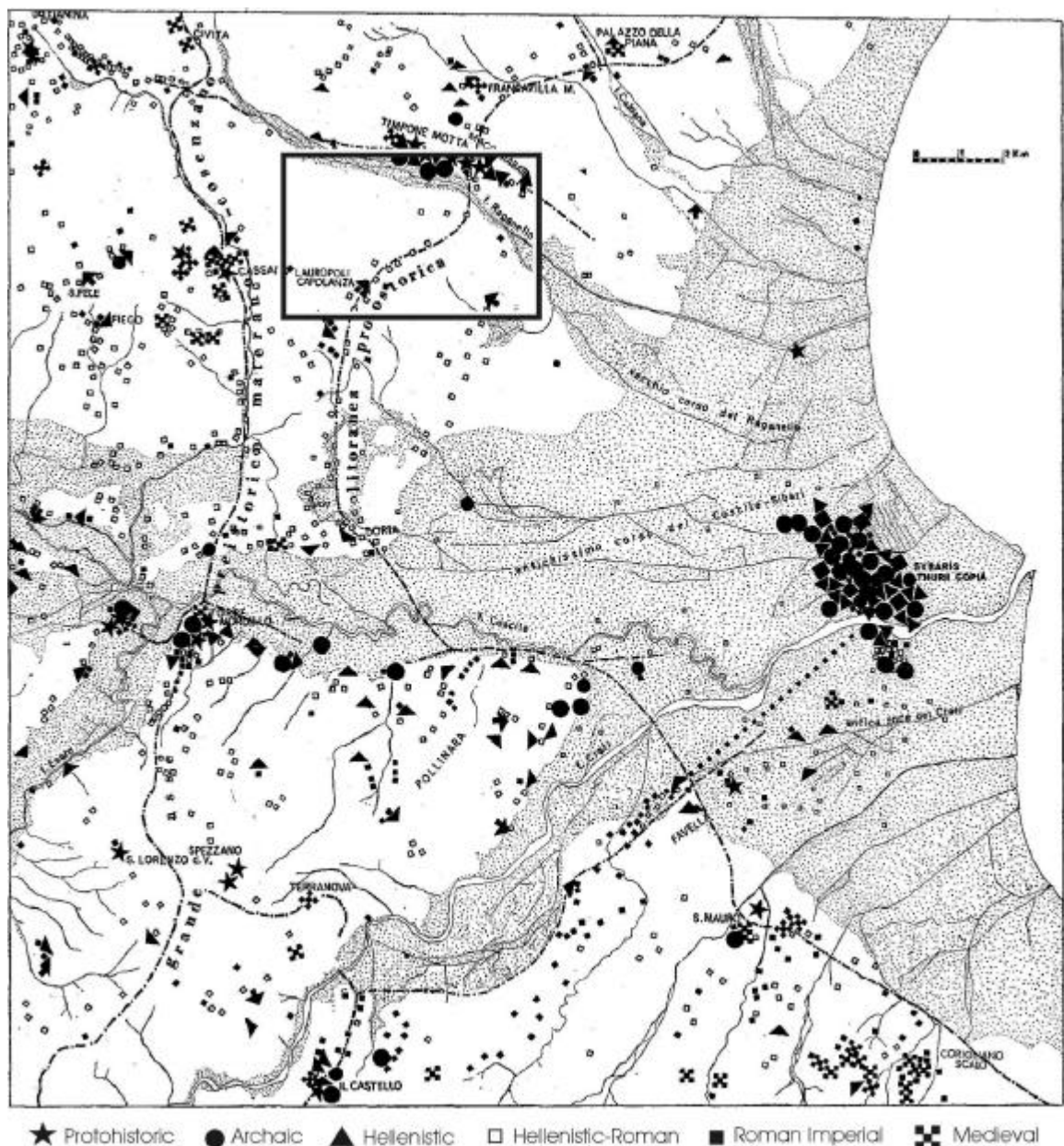


Figure 2 - Distribution of settlements by period from the Quilici survey, after De Rossi et al. 1969, fig 3. Dithered areas: alluvial deposits. The rectangle indicates the area in which The RPC survey took place.

<sup>5</sup> The terminology used in this paper is the 'early' one advocated by Peroni, in which protohistory includes the MBA to IA periods, and history begins with the early Greek colonisations of the 7<sup>th</sup> and 6<sup>th</sup> centuries BC. A more conservative chronology would have protohistory begin with the late Iron Age (8<sup>th</sup> century BC), and the historic period with the late Classical and Hellenistic historians of the 5<sup>th</sup> and 4<sup>th</sup> c BC.

missing from the earlier Quilici survey results. Based on this work Haagsma (1996) suggested that Roman intensive land use may have avoided the foothills and may have been concentrated in the coastal plain. In 1995, and again in 1998, several small field surveys were conducted by students of Kleibrink in settlement and cemetery zones around the foot of the

Timpone Motta. The 1995 survey by Kleibrink and Waterbolk (reported in Haagsma 1996) found a lot of material then interpreted as having been “washed off the Timpone”, but only one small Archaic site; Haagsma and Attema also located a 6<sup>th</sup> century wall segment and kilns associated with a settlement on the lowest plateau of the Timpone della Motta. A subsequent reassessment of the stored material from this survey by Attema and De Haas resulted in the definition of several new sites, including the Archaic/Classical extension to the Iron Age cemetery of Macchiabate belonging to the settlement on the Timpone della Motta (De Haas 2001:18-19).

Despite covering only very small areas and few sites, these surveys provide significant additional information in the form of evidence for periods 'missing' from the Quilici data set, such as the Archaic (6<sup>th</sup> century BC), and for continuity and change in the processes of centralisation and acculturation between the indigenous Oenotrians and the Greek colonists.

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#### 4            P A T T E R N S   A N D   B I A S E S

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The interpretation of regional archaeological records in terms of a history of settlement and landscape must be informed by an assessment of the biases that might conceal or produce patterning in those records. A cursory look at the geological map of the Sibaritide shows that alluviation of the coastal plain must have been a factor of major significance, resulting in an almost total lack of find spots below a quota of 25 m asl and in the alluvial plains of the Crati and Coscile rivers extending into the hinterland (dithered areas in Figure 2). Other factors which previous studies have suggested to be *a priori* causes of significant biases in the archaeological record are: the land use and land cover (abbreviated in what follows to 'LULC') at the time of the survey, the accessibility given the contemporary infrastructure, and the selectivity inherent in the methodology employed for the survey.

Accordingly, the main aim of the SIBA'00 survey campaign has been to assess the influence these factors had on the quality of the extant archaeological record, that is, primarily of the Quilici data set. Since we were unsuccessful in obtaining the necessary information either from the archives of the Soprintendenza archeologica of Calabria or from Lorenzo Quilici himself, this assessment had to be obtained through a combination of targeted desktop and field studies.

In order to assess the influence of land use / land cover around the time the Quilici survey took place, a land utilisation map depicting the situation of the early 1950's at a scale of 1:200,000 was digitised and georeferenced (CNR 1956a,b)<sup>6</sup>. This map shows that the Sibaritide plain was dominated at that time by arable (*seminativo asciutto*) but that a fair amount of grazing land (*pascolo ed incolto prodottivo*) was also present; olive groves and arable dominated the foothills (to which fruit- and vineyards may be added especially in the area around the town of Cassano allo Ionio); while the higher slopes of the Pollino were mostly down to wood- and grazing land.

The frequency of Quilici sites with regard to land use was tested for deviations from randomness, using the  $\chi^2$  - test after removing all alluvial areas below 25m ASL. Table 1a lists the preliminary results of this

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<sup>6</sup> Georeferencing is the procedure whereby digital map data are tied to an area of the Earth's surface by specifying the map projection and co-ordinate system. Here, the Gauss-Boaga projection and the Italian national co-ordinate grid according to European Datum 1940 are being used.

test, which indicate that there is a strong correlation between land use and site density<sup>7</sup>. As we can see, the frequency of sites in woodland (cats 13 and 14 combined) is low with only 9 observed sites where 22 would have been expected given that 3.3 percent of the study area is covered in woodland. Similarly, 52 observed sites in mixed vineyard-olive grove (cat 9) against an expected number of 24 represents a significant deviation from randomness. Of the land use types that occur most frequently, dry arable with trees (cat 2) is slightly favoured with 56 sites against an expected 39, while productive grass- and uncultivated lands (cat 19) is slightly avoided with 75 sites against an expected 103. However, in order to satisfy all of the requirements for this test, some land use types must be grouped together so that the expected number of sites per category is less than 5 in less than 20% of categories (see Figure 3).

Site Characteristics		% cover	Expected sites	Actual sites	Chi square
(0)	no data			85	
(1)	Seminativo (asciutto)	46.4	309.1	325	0.817
(2)	Seminativo arborato (asciutto)	5.9	39.1	56	7.348
(3)	Seminativo irriguo	0.6	4.2	4	0.010
(4)	Seminativo arborato irriguo	0.5	3.3	0	3.318
(7)	Vigneto	2.1	13.8	12	0.231
(8)	Uliveto	20.5	136.8	122	1.597
(9)	Vigneto-Uliveto	3.5	23.6	52	34.225
(10)	Agrumeto	0.3	2.0	2	0.000
(11)	Frutteto (frutta polposa)	0.1	0.5	0	0.494
(13)	Bosco ceduo	1.1	7.2	1	5.387
(14)	Bosco d'alto fusto	2.2	14.7	8	3.042
(19)	Pascolo ed incolto produttivo	15.5	102.9	75	7.568
(20)	Sterile	0.2	1.2	0	1.240
(21)	Insedimenti ed altre forme	0.8	5.2	9	2.854
(99)	Acque	0.4	2.4	0	2.449
Totals		100.0	666.0	666	70.579

Site Characteristics		% cover	Expected sites	Actual sites	Chi square
(0)	no data			85	
(1 & 2)	Seminativo asciutto	52.6	350.1	381	2.727
(3 & 4)	Seminativo irriguo	1.1	7.6	4	1.683
(7)	Vigneto	2.1	13.9	12	0.250
(8)	Uliveto	20.7	137.5	122	1.756
(9)	Vigneto-Uliveto	3.6	23.7	52	33.721
(10 & 11)	Agrumeto / Frutteto	0.4	2.5	2	0.094
(13 & 14)	Bosco	3.3	22.1	9	7.727
(19)	Pascolo ed incolto produttivo	15.5	103.5	75	7.838
(21)	Insedimenti ed altre forme	0.8	5.2	9	2.795
Totals		100.0	666.0	666	58.591

Table 1: Results of a  $\chi^2$  test of 666 Quilici sites against 1956 land utilisation types. 751 sites in region of 350 km<sup>2</sup>. A) Raw results, B) results after reclassification

The results of a second  $\chi^2$  - test (Table 1b) confirm that land use and site location correlate very significantly (far above the 0.1% level of significance). However, they also show that none of the three most frequent land use types (dry arable, olive groves, and rough grazing lands) has had a dramatically positive or negative influence on the number of sites discovered. Interpretation of these results is not straightforward, not just because land use at the time of the Quilici survey may have been significantly different from the land use that was mapped in 1956, but also because the clustered nature of

<sup>7</sup> The total  $\chi^2$  of 71 at 14 degrees of freedom is significant at the .001 level.

archaeological site records makes them notoriously subject to spatial autocorrelation effects<sup>8</sup>. As an example of the former, it seems *a priori* unlikely that the Quilici team could have observed even as many

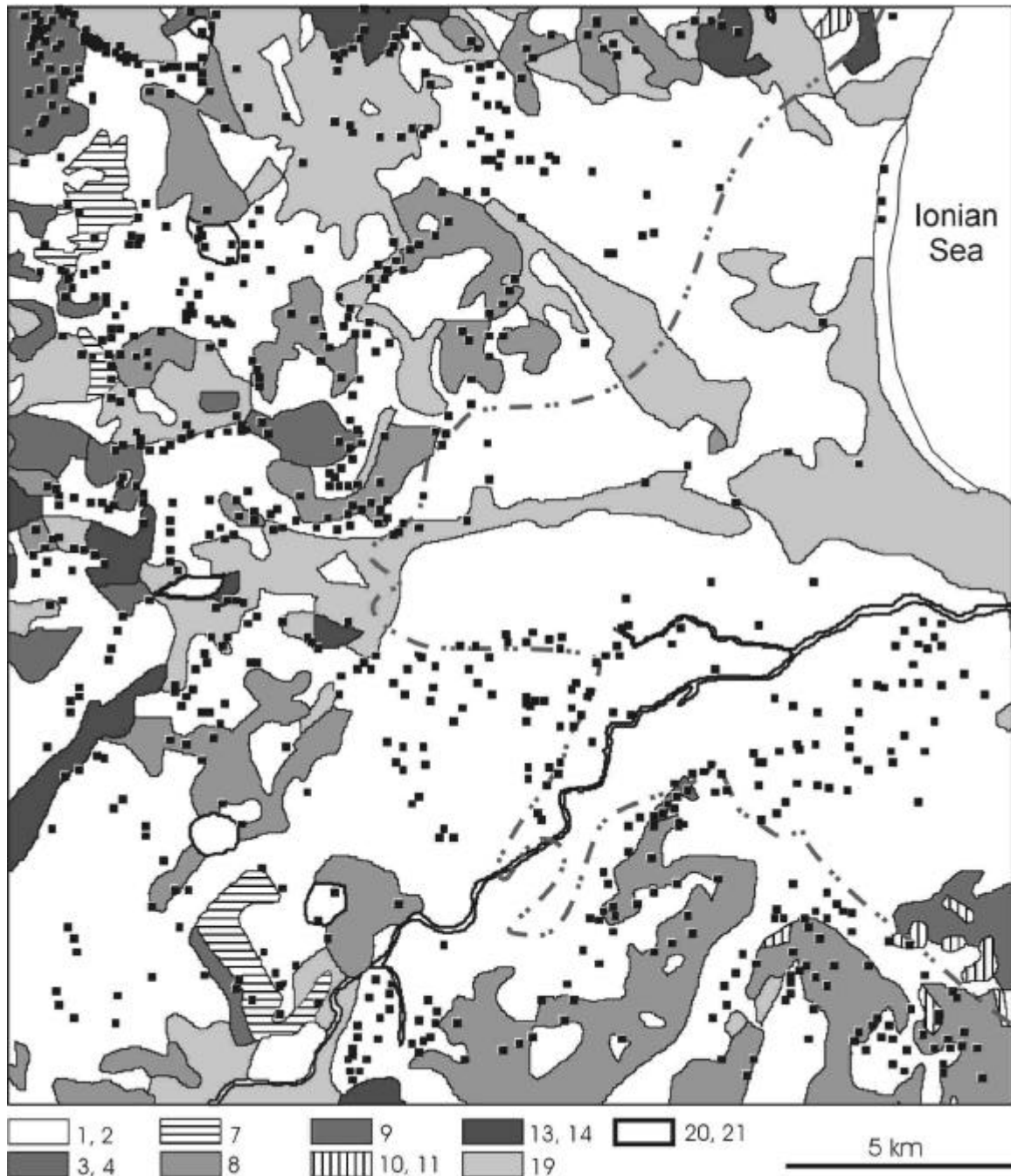


Figure 3 - Distribution of Quilici sites across 1956 land utilization types. For Legend, see table 1B. Land below 25 m asl is indicated by dashed line.

<sup>8</sup> Spatial autocorrelation refers to the fact that observations made in close proximity to each other tend to have similar geographical attributes; thus land use observations made at two archaeological sites separated by only 100m have a much higher chance of turning out to be identical than if the sites were separated by a distance of 1000m.

as 75 sites under the very adverse visibility conditions typical of grass- and uncultivated land (see Table 1B, cat 19). And indeed it may not be coincidental that the Quilici sites falling within the SIBA'00 survey transect (see section 7 below) appear to cluster within one such zone of grass- and uncultivated land. Perhaps these areas had already been brought under the plough by the time the Quilici team surveyed the area in the late 1960s. Access to the original survey records will play a very important role in assessing the significance of the land use changes that may have taken place in the 1960s.

Quilici himself adduced an example of the latter effect, interpreting one dense cluster of sites located near the town of Eianina as part of a large roadside settlement within the territory of the Roman colony of *Interamnium* (De Rossi et al. 1969:9-10)<sup>9</sup>. Figure 3 shows the land use around the cluster to be the otherwise rare category of mixed vine- and olive yards (Table 1B, cat 9). In combination with the fact that neither vineyards nor olive groves in monoculture (cats 7 and 8) give rise to anything like the observed high frequency of archaeological site locations in the mixed unit, the high frequency must be caused by the spatial clustering of the sites rather than by particularly favourable land use at the time of the survey - whatever that may turn out to have been.

The distinct linear clustering of sites, which Quilici himself interpreted as an indication of the existence of 'villages' along proto- and early historic routes, could also be caused by biases in the Quilici survey itself. With a survey universe (excluding the coastal plain) of some 350 km<sup>2</sup> it is clear that the survey team could not possibly have systematically covered everything. It would instead have had to focus on those areas that were most likely (from previous finds) to contain sites and which could be reached within a reasonable amount of time by road or track. Figure 4 again shows the Quilici data set, this time against the background of a relief map, and in relation to towns and metalled and semi-metalled roads digitised off the IGM 25V map series. The proximity of sites to infrastructure seems fairly straightforward in some areas, especially if we remember that minor tracks were not digitised.

These preliminary studies therefore indicate that the potential of further bias modelling for the Quilici data set must be explored when the original research archive has been located. The second method for assessing biases in the Quilici data set is through field studies designed to detect archaeological materials present in areas, or from periods, that Quilici and his team might have ignored or been unable to detect. These studies are the subject of the next section.

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## 5 THE SURVEY: APPROACHES

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The approach taken by us was to select a representative transect through the transitional zone between the coastal plain and its mountainous hinterland, consisting of marine and fluvial terraces (the 1<sup>st</sup> and 2<sup>nd</sup> geological formations discussed above), and to see how the recorded sizes, locations, interpretations and dating of the sites mapped by Quilici and his team compare with the current archaeological surface record. The transect was approximately 6 km long and 1.5 km wide and located between the valley of the Raganello river and the modern town of Lauropoli (figure 5). The 2<sup>nd</sup> geological formation, which is morphologically divided into four distinct levels or 'terraces', is today used for the most intensive forms of agricultural exploitation, consisting of mostly arable fields but with large sections given over to olive culture; due to the extremely restricted surface visibility in the other three units, our survey took place almost entirely within this unit. Archaeological sites mapped by Quilici and his team are also exclusive to this unit.

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<sup>9</sup> Quilici identified the modern town of Castrovillari, on the upper reaches of the Coscile river, with *Interamnium*; but the distances, of 13 and 8 miles respectively, provided by the Antonine Itineraries and the *Tabula Peutingeriana* for the stretches of the *Via Popilia* between *Muranum* (modern Murano), *Interamnium*, and *Taurasia* (modern Tarsia) make it unlikely that this identification is correct. They instead indicate a location in the middle Coscile valley.



*Figure 4 - Association of the Quilici data set (dots) with modern accessibility circa 1956 (paved roads only). 25m Elevation contour indicated by dashed line.*

The SIBA'00 survey was conducted using two teams working independently and studying the same general area at two different spatial scales. The first team used methods developed in recent years for a high-intensity survey of all available fields within a 5 by 1 km transect running parallel to the Raganello river, and covering all four main geomorphologic units (fluvio-marine terraces). In this survey, agricultural fields were subdivided by pacing into units approximately 50 by 50 m (0.25 hectares) in size, and these were walked at 10 m intervals, with all manmade materials collected except those that were of obviously recent date. Further samples were collected if circumstances (such as an increase in finds density) warranted. In order to assess the effect of differential visibility on the recovery rates, five factors affecting the recovery of archaeological materials were recorded separately for each collection unit, on a scale of 1 to 5: stoniness, shadiness, vegetation cover, tillage/dust, and amount of recent material on the surface; an independent estimate of the total visibility, again on a scale of 1 to 5, was also made.



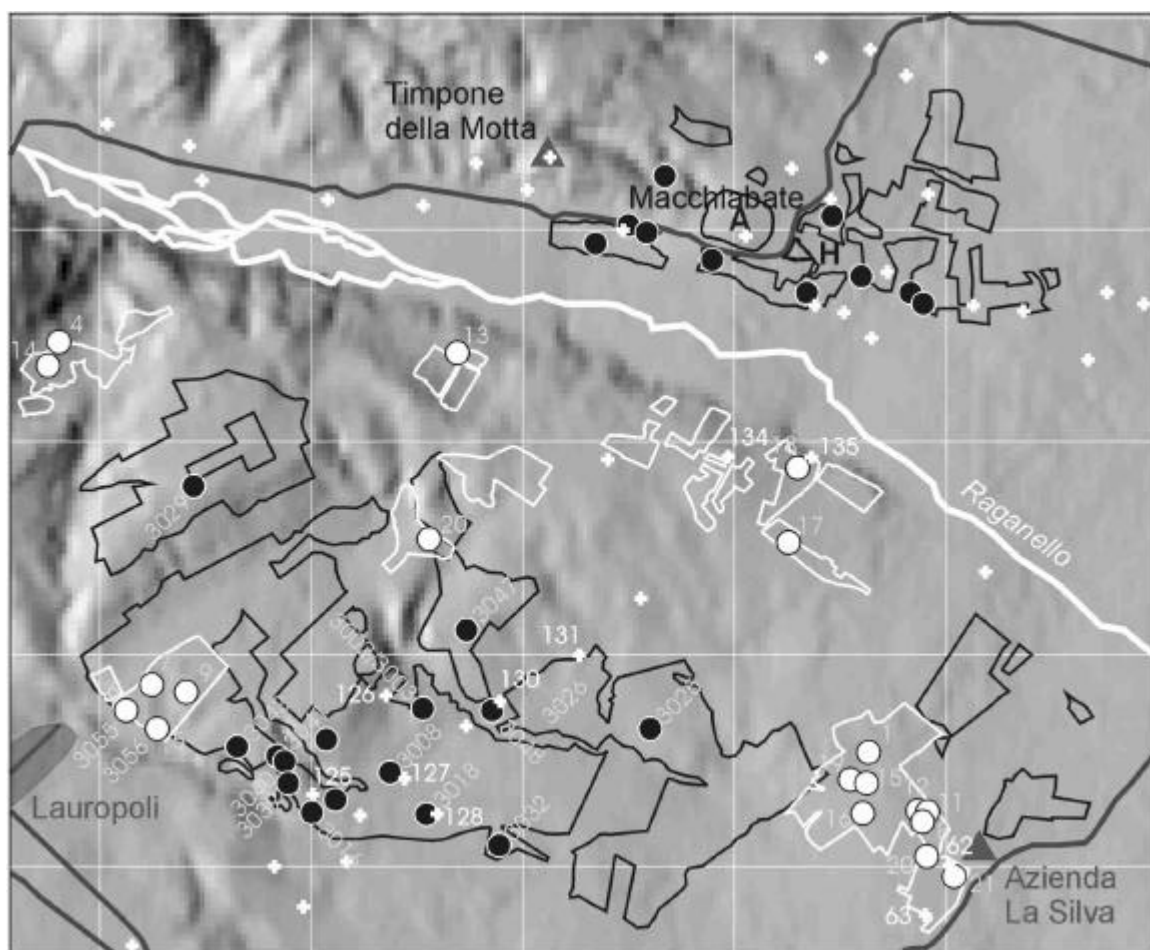


Figure 5 - The SIBA2000 fieldwork transect (excluding Monte S Nicola), with extensive (black) and intensive (white) survey areas. Plus signs: Quilici sites; circles: RPC sites and scatters.

The second team conducted a much more extensive and site-oriented survey in an area directly neighbouring the intensive survey transect, and overlapping it in several parts in order to provide material for comparing the two. The main aim of this survey was to check whether the *broad* settlement patterns mapped by Quilici and his team were upheld, by locating and describing any ‘sites’ occurring in the area; it therefore used agricultural fields as its collection units, and a walker interval of 15m. Once a site had been identified by this team, a more detailed survey was made at 5m intervals in order to map finds density contours and make diagnostic collections.

Only two forms were used during the survey: a Unit Form to record properties of the collection unit including bias factors and number, type, and summary contents of the samples (termed ‘Bags’) collected; and a Bag Form to record the contents of each of these samples. Unique Bag ID’s are formed by sub-numbers from unique Unit ID’s; a water proof ticket with the Bag ID was kept with the finds throughout the processing. This system, developed out of previous administrative systems used at the GIA and AIVU, is described in more detail elsewhere<sup>10</sup>. Mapping of spatial collection units was done using a combination of independent single-receiver GPS measurements and 1:10,000 scaled field maps; again, a more detailed discussion is forthcoming (Ryan & Van Leusen in press).

<sup>10</sup> Van Leusen forthcoming, chapter 8.

## 6 FINDS PROCESSING

Rather than making any decisions about the significance of the finds in the field, the intensive survey team simply collected the finds for processing and interpretation at the survey base. For the purpose of tracking individual finds bags, a simple system of check-boxes was used on the field forms for each collection unit. Processing at the survey base began with washing and drying, after which all finds were classified by Peter Attema according to the system laid out in table 2. Both survey teams together collected some 210 kg of material (some 6000 finds) from 610 collection units, of which 70 kg were classified during processing as largely recent or sub-recent tile/brick (subsequently discarded). Table 2 provides the breakdown of these totals by material category. The column headed '%arch' gives the relative weights per category when considering only pre-modern ceramics (totalling 129.2 kg).

Table 2 - Material categories used in summary classifications of the SIBA'00 survey finds, with preliminary total counts, weights, and percentage by weight of pre-modern ceramics.

Cat	Description	Count	Weight (g)	%arch
1	<i>tile</i>	230	36300	-
1a	coarse tile	144	22955	17.8
1b	depurated antique tile	84	13220	10.2
1d	(sub-) recent tile	2	125	-
2	<i>coarse wares</i>	1208	45321	-
2a	coarse thick ware (pithos)	175	27970	21.6
2b	coarse medium thick ware	942	16820	13.0
2c	coarse thin ware	91	531	0.4
3	<i>Depurated wares</i>	2134	23335	-
3a	depurated orange ware	457	4783	3.7
3b	depurated pale ware	1677	18552	14.4
4	<i>Fine wares</i>	70	718	-
4a	black gloss / banded ware	62	638	0.5
4b	terra sigillata	6	75	0.1
4c	thin painted ware	2	5	0.0
5	<i>Indeterminate wares</i>	2102	91712	-
5a	indeterminate coarse ware	300	8532	6.6
5b	indeterminate depurated ware	396	13567	10.5
5c	indeterminate (sub-) recent ware	1406	69613	-
6	<i>Combed wares</i>	10	140	0.1
6a	hard orange combed ware	2	35	-
6b	hard pale combed ware	8	105	-
	<i>Other wares and materials</i>			-
7	glazed wares	11	225	0.2
8	hard red ware, medium thick	32	485	0.4
9	lithics	10	75	
10	impasto wares	42	730	0.6
13	grumi	72	2625	-
14	glass	5	55	-
15	waster	8	2760	-
16	slag	19	6215	-
	<b>totals</b>	<b>5936</b>	<b>210696</b>	<b>100.1</b>

## SYSTEM OF CLASSIFICATION

The main aim of the classification of ceramic wares used in the SIBA'00 survey was to assign dates and functions to the material found. The classification is based on the macroscopic properties of the ceramics – fabric, inclusions, colour, thickness and morphological characteristics. Since most of the surface

material is very fragmented and abraded, a primary division into three clear-cut ware categories was used:

1. *impasto*, which is the handmade pottery characteristic of the protohistoric periods. It is irregularly fired and often has a burnished surface;
2. coarse wares, which are turned or finished on a wheel and characteristic of the Archaic to Roman periods. They are generally orange firing wares made of a clay with fine to coarse inclusions;
3. depurated wares, which are wheel-turned and either pale- or orange firing and have either a hard or a soft powdery surface. Depending on the clay base and firing characteristics, these wares can be classified into various periods from the late Iron Age to sub-recent times.

Classifications within this primary division are based on characteristics relating to function (e.g. category 1 “tile” is a functional category; category 2a “coarse thick ware” is functionally interpreted by the addition ‘pithos’). Sherds belonging to these broad functional classes are fairly easily identified even in a much-abraded state. The association of certain types of tiles, pithoi and datable pottery sherds such as black gloss and terra sigillata may then indicate the existence of a farmstead at a particular time and place.

#### *Categories 10, 13: Impasto wares and ‘grumi’*

Impasto wares are hand-formed, with coarse temper and varying types of surface finish. In principle they can be classified by form, thickness, finish and decorations into various wares, but the SIBA’00 material allows only a simple division to be made between the well-burnished early to middle Iron Age ware found near Monte San Nicola and the undiagnostic and often abraded sherds of late Iron Age ware found elsewhere. *Grumi* (burnt daub) appears as orange-red low-fired crumbs in ploughed fields and by itself cannot be dated; in association with impasto or dated archaic wares it may be assigned to one of these periods.

#### *Categories 1a, 2a-c, 5a: Coarse wares*

These are coarse wheel-made wares of red firing fabrics containing visible temper, production of which began in the Archaic period and continued through the Hellenistic period. Wares can be classified by form and thickness into tiles, storage, kitchen, and table wares. A further form-based subdivision of coarse wares is envisaged, but must await closer study of the material (cf. Attema et al. 2000, Appendix 1) and comparison with collections from regional excavated contexts<sup>11</sup>. In total, coarse material (cats 1a, 2a-c) makes up almost 53% by weight, and the Hellenistic to Roman material (cats 1b, 3, 4, 5a-b) some 46%. Wheel-turned coarse wares lacking “archaic” characteristics of colour, temper and surface finish may date from the Hellenistic or Roman periods, but cannot be dated independently.

#### *Categories 1b, 3, 5b: Depurated wares*

Depurated tiles and wheel-turned pottery wares are made out of levigated clays, to which temper may be added to achieve specific properties. These wares range in colour from orange to pale buff; different wares and forms may be distinguished on the basis of form and thickness. Roof tiles, which usually have added temper, tend to be preserved in relatively large fragments and can be distinguished by overall shape and rim profile<sup>12</sup>. The remaining depurated material mostly consists of orange or pale firing amphora fragments, and a small amount of ‘fine’ wares which can easily be recognised by their surface treatment, fabric, form, thickness, and decoration. All of these also occur in severely fragmented and/or abraded form and, being undiagnostic, are then assigned to category 5b.

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<sup>11</sup> Subsequent closer inspection and cataloguing of the diagnostic material by scatter during the campaign of September/October 2001 has confirmed the existence of sites with an origin in the (later) archaic period, supporting an early date for the associated coarse wares.

<sup>12</sup> These rim profiles will be the subject of a closer study in the near future.

*Categories 4 and 6: Fine and Combed wares*

The fine wares encountered during the survey consist for the most part of a pale or orange firing depurated clay with a glossy surface decoration of black slip, either (archaic/classical) banded ware or (Hellenistic) black gloss ware. A majority of the sherds had, however, lost most or all of its surface finish; if these could not be identified as a fine ware by form (e.g. “kylix”) they were classified as category 5b “indeterminate depurated ware”. Other fine wares occurring in very small numbers are terra sigillata and an unidentified thin painted ware. Only 10 sherds with a ‘combed’ decoration were found during the survey. The material, which is hard and has either an orange or a pale colour, suggest a late (possibly post-antique) date but no parallels have been found yet. It is expected that further study of categories 4 and 6 will result in a finer typo-chronological division of the material.

*Category 9: Lithics*

No lithics were previously known from the study area, and indeed the SIBA’00 survey collected only a very few, most of which were judged to be probably of natural origin in view of their irregular negatives and retouches<sup>13</sup>. Only three are clearly intentional flakes, one of which is a large white patinated flake whose distal end was intentionally retouched into a scraper. Although no firm date can be given, the Levallois-like technique employed suggests an attribution to the Middle Palaeolithic (however, the piece is atypical). The other two flakes cannot be dated.

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 7 RESULTS
 

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## THE INTENSIVE SURVEY

The intensive survey teams covered some 125 hectares (552 collection units) spread over the four marine-fluvial ‘terraces’ within the survey transect in a total of 121 person/days (inclusive of administration, GPS measurements, etc), for an average of 1 hectares per person/day. This is somewhat slower than the speeds achieved during similar surveys elsewhere (cf. Attema et al. 2001, in press) and was mainly due to the extra time needed to cope with mapping problems. Table 3 and Figure 5 give an overview of the fields covered by the intensive survey.

In order to produce distribution maps by period, the raw counts per material category per collection unit were corrected for unit area, percent coverage, and visibility, using the formula

$$D = N * (100 / C) * (100 / V) / A$$

where D = corrected finds density, N = raw finds count, C = estimated percent coverage, V = estimated percent visibility, and A = Unit area in hectares. It is recognised that this procedure, while producing normalised finds densities expressed in numbers per hectare, tends to exaggerate small density variations where low numbers of finds are involved; appropriate care must therefore be taken when interpreting the distribution maps reproduced here in figure 6.

The distribution of protohistoric material shown in Figure 6A is characterised by small amounts of material in all surveyed fields, generally associated spatially with the major terrace edges. The material tends to consist of undiagnostic impasto pottery, except on the higher terraces near the Monte San Nicola where denser concentrations of more identifiable burnished Bronze Age and Iron Age wares occur. Here the presence of a large protohistoric site (Peroni & Trucco 1994:819-20 site 31) was confirmed.

Table 3 – Preliminary results of the intensive survey, by field

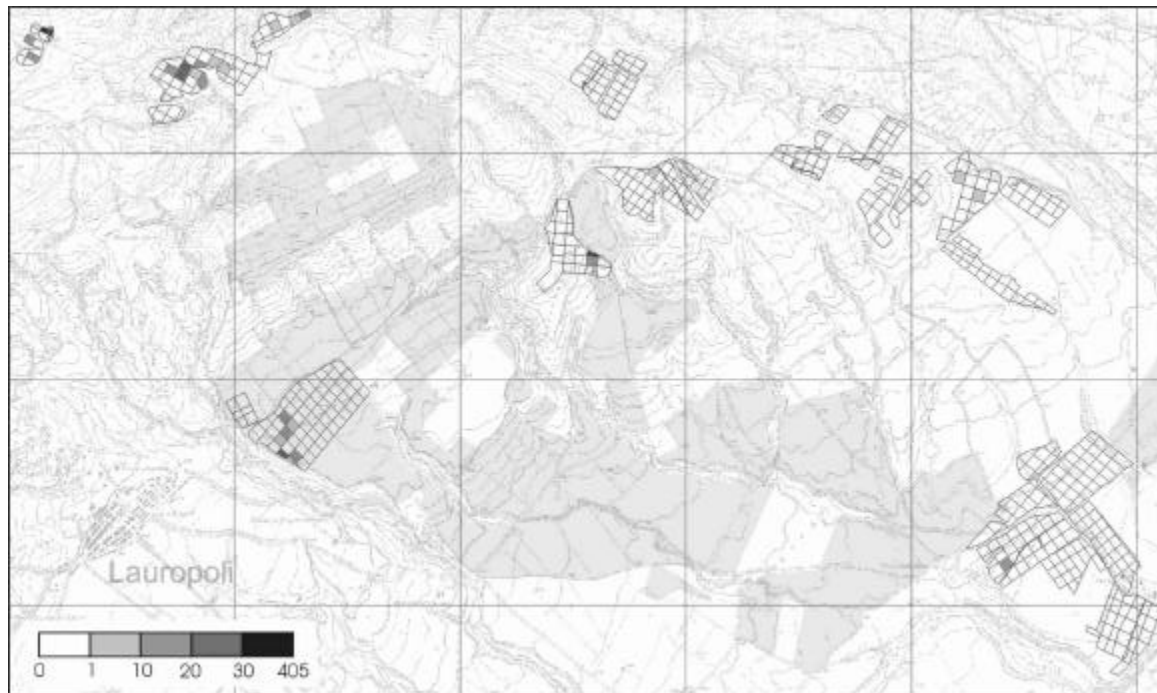
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<sup>13</sup> The nearest Neolithic site is at Favella della Corte, south of the Crati river. The lithics collected by the SIBA2000 survey were studied in April 2001 by Marcel Niekus of ARC (Centrum voor Archeologische Research & Consultancy).

Units	Toponymic	Notes
1001 – 1031	Azienda La Silva West	An old olive grove with stands of oak, cut along the slope by a wide concrete-lined V-shaped ditch and a U-shaped aqueduct (both probably dating to the 1930s). Quilici site 62 ('scatter of Hellenistic-Roman sherds, including BG <sup>14</sup> ') was found again but appears 'smeared out' across a large part of the field; two out of several finds concentrations are sufficiently distinct for individuation (scatter 20 in units 1020-23 and 1030-31, scatter 21 in units 1001-04 and 1009-11). Quilici site 63 ('scatter of Hellenistic-Roman material, including grey ware'), supposedly present at the western edge of this field, could not be found despite specific searching.
1032 – 1058	Azienda La Silva North	Ploughed field. Part of Quilici site 62 was found nearest the Azienda buildings (scatter 20, unit 1045); the rest of field contains one other major (scatter 8, units 1048-9) and two minor finds concentrations (scatter 11, unit 1052; scatter 12, unit 1050). Concentration of recent material in unit 1037.
1059 – 1087	-	Ploughed field; one small site was located (scatter 1, unit 1060)
1088 – 1117	Aloisi Olive grove	Young olive grove, just harrowed; used concrete posts to set out grid; units 1108-9, 1088-9, 1094-7, 1106-7 and 1113-4 were surveyed by team 2 before harrowing; no sites present.
1118 – 1142	Sferra- cavallo	Irregular field; found one small sherd concentration with impasto (scatter 10, unit 1133).
1143 – 1208	-	Large ploughed field just east of Laupoli; steep slopes into valley on two sides; contains four sites (scatter 9, unit 1168; scatter 7, units 1186-7; scatter 5, unit 1202; scatter 6, unit 1207).
2001 – 2036	Aloisi North	2001 – 2022 irregular ploughed field with evidence of deep ploughing; mapped two concentrations of thin wares (scatter 15, unit 2001; scatter 16, units 2005-6), the latter continuing across a recent path into units 2025-7, and further disturbed by works relating to the driveway and garden of the house belonging to Dr Aloisi. 2023 – 2036 were surveyed in a young olive grove before harrowing.
2037 – 2055	-	Irregular ploughed field; units 2038-9 contains a finds concentration (scatter 19) which might be a kiln but also contains recent material; 2049 contains a sub-recent tile kiln.
2055 – 2064	-	Irregular ploughed field; no remarks.
2065 – 2089	Rubbish dump	Elongated ploughed field with unploughed sections; contains a very diffuse scatter of coarse and thin wares in the topmost units (scatter 17, units 2079-81 and 2084-86).
2090 – 2105	-	Ploughed field along Raganello valley; no remarks.
2106 – 2125	-	Irregular ploughed field along Raganello valley with adjoining units along lower terrace slopes; found Quilici site 135 ('scatter of Hellenistic-Roman material, including some large sherds'; is scatter 18, units 2106-8 and 2112-5), some impasto sherds, and off-site material provenient from the next higher terrace.
2126 – 2148	-	Group of irregular ploughed fields along lower edge of terrace; three independent grids were used (for units 2126-35, 2136-7, and 2138-48); finds were concentrated along the north-eastern edge facing the Raganello valley (units 2126-7, 2126/8, 2136), but no distinct concentrations could be defined.
2149 – 2161	-	Irregular ploughed field; no remarks.
2162 – 2177	-	Ploughed field, sloping steeply toward the Raganello valley, plus units adjoining path along top of the slope; found only a sub-recent finds concentration approximately where Quilici site 134 ('diffuse scatter of Hellenistic-Roman material') should have been (unit 2176).
2178 – 2184	-	Some small ploughed fields on slope facing the Raganello valley, with unploughed section in between; no remarks.
2185 – 2234	Rebecca (Masseria Fraschino)	Irregular ploughed fields with steep terrace and gully slopes on their eastern side; no remarks.
2236 – 2268	-	Four ploughed fields on steep slope facing the Raganello valley; located a possibly Bronze Age / Iron Age 'grumi' site on fairly level bottom section of slope (scatter 13, units 2263-4 and 2268).
2270 – 2275	-	Part of a ploughed field, surveyed rather too quickly because of failing light (= low quality). No finds concentrations.
2276 – 2289	-	Two irregular ploughed fields on terrace along Raganello valley; no remarks.
2290 – 2330	-	Three irregular ploughed fields on terrace along Raganello valley; steep slopes on southern edges; located finds concentrations in two fields (scatter 4, unit 2306; scatter 14, units 2312-3 and 2316-7).
2331 – 2344	Monte Nicola S	Three small irregular ploughed fields just below the unnamed hilltop on which stands the radio tower; containing one previously unknown Hellenistic site (scatter 2, unit 2344). Found part of Peroni Bronze Age / Iron Age site 31 on the saddle (scatter 3, units 2332 and 2334) and on the south-east slope of Monte S Nicola (grab sample).

<sup>14</sup> BG = Black Glaze pottery (also termed Black Gloss, the black decorative surface coating is in fact a clay slip).

Coarse (unburnished) protohistoric impasto fabrics are very difficult to find in arable fields under the conditions prevalent in the Sibaritide foothills. Their recovery was made extremely difficult because most fields were full of bits of ploughed-up conglomerate rock of a colour and shape often mimicking potsherds. It is noteworthy that this material tended to be found only when surveyors were sitting down or were looking especially for it; we can therefore not be certain that the map shown in figure 6A is an accurate reflection of the distribution of this material.



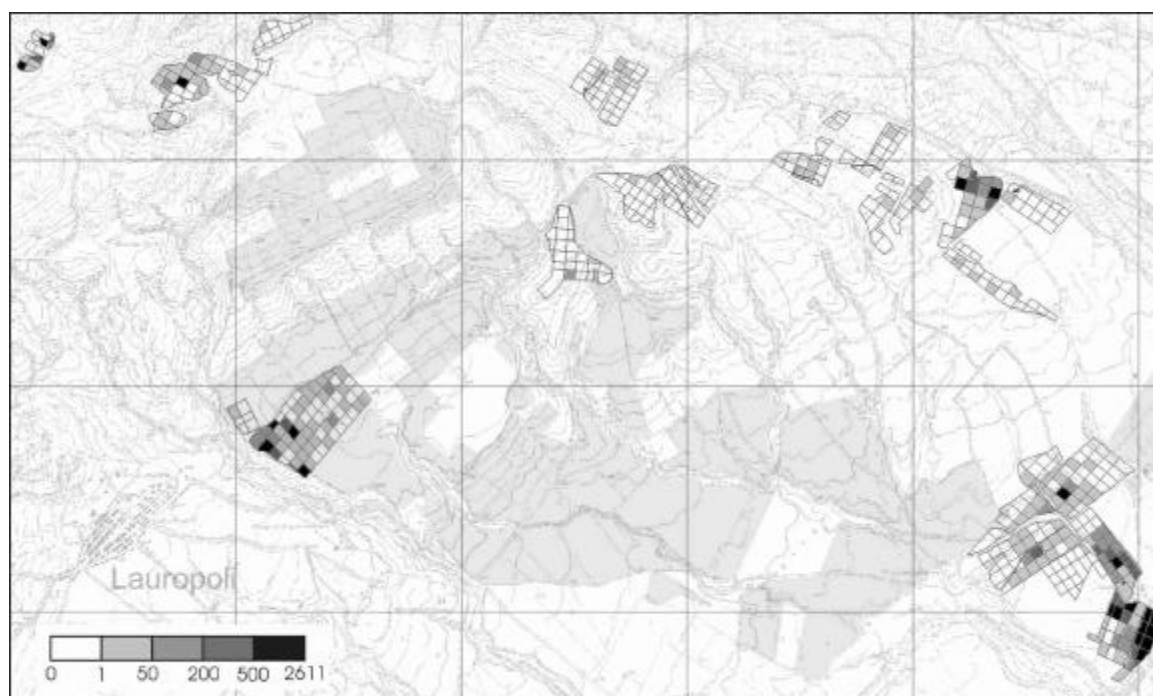
6a.

For both the coarse (figure 6B) and the Hellenistic-Roman material (figure 6C), the corrected finds distributions show a quite intensive use of all terrace edges (including minor 'internal' ones), except perhaps those that are very small or inaccessible. The two distribution patterns themselves are very similar, any differences being quantitative rather than qualitative: no concentrations of coarse wares occur away from concentrations of Hellenistic-Roman material. It therefore remains to be determined whether the coarse wares should be interpreted as evidence for an early (6<sup>th</sup> – 4<sup>th</sup> century BC) settlement expansion followed by a Hellenistic phase of continuity, or as just another category of Hellenistic wares. In the latter case, little direct evidence for Archaic-Classical rural settlement remains, and the first substantial rural expansion in the foothills could have occurred as late as the late fourth – third century BC. Among the fine wares, one small group of 'banded ware' kylix fragments has already been tentatively assigned to the Archaic period on the basis of comparable material present in the museum at Amendolara, but this needs further study.

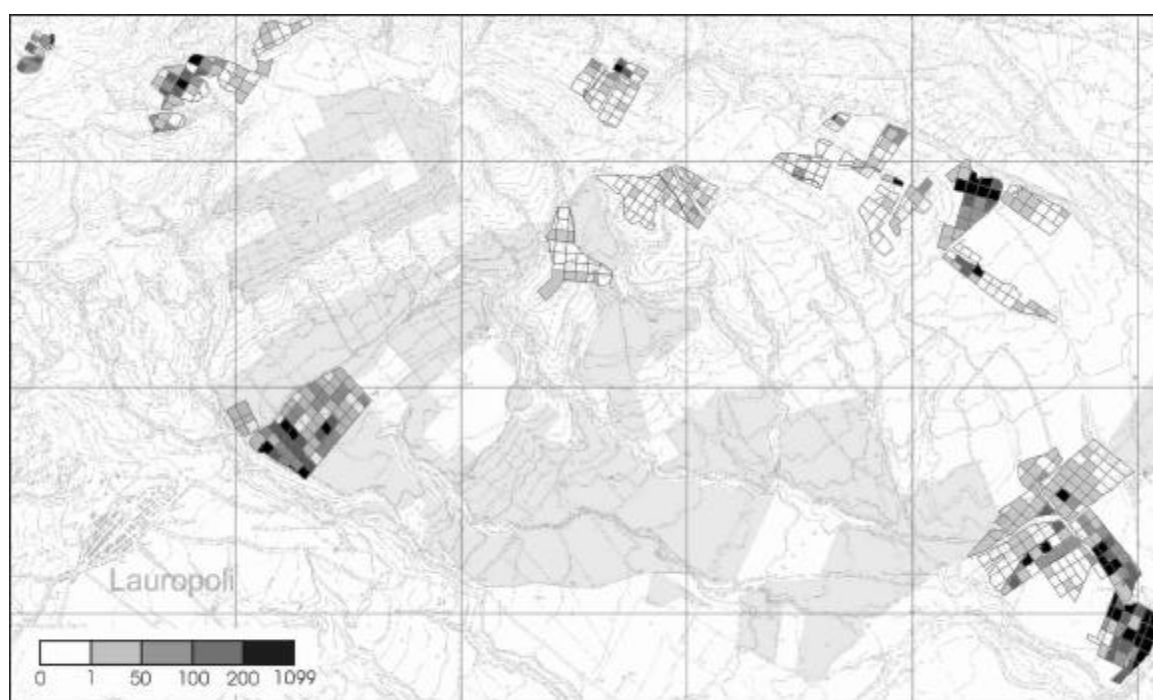
It may be noted further that, *contra* Quilici, the Hellenistic to Roman material in the survey transect consistently points to dates in the range 325 BC – AD 100, and only rarely into the later Imperial period. This contradicts received wisdom regarding the historic settlement dynamics in Calabria, referred to in section 9.

#### THE EXTENSIVE SURVEY

The extensive survey team covered some 50 agricultural fields (315 hectares) in an estimated 38 person/days, for an average of 8.3 hectares per person/day. Table 4 lists and describes the sites located by this team and the sites mapped by Quilici in the same area.



6b



6c

Figure 6 - Corrected finds density distributions resulting from the intensive survey. Grid spacing: 1 km. A: protohistoric period (cats 10, 13). B: "Archaic" material (cats 1a, 2a-c). C: Hellenistic to Roman material (cats 1b, 3, 4, 5a-b).

Table 4 – Site list for the extensive survey.

RPC ID	Quil ID	Max N/m <sup>2</sup>	Area (m)	Notes
3002	126?	50	5 x 5	These two concentrations possibly constitute a new site, but are more probably related to Quilici 126 (a 'Hellenistic-Roman scatter containing tile frs'). They contain both "archaic" coarse ware and BG ring bases, pithos sherds, and tiles, including one half of a terracotta mould for votive feet. Site 'halo' extends into fields 3004/3010, including Hellenistic imbrex, but mostly consisting of tiles with many quartz inclusions. Nearby in this same field is a large dump of stones, presumably ploughed up locally.
3003		30	5 x 4	
3008	127	10	10 x 15	Site contains "archaic" coarse tile and pottery, Hellenistic and Republican roof tile, and 4 <sup>th</sup> -3 <sup>rd</sup> c BC pithos. Separate from this in field 3007, but concentrated along the modern road bed, is some off-site material: rim and handle of a late 4 <sup>th</sup> c BC skyphos, and a loom weight. Logged by Quilici as a 'diffuse scatter of Hellenistic-Roman material'.
3016	125	35	50 x 30	Scatter of coarse "archaic" ware and Hellenistic material located on terrace edge overlooking the Franceschiello valley, partly obscured by modern path and rubbish dump: BG pottery, pithos, foot of 3 <sup>rd</sup> c BC kantharos, early 2 <sup>nd</sup> c plate. Site 'halo', extending over 100m into field 3015, contains some concentrations of cobbles: Hellenistic-Roman material, material of late 4 <sup>th</sup> c BC BG cup and Corinthian B amphora, 2 <sup>nd</sup> -3 <sup>rd</sup> c AD 'African' TS <sup>15</sup> , and a coarse ware loom weight. Logged by Quilici as a 'large dense Hellenistic-Roman scatter including BG'.
3018	128	35	50 x 75	Large scatter containing tile, storage pots, coarse and fine wares. Located on an elevated portion of the terrain cut by a modern field boundary. It is very homogeneous in fine wares and contains a/o several 1 <sup>st</sup> c AD Roman TS frs (CFTS form 21.3), some with plastic decoration, and a column fragment. Diffuse material occurs off-site in fields 3017 and 3019; dump of stones, tile and dolium frs in eastern tip of 3019. Logged by Quilici as a 'Hellenistic-Roman scatter and villa with floor in opus spicatum (information from farmers)'.
3025	New	5	15 x 15	Scatter of Hellenistic material, dolium, BG, loom weight, all material of similar fabric; also a number of river cobbles present.
3026	131?	-	75 x 125	Large area of diffuse finds in northern corner of field; mostly amphora, but also containing 4 <sup>th</sup> - 3 <sup>rd</sup> c BC Corinthian material, and one loom weight. Note: not intensively walked (perhaps off-site). Identification with Quilici 131 (a 'diffuse Hellenistic-Roman scatter containing an amphora handle'), which could not be found in the neighbouring field 3027, rests on the assumption that the latter may have been inaccurately mapped; the core of site 3026 is probably located in the neighbouring field to the north (not surveyed).
3029	New	2	2 x 2	Small scatter of Hellenistic tile, coarse and depurated wares.
3032	New	25	30 x 20	Vitrified kiln material, wasters, a 2 <sup>nd</sup> c BC amphora spike and neck of a jar in <i>pasta grigia</i> , and 2 <sup>nd</sup> - 1 <sup>st</sup> c BC Roman roof tiles.
3039	New	5 - 10	10 x 20	Scatter located on edge of terrace overlooking the Franceschiello valley. Material of "archaic" coarse ware, Hellenistic cooking pots, Roman roof tiles, possibly TS.
3040	New	-	10 x 10	Site contains a great many river cobbles; coarse "archaic" tiles and thick-walled pottery present but not diagnostic, hence no clear dating evidence. May be related to site 3041 nearby.
3041	New	-	40 x 40	Site is strategically placed, with a good view of the terrace. Contains Hellenistic tile, BG ceramics, Corinthian A/B, dolium, and recent fabrics. Note: visibility low because of bushes.
3042	New	-	20 x 10	Very diffuse scatter of shapeless impasto sherds on terrace edge overlooking the Franceschiello valley; this material occurs lower down the valley slope in field 3043 as well.
3047	new	5 - 10	10 x 20	Scatter of possibly Hellenistic material, contains no clear diagnostics. Depurated orange firing roof tiles with some inclusions; various medium and thin coarse wares; a few depurated orange firing sherds with some inclusions.
3048	130	-	90 x 30	Sizeable scatter of Hellenistic material found on both sides of the modern road bed: coarse "archaic" roof tiles and medium thick wares, 1 x BG, one coarse loom weight. Note: very low visibility because of olive trees. Logged by Quilici as a 'diffuse Hellenistic-Roman scatter'.
3055		2 - 5	40 x 20	Scatter of Hellenistic material collected <i>after</i> intensive survey (= scatter 6): coarse tiles, medium thick and thin wares. Site contains relatively many luxury items: late 4 <sup>th</sup> c BC Corinthian A/B amphora frs, BG including foot of cup, and other depurated pale and orange firing sherds of table wares.
3056		-	10 x 10	Low-density scatter of coarse material, probably including LIA impasto, collected <i>after</i> intensive survey (= probably scatter 5). Coarse tiles, medium and thin wares, including one rim with comb motives on the lip.

<sup>15</sup> TS = Terra Sigillata.



The extensive survey recorded a small concentration of impasto material on site 3042 (extending into field 3043), and another one of coarse impasto-like material in field 3056. The large majority of the material and sites were dated to the Hellenistic period. Sites 3002/3003 appeared to consist of recently ploughed-up high-quality material, possibly belonging with Quilici site 126 (located some 100 m upslope but of which almost no remains could be found); confirmed 4<sup>th</sup>-2<sup>nd</sup> c BC sites include 3008, 3016, 3026, 3041, and 3055; generic Hellenistic material occurs at sites 3025, 3029, 3039, 3047 and 3048; early Roman (2<sup>nd</sup>-1<sup>st</sup> century BC) at sites 3032, 3039; and Roman Imperial wares (1<sup>st</sup>-3<sup>rd</sup> century AD) are found at sites 3016 and 3018.

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## 8 SETTLEMENT AND INFRASTRUCTURE

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Whilst the results of the SIBA'00 survey should first and foremost be compared to those of the Quilici survey which they were intended to test (De Rossi et al. 1969:147-155), the general lack of rural settlement data pertaining to the coastal and alluvial plains of the Sibaritide means that we must also view them in the less specific geographical and historical context of Roman Calabria, as provided by Accardo's recent study (2000). It bears repetition that most of the surface material found north of the Crati-Coscile was ascribed by Quilici either to the late Hellenistic (late Republican) period or to the Roman Imperial period. Even sites and scatters not expressly dated by him were to be ascribed to these three centuries (150 BC – AD 150). Most of these appeared to represent small farms continuing into the Imperial period, and tending to cluster into 'villages' located on the lowest parts of the foothills; there were also a few small villages lying along the water-rich valleys south-west of Cassano allo Ionio, and a few widely scattered larger farms (*fattorie padronali*) which may be recognised by architectural remains. The territory as a whole was therefore littered with settlements (villas and villages) in the Roman period, clusters of which 'define a finely branched network of routes', until at least the second century AD. However, the material itself was described by Quilici as 'quite unpretentious, even poor, indicating local production and use' - recalling Strabo's (VI, 253) judgement of Sybaris in his time as 'barbaric'.

At the regional scale, Quilici contrasted the pattern of autarchic 'villages' to the north of the Crati-Coscile with that of single farms to the south and west, and wondered if this might not also express a difference of social, even ethnic, units rather than being purely a consequence of the differing geomorphologic structures of these areas. He suggested (1969:149) that the difference may be related to the presence of 'colonial' landscapes of single villas emanating from the Roman colonies of Interamnium (Eianina and the upper Coscile) and Copia Thurii (the hills south of the Coscile), while the area of larger villages in the foothills north of the Coscile represents a survival from the pre-Roman Hellenistic society. If true, the Hellenistic settlement pattern recovered by the SIBA'00 survey should consist of sporadic villages along major thoroughfares. The location of roads connecting the coast to inland regions would have been dictated by the major valleys and passes in the uplands and mountains (1969:151); a system of fortlets and watchtowers safeguarded Hellenistic Thurioi and may have done the same for Archaic Sybaris, but so far no evidence for this has been found.

Although actual finds predating the late Hellenistic period were rare at the time of his survey, Quilici also attempted to reconstruct protohistoric patterns of settlement and, especially, infrastructure (*viabilità*) in the Sibaritide (1969:97, 152-5). Several of his routes either cross or come near to the SIBA'00 survey area. Using an 18<sup>th</sup> century parallel, he postulates the existence in the early Iron Age of a 'coastal' route following the foothills, connecting the large protohistoric centres, and avoiding the (marshy) plain<sup>16</sup>. A second route is postulated parallel to this along the lower lip of the lowest 'terrace'; a third route follows the 'radial' morphology of the terrain and the line of a known Roman road from Castrovillari to Frascineto and further on to Civita and, presumably, Thurioi/Copia in the plain; a fourth route

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<sup>16</sup> The use of historic parallels in the reconstruction of prehistoric routes is justified on the assumption these routes are the 'most natural' and by the supposed conservatism of their use; compare Small et al. 1998:338 for a similar argument concerning transhumance routes in Apulia.

connecting Torre Mordillo, Cassano, and Civita forms part of a postulated protohistoric long-distance ‘mountain route’. Quilici derived this protohistoric infrastructure from the locations of known sites and the terrain morphology, interpreting rivers as barriers, ridges as routes, and valley floors as difficult terrain because of water and vegetation. The peaks and gorges are orientation points, sulphurous springs meeting places. The formation of routes under ‘free’ conditions, he maintains, would have been similar to that of the Middle Ages which is preserved today in ancient mule paths. Some of the latter (between Francavilla Marittima, San Lorenzo Bellizi, and Alessandria la Carreta) were explored during the SIBA’00 campaign and were found to have protohistoric sites along them, but it is not yet proven that such sites cluster on these routes. Figure 2 shows the two main protohistoric routes postulated by Quilici.

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## 9 CONCLUSIONS

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The results of the SIBA’00 survey can successfully be used to re-interpret the geographical and chronological patterns of settlement suggested in the late 1960’s by Lorenzo Quilici. Both the intensive and the extensive surveys have recovered about twice the number of sites mapped by Quilici in the same area, despite the deterioration of the soil archive in the intervening decades. The resultant site distribution suggests, but does not prove, that Quilici’s ‘villages’ are artefacts of research and visibility biases. A definite answer to this question will require targeting a wider area for extensive survey in the future, and obtaining access to the original research. Although routes may well have existed where he posits them, sites also occur well away from these along all ‘minor’ terrace edges. With respect to dating, the materials collected in the SIBA’00 survey also suggest consistently earlier dates (Archaic to early Roman) than those suggested by Quilici (late Hellenistic to early Imperial<sup>17</sup>); and these results may tentatively be extrapolated across all of the Sibaritide.

### PROTOHISTORIC TO ARCHAIC

The adverse conditions for retrieval of protohistoric ceramics on the intensively worked terraces must be taken into account when interpreting the archaeological record of relatively well preserved upland protohistoric sites. There is currently no evidence that protohistoric (BA-EIA) settlement occurred anywhere in the survey transect but at the very highest elevations (the Monte S Nicola at 500 m ASL stands some 150 m above the highest terrace). This can be interpreted as confirmation of existing thought about protohistoric settlement patterns, but it leaves unexplained why the most important hilltop settlements should be located on hills overlooking the Sibaritide plain. Could the needs of pastoralism – winter grazing in the plain, which at this time would have been a heavily wooded and seasonally flooded marginal area with soils too stony or clayey for palaeo-technic agricultural use – have been so vital as to be the determining element in settlement type and location choice? Alternatively, the postulated ‘ring’ of protohistoric centralised settlements around the plain may, in part, prove to be chimerical, the result of biases in academic research and interpretation. One indication that this may have been the case is the apparent concentration of protohistoric research on the hilltops of the *fascia collinara* (see above, note 4). Vanzetti recently again stressed the tendency of the Roman school of protohistoric studies to assume the presence of a settlement where the evidence permits rather than suggests this (Vanzetti 2000, forthcoming: 7, 23). For example, Broglio di Trebisacce is seen as one single large settlement rather than as the two nuclei separated by 250 m for which archaeological evidence exists. Equally, settlements are assumed to be as large as the geomorphologic units (plateaux) they occupy, and ‘missing’ periods are assumed to be present even in the absence of evidence. Taken together, these assumptions may mask more complex realities in the protohistoric evidence. We feel the possible continuation of the prehistoric settlement pattern into the hinterland must be studied before further regional interpretations can be made.

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<sup>17</sup> Hellenistic ceramics were dated during the survey by G-J. Burgers, using ceramic typologies developed by D. Yntema at the Free University of Amsterdam.

For the Later Iron Age and Archaic periods, the evidence from the survey is equivocal. Despite the historical evidence for the establishment of Sybaris around 720 BC and the archaeological evidence for continued use of the sanctuary and necropolis at neighbouring Timpone Motta into the late 6<sup>th</sup> century BC (Attema et al. 2000), no securely datable materials from this period have been found in our survey. Given our experience with the very low visibility of coarse impasto wares among the naturally occurring stones in the survey area, we must conclude that neither our own surveyors nor the Quilici team were able to identify such material with any degree of reliability; we cannot therefore infer anything from its absence. Further fieldwork will be needed to produce a more reliable distribution map of this material. For the Archaic, much will depend on a closer dating of the coarse wares, which make up more than half of the finds by weight, through association with datable fine wares or through typological comparison with excavated material within the region.

#### HELLENISTIC TO ROMAN IMPERIAL

No such visibility problem occurred with the classical Hellenistic and Roman ceramic types. It appears from the results of our field work that the large-scale spatial patterns mapped by Quilici in the 1960's are, at least for the transitional zone between the plain and the hinterland, partially correct. Large and small sites of the Hellenistic/Roman period do occur in elongated clusters along 'major' terrace edges. However, such sites also appear to cluster locally along the edges of small valleys cut into the terraces; this is at least the case along the eastern edge of the *Vallone Organata / di Franceschiello* which runs just to the east of Lauropoli. The possibility that Quilici's site clusters are caused by, rather than merely correlated to, modern accessibility and land use must remain a hypothesis at this stage; it may eventually be confirmed or rejected when we obtain access to his survey archive.

Among the 'new' small classical sites identified by the intensive survey, several are located within the clusters initially identified by Quilici while others are scattered all over. It was observed both by the Quilici team and in the SIBA'00 survey<sup>18</sup>, that many of these Hellenistic-Roman ceramic scatters are relatively small and poor, with a 'standard' assemblage consisting of some coarse and depurated storage and kitchen ware, a few bits of fine ware including Black Gloss, and one small pyramidal loom weight. To confirm this impression, a comparative study of the assemblages taken from several such sites both in the Sibaritide and in the Brindisino is being planned.

It now remains to put these results into the general context of Roman Calabria (after Accardo 2000). Despite the settlement expansion apparently ongoing from the late 4<sup>th</sup> century BC, the Greek colonies of southern Italy were already under pressure from the equally expansive indigenous Bruttii by the early 3<sup>rd</sup> century BC, and the Romans became involved when they were called in against a coalition formed by the Bruttii, the colony of Taras, and Pyrrhus of Epirus. We are told that, when this coalition was finally defeated in 272 BC, much land in Calabria was already confiscated from the Bruttii; resistance flared up again during the second Punic war and by the end of the 3<sup>rd</sup> century the remaining Bruttii are enslaved. Both these wars and the advent of malarial disease caused a severe decline of the Greek city-states during that same period.

Following a period of military occupation and administration, Roman colonies were established on *ager publicus* (and other towns revived or refounded) in Calabria in the course of the 2<sup>nd</sup> century BC – Copia Thuri being one of the first. From this time until the 2<sup>nd</sup> century AD, medium to large-sized agricultural villas spread in Calabria mainly in the territories of these coloniae. The Via Popilia, extending the Via Appia from Capua to Rhegium and probably built in 132-1 BC, ran through the Sibaritide from Muranum in the north to Consentia in the south, probably following the valleys of the middle Coscile and Crati rivers<sup>19</sup> and with secondary roads to Copia. These roads and rivers must have been extremely important

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<sup>18</sup> Quilici remarks that "black gloss is encountered only rarely and generally the assemblages are poor with no evidence for substantial constructions; there are no cisterns and graves are very unassuming as well" [my translation].

<sup>19</sup> Accardo (2000:30-39). Thought to have been navigable, the former for a distance of 18 km until the confluence with the Esaro; the latter for 40 km, at least halfway to Consentia.

in enabling the marketing of agricultural produce, and archaeological indicators of colonisation and Romanisation are therefore likely to cluster on them<sup>20</sup>. In the centuries AD, the last traces of the institutions of Magna Graecia were supplanted by those of the Roman state, and areas of extensive (*latifundia*) and intensive (villa) cultivation developed.

However, besides the land designated for the colonies, large tracts of land were also sold to rich Romans who developed slave estates from about 100 BC. High land prices and the capital outlay needed for market-oriented production of wine and olive oil induced many small farmers to sell their land. A slave-based capitalist villa economy developed in Calabria, as elsewhere, into the early Empire. From the beginning of the 4<sup>th</sup> century AD Calabria suffered from the general crisis of the Roman Empire, and some 40% of villas were abandoned or subsumed into *latifundiae* founded on a combination of cereal farming and pastoralism. By the end of that century these had developed into independent and fortified power bases for the *potentiores*, foreshadowing the feudal estates of the middle ages. However, literary references indicate that the region in general continued to be productive into the 7<sup>th</sup> century AD.

Only one clearly Roman villa, possibly of the platform type, was (re-) located (from Quilici site 123) during our survey, confirming the results of the 1995 survey on the terraces between Francavilla and Broglio di Trebisacce and the pattern of widely spaced villas with no off-site distribution as observed by the Quilicis. While it is possible that a denser pattern of villas was located in the plain, its depositional history currently precludes us from finding proof of this; a study of Medieval and sub-recent historical documents may be helpful in back-tracing Roman settlement patterns. The same goes for the Byzantine and medieval periods, for which no physical evidence was recovered at all during the survey although several chapels and a monastery are known to have existed in the region<sup>21</sup>. Future research should be targeted at those local geomorphologic units in the plain for which there is evidence or at least a possibility that antique and later remains might be observable.

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<sup>20</sup> According to Accardo (2000:56), villas in the territorium of Thurii lie mostly in these valleys, are medium-sized and specialise in the production of wine and oil. Almost all date from the 2<sup>nd</sup> c BC to the 2<sup>nd</sup> c AD; some continue into the 4<sup>th</sup> and 5<sup>th</sup> c AD.

<sup>21</sup> One Byzantine chapel was located on top of the Timpone della Motta at Francavilla Marittima.

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# A COMPARISON OF ARCHAEOLOGICAL DATA SETS FOR THE PONTINE REGION

## 1 INTRODUCTION

In chapter 2 of this thesis I discussed the possibilities for supra-regional comparison and high-level explanation of the settlement dynamics in the three study regions, concluding that comparisons made on the basis of the available high-level narrative are not satisfactory and should instead be based directly on an evaluation of the archaeological record. Here, I intend to explore the potential for this type of comparison from two angles, using data and examples from the Pontine region: firstly, the construction of a relational database capable of representing the diversity and variable quality of regional archaeological records and the interpretative constructs based on them; and secondly, the practical comparison of multiple data sets deriving from a single, or several adjacent, landscape units within the general region.

Given the ultimate goal of spatio-temporal comparison, within a GIS environment, of the Late Bronze Age to Roman settlement history of the three regions studied by the RPC project, a compendium of archaeological data available for these regions and periods must be created. In fact, two largely separate sets of questions have to be confronted

- How to design and build a regional database that can hold all existing traditional site-based observations and interpretations, as well as new area-based survey data, *and* allow the addition of extra layers of RPC interpretations?

The first part of this question has of course been asked many times before, whenever archaeologists have attempted to create regional-to-national scale archaeological databases. A seminal publication in this regard has been Larsen's (1992) volume on national archaeological records which, according to its editorial preface, was 'a balanced status of attempts... to computerize the archaeological heritage'. Although the volume may be said to summarise the experience gained since the mid-1980s by the national digital records builders of (western) Europe, unfortunately the only high level data models presented in it are those for the Danish and Dutch national archaeological records (Christoffersen 1992:15, Roorda & Wiemer 1992:119). It seems that documents detailing these and other high level data models have, since that time, been circulating as internal reports, deemed to be of insufficient outside interest to warrant publication. The second and third parts of the question are only now beginning to be tackled with the inception of regional *analytical* (as opposed to management oriented) archaeological databases, in the context of research projects such as (within Italy) the RPC and the Tiber Valley Project, and the project set up in the mid- 1990s at the University of Lecce for collating the indigenous settlement of southern Italy (Puglia and Basilicata) in a GIS environment. According to Francesco D'Andria (n.d.:105) the latter project, for the first time, brought together the detailed data needed to effectively study indigenous settlement dynamics, without which regional models such as those created at the *Accordia* Research Institute at the University of London are of doubtful value, but again no detailed

publication of the data model has been forthcoming<sup>1</sup>. Section 2 of this chapter can be regarded as a case study in the design of wide-area GIS integrated archaeological databases. It introduces and details the design considerations for the RPC interregional archaeological database.

- How to compare the various data sets which exist within each RPC region, and how to interpret the results of such a comparison?

The first part of this question, regarding the methodology of comparison, has already been posed in chapter 2 of this thesis, along with the subsidiary questions of: What grounds do we have for believing that inter- and infraregional comparisons can be made at all, and: Which things would we want to compare? The tentative reasons for the *comparability* of regions given there rested on geographical, ethno-archaeological, historical (Iliad & Odyssey, classical authors), and archaeological (distribution of elite goods) arguments; the proposed *comparanda* included demographic developments, cultural developments, and processes such as centralisation, urbanisation and colonisation. It was tentatively concluded that our poor understanding of the problems and potential involved in interregional comparisons would benefit from approaching the more modest goal of intra-regional comparison first. In section 3 below I therefore describe, assess and attempt to compare the data sets that have so far been available to the RPC project in one of its regions. General conclusions regarding the comparison of the core processes within and among all three RPC study regions are drawn in a final section.

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## 2 TOWARDS AN INTERREGIONAL DATABASE

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### 2.1 AIMS

In a broad sense, then, the purpose of the RPC database is to collect together all of the available data on archaeological remains within the three regions of interest, and to use this data in an interpreted form for archaeological landscape analysis. More specifically, we want to create a database in order to:

1. collect available site-oriented information from sources
2. assess and document that information; generate metadata
3. reorganise it if necessary (eg, terminology, splitting or merging of observations)
4. interpret it in terms of meaningful entities

We also want it to:

5. hold non-site data types (eg, off-site survey data such as those generated by the RPC project's recent fieldwork, and negative observations)
6. be able to answer specific archaeological questions about spatial patterning

The database must hold the unaltered data as presented by the available sources, and keep them separate (and separable) from any additional or transformed data and interpretations. A particularly important role will be set aside for metadata (point 2 above), because of the need to prevent low quality data from inadvertently 'polluting' our analyses:

- a) We want to be able to specify a particular spatial and/or temporal scale within database queries
- b) We want to be able to apply interpretative ranking criteria (point 4 above) to queries
- c) We want to be able to apply criteria of data precision, accuracy, and probability to queries.

#### DESIGN PRINCIPLES FOR THE RPC PROJECT RDBMS

Point 4 above requires that we should be able to organise observations (~ 'events') into recursive hierarchies of interpretative entities<sup>2</sup>, and that we be able to distinguish interpretations by phase or period.

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<sup>1</sup> Possibly, Semeraro (1997) has some description of database design and methodology of data creation.



For example, in the case where a particular period is ‘missing’ at a site, we should be able to choose between regarding the suite as unoccupied during that period, or regarding it as a ‘possible’ or even ‘probable’ site. The importance of making such distinctions was recently highlighted again in a paper by Alessandro Vanzetti (forthcoming), when he noted the tendency of the Roman school of protohistory to *assume* continuity in cases where there is a geographical or chronological hiatus in the archaeological evidence.

Given the problems discussed above in interpreting existing archaeological records, it is essential that the database framework should keep the ‘information trail’ intact so as to allow the researcher to access and check all data transforming steps occurring in between raw data input and high-level interpretation. This means that compiled data should be entered into the database *unaltered in any way*<sup>3</sup> and that all subsequent interpretative steps are to be fully formalised and documented.

The database should also be scale independent, that is, it should be able to hold data irrespective of its level of detail (size, duration). This principle has long been championed by Arroyo-Bishop and Zarzosa (1992, 1995) in their object-oriented database system called ArchaeoDATA. Their database design permits features, artefacts, ecofacts, and any other object to be linked into interpretative entities at any scale.

The landscape archaeological approach of the RPC project calls for a reconsideration of the ways in which basic information about archaeology should be structured. The current approach to regional archaeological database design, including that of the RPC project, is to structure the database around the archaeological entities (typically, sites). The database structure mirrors the processes by which archaeological information has been produced, must be transformed, and will be analysed: field observations are turned into ‘records’ (for publication or archiving) through various processes by a ‘source’, who usually (but not always) groups and interprets them as ‘sites’ before publishing them; these constructs must then be deconstructed again by us into their constituent ‘observations’, and reinterpreted in an iterative process as complexes of observations (interpretative hierarchy).

An alternative structuring principle presents itself if a close integration of the RDBMS with a GIS is desired. Rather than the ‘antiquarian’ approach in which an ever increasing stock of knowledge is built, the ‘landscape’ approach takes the presence of a limited amount of geographical space containing a limited amount of archaeological resources as its starting point. This geographical space is represented by a limitless number of themes (or map layers) considered relevant by the user; each theme is partitioned as and when ‘events’ relevant to that theme occur. For example, the event of a survey taking place will be recorded in a ‘research activity’ theme, while the discovery of a Roman villa during that survey will be recorded in a ‘Roman period’ theme. Each ‘event’ not only has a specific spatial extent, but also a temporal extent (or duration). Basing the database design upon this principle is preferable from a landscape archaeological viewpoint as well, which also looks at cultural remains in the context of the landscape as a continuous whole.

## 2.2 DATA

The first step in creating a regional archaeological database is to compile existing published or archived material. For the RPC regions there are three main types of sources: published volumes of the *Forma Italiae* series of map sheet surveys, publications in local (Italian) journals, edited volumes and monographs, and the publications and records kept by GIA and AIVU themselves. This represents a mixture of primary, secondary, and even tertiary sources so in some cases the link with an actual field observation

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<sup>2</sup> In the Dutch ARCHIS system (version 1), observations are aggregated into meaningful sets termed ‘complexes’ (Roorda & Wiemer 1992:118-120); ARCHIS 2 is intended to include a set of rules for performing this aggregation. A ‘recursive’ hierarchy is one which allows such complexes to be aggregated into ever higher level interpretative entities.

<sup>3</sup> Translations, if subject to proper quality control, are allowable.

Table 1: Sources for the RPC site database, Pontine Region

RPC Map ID	Project / Source Reference	No of sites
10,101 – 10,152	Lanuvium Survey (Attema forthcoming)	52
10,401 – 10,500	Gierow 1964a, b	67
10,501 – 10,530	Ninfa Survey 98/99 (Van Leusen 1999)	24
10,551 – 10,594	Fogliano Survey 98/99 (Attema et al. 2000)	38
10,601 – 10,700	Chiarucci 1978 (only 1 site entered)	
10,701 – 10,854	Segni Survey (Attema 1997, Carpino 1997, Enei 1990)	153
10,855 – 10,900	Attema 1993	46
10,901 – 10,951	Sezze Survey (Attema, Zaccheo & Pasquali)	51
10,952 – 10,963	Norba Survey (King 1995)	12
	Cisterna Survey (Attema 1993)	
	Olmobello Survey (Attema)	
11,001 – 11,200 / 11,401 – 11,445	Lugli, <i>Forma Italiae</i> : Terracina	297
11,201 – 11,396	Picarreta 1977, <i>Forma Italiae</i> : Astura	196
11,501 – 11,600	Lugli, <i>Forma Italiae</i> : Circeo	~76
11,601 – 11,801	Vittucci 1968, <i>Forma Italiae</i> : Cori	201
11,802 – 11,934	Drost (unpublished)	133
11,951 – 12,000	Mazzolani 1969	51
12,001 – 12,171	Morselli & Tortorici 1982, <i>Forma Italiae</i> : Ardea	171
13,001 – 14,000	Agro Pontino Survey (Voorrips et al. Unpublished)	381

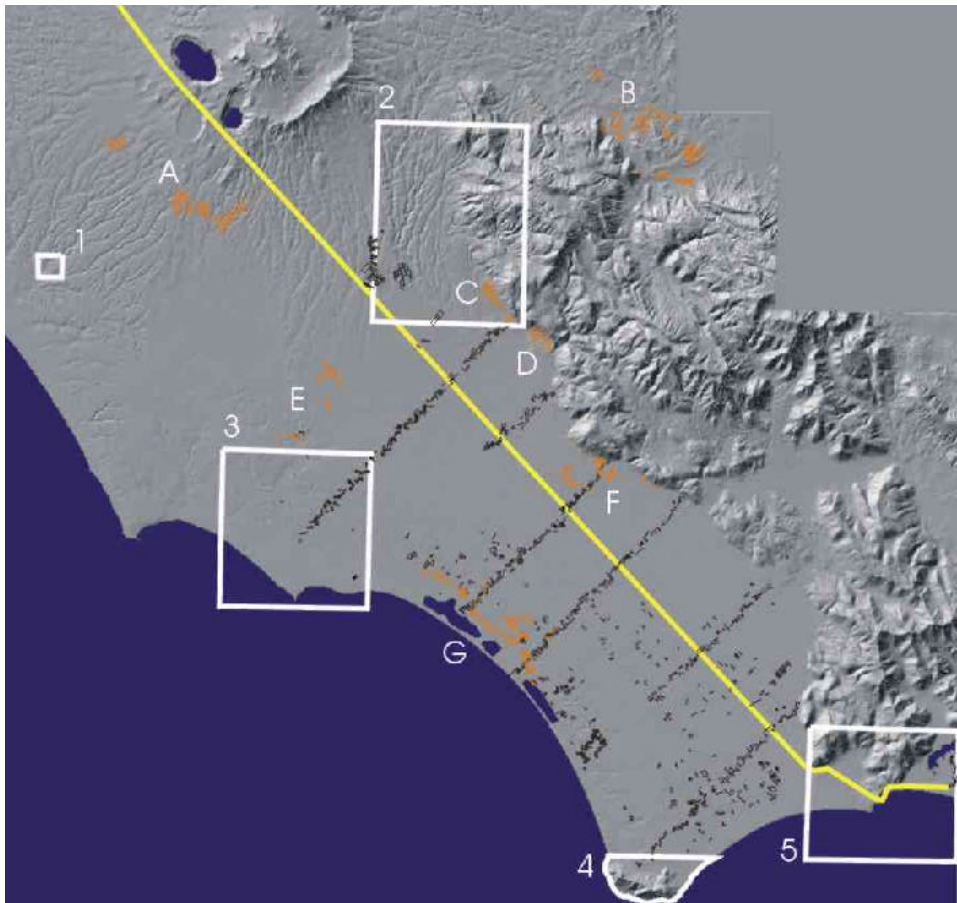


Figure 1: Survey areas of the Pontine Region. White: *forma italiae* (1 Ardea, 2 Cori, 3 Astura, 4 Circeo, 5 Terracina), Black: Agro Pontino Survey areas 1981-1989, Orange: Pontine Region project & RPC project survey areas (A Lanuvium, B Segni, C Ninfa, D Norba, E Olmobello, F Sezze, G Fogliano)

will be quite tenuous. The complexity of this dataset may be illustrated by the listing of sources for just one of the three study regions, the Pontine region (see table 1 and figure 1). Blocks of 5-digit RPC map codes are set aside for each major publication. Table 1 identifies these sources and the conversion used to obtain RPC Map ID's from the site ID's used by the source. A complete concordance between source ID's and RPC Map ID's can be found in the RPC sites database.

At current count, the database for this region contains about 1880 site observations. This extant archaeological record cannot be taken at face value, but must be interpreted on at least three different levels during compilation. Firstly, the meaning of the terms used may have changed over time or may be idiosyncratic as records are usually produced by many different people; secondly, interpretation and observation are usually mixed together and sometimes a description of the original observation fails completely; and lastly, elements of the record may contain errors, inaccuracies, and imprecisions (cf. Scollar 1992). All of these require careful interpretation if the compilation is to become a useful, and usable, archaeological database.

## QUALITY

If we are to interpret what the sources tell us in terms of the classification system presented above, we also need to find ways of dealing with the 'fuzziness' of the source data. This can take any of several guises: lack of clarity, or overlap, in the definition and scope of descriptive terms; lack of distinction between observations and interpretations; and measurement errors and uncertainties.

### *What does it mean (terminology)?*

Many of the terms used to describe archaeological field observations, and constructs based upon them, do not have precise definitions, have been used differently by different authors or by the same author over time, and/or have been used to describe overlapping sets of archaeological observations. The lack of formal definitions to accompany the terms used precludes a precise comparison of results; one example where different terms have been used to describe broadly similar phenomena is Perkins' use of 'village' in preference to 'nucleated settlement' (cf. Section 2.4 below). The latter term is employed by Burgers (1998) who distinguishes the following four levels of settlement: dispersed settlement, nucleated settlement, hamlet/village, town. Attema (1993) also distinguishes four levels of settlement, but used different terms: isolated farm, hamlet, proto-urban settlement, urban settlement. Neither gives precise criteria by which to distinguish the levels, but they do seem to attempt to describe similar phenomena.

### *How much of it is interpretation rather than observation?*

In bringing together information provided by many sources and over a long period of time, we cannot assume that all the interpretations made by these sources were either correct at the time, or have remained so ever since. In an ideal world we would be able to separate these interpretations from the *observations* that they were based on, but this is unrealistic for two reasons. Most importantly, no such clear distinction exists in reality between 'observations' (a term suggesting value-free data) and 'interpretations' (a term which acknowledges the changeable nature of what we consider to be the significance of archaeological remains). Hence it may be better to regard all observations as interpretations as well (eg, Scollar 1992:98). Secondly, many sources record little if any of the descriptive information on which their interpretations are based, and in practise we will therefore not be able ever to evaluate the nature of most historical primary (or even secondary) records. What we *can* attempt to do is to separate such records into descriptive elements and interpretative elements; this would allow us then to ignore previous interpretations and attach our own interpretations to the compiled descriptive information instead.

### *What is the precision and accuracy of measurements and estimates?*

All measurements and estimates given by the source (for example, of the number, size and density of finds in a scatter, or of its location) carry the implicit properties of precision and accuracy. Some of this fuzziness is indicated by the source in an often informal and inconsistent manner, through the use of qualifications such as '*probably* a site', 'nearby', 'late Republican *or* early Imperial'; but more often such

indicators remain implicit<sup>4</sup>. Within a GIS, when precise characteristics of large numbers of site locations are derived from their recorded locations (co-ordinates), even relatively small errors can have large consequences. For example, let us assume that a site's location has been stated unambiguously by a pair of co-ordinates rounded to the nearest 10m grid point; its GIS-derived slope might then be an equally unambiguous 3% and its aspect NE. However, if we know that the co-ordinates provided by the source have a measurement error of 50 meters, then the true location of the site is no longer unambiguous – it may be anywhere within a 50m radius of the co-ordinates, though it has a higher probability of being close than of being far away. In this latter case the slope of the site could be derived by the GIS as '3% with a probability of .67, 2% with a probability of .33', and its aspect as '.50 NE, .25 E, .25 none'. It is therefore very important to include assessments of the precision and accuracy of such measurements where-ever possible. There are at least two ways in which such assessments can be made:

1. by codifying our degree of confidence in the general accuracy of the information provided by a source, and of its judgement in individual cases;
2. by deducing measurement error from the available information about the methods employed by the source, and applying this error to its observations.

A standard locational error can be deduced if the measurement method is known. Thus, locations determined on the basis of topographical maps contain a standard error due to the minimum size at which map features can be drawn, equal to 1/2000<sup>th</sup> of the map scale denominator; for a 1:25000 scale topographic map, this error is 12.5m. This represents the minimum error, assuming that the original map features were drawn at maximum precision and that no other degrading factors (e.g., map reprojections) were involved.

A similar standard error is associated with measurements taken using survey equipment based on GPS (see chapter 7). The size of the error depends on the type of equipment (survey quality equipment having a much higher accuracy than 'navigational' GPS) and even the location, date and time of the measurement (the notional horizontal accuracy of 'navigational' GPS has gone up from about 70m to about 10m after the removal of signal degradation on 1 May 2001; however, in all cases the accuracy of measurement varies throughout the day with changing satellite configurations).

### *Errors and omissions*

There may well be errors in the source records; these may be *incidental* (as in the mistaken identification of a Roman terrace wall as a road revetment) or *pervasive* (as in the misidentification of African red slip ware before Hayes published his typological study of it in the 1970s). The database framework must allow for both types of error to be corrected, and for the correction process itself to be formalised. If the inaccuracy cannot be corrected, then the database framework must allow it to be described and flagged so that the inaccurate record can be avoided during queries. Archaeological records are also typically *incomplete*, ie they do not contain the full complement of data elements. Since missing data may or may not be fatal to the interpretation, the database framework must contain a formal procedure for deciding how the absence of any data element affects any query (ie, queries must contain a set of rules about the minimum requirements to each data element).

## METADATA FOR SOURCES AND OBSERVATIONS

In all this, it is clear that a very important role in the interpretative process will be reserved for our assessment of our sources of information. Can they be trusted? What are their limitations? How confident are we that the recorded information is accurate? The implication for the data model to be constructed is that data fields derived from external sources (table A) must be linked to a table holding both descriptive and evaluative information about these sources (table B).

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<sup>4</sup> Attema (pers. comm.) notes that sites mapped on old IGM 1:25,000 map sheets in his 1987 transect survey have a particularly fuzzy location because of the regular absence of physical controls (field boundaries, etc) in the neighbourhood of the sites.

Table A: OBSERVATIONS

ID	Descriptive fields	Short ref	Ref_spec1	Ref_spec2
1	....	Picarreta 1977	pp 30-34	Site 16
2	...	Picarreta 1977	pp 35	Site 17

Table B: SOURCES

ID	Short ref	Long ref	Metadata
1	Picarreta 1977	Picarreta, F 1977 <i>Forma Italiae regio I, volumen XIII: Astura.</i> Firenze.	Topographic survey; ...
2	...	..	...

Table C: OBSERV\_META

Obs_ID	Obs_date	Obs_method	Obs_LULC	Obs_circ
1	1969/08	Topo survey	arable	Not specified
2	...	...	...	...

Other aspects of data quality do not concern the source itself but rather the circumstances under which he or she collected information. These require that metadata fields regarding the circumstances of discovery and description be added. Three sets of such metadata can be defined (Table C): the research method, ranging from archive study to excavation and aerial reconnaissance; the land cover / land use (LULC, see also chapter 14); and the specific find circumstances, eg ‘chance find’, ‘in eroding bank along canal’. Since these metadata apply only to the time frame in which the observation was made, a fourth metadata field is needed to record the observation date.

### 2.3 UNUSUAL DATA TYPES

Until recently, archaeological records everywhere contained only ‘sites’, essentially point observations ranging from single stray finds to large complexes of earthworks, which were documented in a series of text/number fields, occasionally referenced to archived materials such as notes, sketches and photographs, and indicated as a point, line or area on fairly small-scale (usually 1:25,000) topographic map sheets. Initially, the advent of GIS did nothing to change this situation. No provision was made within archaeological databases for the inclusion of non-vector topological data types such as continuous off-site ceramic densities and toponymics, of probabilistic data types, or of linked or embedded documents (including graphical documents). A number of potential approaches exist to allow us to include such unusual data type in the RPC RDBMS.

Firstly, the quality of regional archaeological databases could be significantly enhanced if the database framework would allow the inclusion of unusual *document* types (‘objects’) such as word processor files, annotated aerial photographs, graphics, etc. The mechanism for this already exists in the current generation of office database software (‘Object Linking and Embedding’ or OLE). A primary benefit of this would be that it allows us to include *all* of the original source data in the database, and not just the descriptive text.

#### SURVEY DATA AND ‘NONSITE OBSERVATIONS’

The cartographic heritage of traditional archaeological records is still with us in the current generation of archaeological databases, which are geared to recording the presence of archaeological entities and assemblages (‘sites’), and completely ignore the requirements of modern landscape archaeology which are to record information for *all* parts of the landscape (including what has been termed ‘off-site’ and even ‘non-site’ observations<sup>5</sup>). In practise, this has meant that information from landscape survey must be ‘degraded’ into a set of ‘sites’ before it could be included in the database, and that an observation of site

<sup>5</sup> *Contra* Scollar (1992:98), who believes that recording absence data only results in needless clutter.

*absence* (eg, during a watching brief) could not be recorded at all. Since the RPC database is to contain a significant amount of data resulting from landscape surveys, its database framework must be able to deal with both these data types.

In addition to knowing where archaeological remains were *found*, it would be very important for a student of a regional archaeological record to know where they were *looked for*. In other words, the history of research and discovery within the region has to be documented within the database as well. A workable format for this consists in the mapping of the ‘activity areas’ of those individuals who have contributed multiple observations to the database, either in the form of formal study areas (eg, *Forma Italiae* sheets, municipal inventories) or of informal activity areas (active amateur archaeologists, cf. Fokkens 1991), and in the mapping of interventions (eg, infrastructural works) observed by an archaeologist. The database framework should allow each observation to be related to such an ‘observation window’, which itself could be recorded in a vector format in the associated GIS. This format also allows efficient recording of ‘nonsite’, that is, site *absence* observations. As a first approach, the outline of all study areas could be recorded as simple polygons; the possibility of going into more detail (recording of individual agricultural field boundaries, grid units, or even transects surveyed) should be studied.

The integration of a GIS with the database part of an archaeological record now provides the means by which the ‘landscape’ approach can become the leading principle. Information about the absence of finds and the absence of observations can now be assigned with ease to a variety of spatial objects, and these can be endowed with ‘fuzzy’ spatial and temporal properties. The analytical use of such an approach lies primarily in the possibility to reason about *bits of landscape* rather than about the archaeological remains that happen to have been recorded in it. In a very pragmatic sense, once we have data layers recording the history of land use and archaeological research and discovery within a region of interest, we can start to implement formal bias models which are able to distinguish between absence of evidence and evidence of absence.

## 2.4 CLASSIFICATIONS

Classifications of objects and assemblages of objects (eg, sites), invariably informal in the compiled sources, have to be formalised in order to ensure that similar phenomena are interpreted in a similar manner in the database. The first step in this is to create authority lists which formalise terminology and limit the freedom of classification; such lists can range from simple option lists (providing essentially a limited vocabulary with which to describe the objects and assemblages) to full thesauri (which describe the conceptual domain of the classification and can provide it with a polyhierarchical structure). Many international examples of such authority lists can be found in Larsen (1992); the full and detailed authority lists for the Netherlands central archaeological register (Brandt et al. 1992) run to more than 300 pages.

An authority list becomes a classification by the addition of criteria. The simplest type of classification is one where the classes are mutually exclusive and the class boundaries can be established in an unambiguous manner, such that all instances can be assigned to a single class. Site typologies are a good example of this and will be looked at in more detail below.

### A COMPARISON OF SITE TYPOLOGIES

The vast majority of classifications used by archaeologists to distinguish site types on the basis of surface survey data are based on either ‘historical’ or ‘empirical’ approaches. Two recent exceptions to the unfortunate fact that such classifications are usually not properly formulated and published are presented here by way of illustration. The historical approach, making use of historically identified Roman site types, was pursued by Arthur for his survey in northern Campania (1991:19-21). The criteria for his classification, and the interpretations based on it, are presented here in Table 2. The alternative, empirical, approach is based on sets of qualitative and quantitative criteria established in a more or less pragmatic and ‘ad hoc’ manner by the researchers involved. Among the criteria used in the past in central Italy to classify sites have been the presence of architectural elements (Cosa survey, Dyson 1978:275), size (Molise, Lloyd & Barker 1981:296; Agro Pontino survey, Koot 1991:130), and location and assemblage

(Liri Valley survey, Wightman 1981:281-5). The ‘polythetic’ classification of surface scatters devised by the Albegna Valley / Ager Cosanus survey team on the basis of overall criteria of size, shape and density, and specific finds or find types provides a good example here (Table 3; Perkins 1999a:106-7, 1999b:18-26).

The differences and similarities between these examples are instructive. Arthur (1991:19) rejects the simple mechanistic criteria applied by Perkins, such as scatter size or the presence of particular structural features, in favour of more complex combinations of criteria that parallel classical terminology. While these, in turn, have the advantage of being readily interpreted in terms of their place in the landscape and function in society, their classical focus and strong (compulsory) criteria fail to address the (undiagnostic, pre- or post-Roman) nature of the majority of actual sites recovered by modern surveys. The latter tend to fall in Arthur’s undifferentiated class ‘pottery scatter’, and here Perkins’ classification based on the application of relatively simple size criteria appears more practical<sup>6</sup>. Perkins accepts that, without excavation, not even Roman sites will consistently provide the type of evidence needed for an unambiguous classification into historical types.

Table 2: Historical classification of Roman site types for the northern Campania survey (after Arthur 1991)

Class	Criteria	Interpretation
Town ( <i>Colonia</i> , <i>Municipium</i> )	1: material indicates varied and distinct areas of activity beyond the purely agrarian, eg exchange, manufacturing, ritual 2: site is sufficiently large as to indicate the habitation of various family nuclei 3: presence of distinct public buildings provided these are not purely religious [otherwise class as village]	Basic Roman political and administrative unit; diversified economic base; productive, marketing, and mercantile facilities; population consisting of multiple families; developed street system
Forum	1 & 2: as 1 & 2 above, but manufacturing evidence may be absent or outweighed by agrarian evidence	Public administrative centre; small nucleated settlement with productive and market facilities
Vicus	Identical to Forum, but in a setting that indicates spontaneous rather than planned development	Smallest legally recognised unit of nucleated settlement, with basic market facilities; hamlet
Pagus	Not readily recognisable except through inscriptions etc	Territorial division which can contain one or more vici
Sanctuary	1: Concentration of votive material	Site of religious congregation, usually also political and (controlled) market function
Villa	1: Stone and/or tile built rural structure with clear and differentiated functional areas for agricultural and residential use 2: residential areas differentiated by size and quality, some with, eg, bath structures and interior decoration	Agricultural estate centre with resident slave <i>familia</i> as rural workforce
Maritime villa	1: as 1 above but can also be suburban 2: as 2 above but with clear evidence of luxury, eg mosaics, wall paintings, architectural marbles 3: proximity to the sea	Vacational residence with sea view; eventual productive functions are secondary
Farm	1: Stone and/or tile built rural structure with evidence of domestic occupation and areas of agricultural activity [2: evidence for a degree of comfort] 3: no evidence for the presence of internal social hierarchy (cf Villa)	Agricultural family establishment; production may be partly based on hired labour or tenants, but not on slaves
Cemetery	1: distinct clusters of specific artefact types associated with tomb construction or grave goods, within a well-defined area [2: presence of multiple frs of the same object, presence of human bone] 3: absence of heterogeneous fragmentary artefacts indicative of rubbish accumulation	Group of burials
Pottery scatter	1: not identifiable as any of the above 2: definable margins	Small single family settlement site; outbuilding; temporary activity area; cemetery

Table 3: Polythetic classification of surface scatters for the Albegna Valley / Ager Cosanus survey (after Perkins 1999a,b)

<sup>6</sup> So far as I have been able to ascertain, no theoretical context is given for setting size criteria for site type classifications; it is just a way of formalising subjective impressions of ‘small’, ‘medium’, and ‘large’ scatters.

Class	criteria	comments
House	1: scatter smaller than 100 m <sup>2</sup> and containing a loom weight, slag, a grinding stone, or <i>pithos</i> when associated with roof tile 2: consistent and continuous scatter of roof tile and/or pottery and/or building stone larger than 25 m <sup>2</sup> but smaller than 100 m <sup>2</sup>	- each artefact class is indicative of food preparation or domestic crafts - pithoi without roof tiles may indicate tombs
House or tomb	1: thin scatter smaller than 200 m <sup>2</sup> with no other distinguishing characteristics	- in the absence of decisive finds, stone or tile may also indicate a tomb
House or necropolis	1: thin scatter larger than 200 m <sup>2</sup> with no other distinguishing characteristics	- the only difference with 'house or tomb' is the size
House 2	1: identical to 'house' but with additional evidence for structures in concrete, <i>cocciopesto</i> , or floor tiles 2: scatters between 0.15 and 0.25 ha in size, with large quantities of building materials, but no structural or architectural evidence	- Roman period only
Villa	1: presence of standing structure, eg <i>cryptoporticus</i> 2: presence of architectural evidence, column drums, bases or capitals, or painted wall plaster 3: scatter larger than 0.25 ha with dense concentration of esp. building materials 4: bibliographic accounts	- Roman period only
Fortified hilltop	1: presence of defences around a hill top smaller than 4 ha	- poorly understood but in generally strategic location
Village	1: identical to 'house' but extends over more than 0.1 ha and less than 4 ha 2: a series of distinct scatters classifiable as 'house', each larger than 0.01 ha but extending over less than 4 ha as a group	Aka 'nucleated settlement'
Minor centre	1: identical to 'house' but extends over more than 4 ha 2: presence of defences enclosing more than 4 ha	- distinguished from 'village' and 'fortified hill top' on the basis of size - may include modern settlements with no other type of evidence
City	1: identical to 'house' but extends over more than 30 ha	-
Kiln	1: presence of ceramic wasters	- may also occur at domestic sites
Sporadic	1: thin or diffuse scatter or stray find, not classifiable in any other class	- often used for small quantities of earlier material found at Roman site
Temple	1: architectural terracottas of temple type	- in practise, these have occurred only in relation to known temples
Road	1: alignment of stones or a cutting in rock	-

All of the above approaches can be contrasted to the statistically derived site type classifications developed and employed within the ARCHEOMEDES programme (Favory and Raynaud 2000), which are based on a hierarchical cluster analysis of a large number of archaeological and environmental variables measured for 934 sites in the Hérault region of southern France. Since such statistical hierarchisation of site types is beyond the scope of the RPC project given the current state of its site database, and Arthur's classification is of very limited use to the diachronic and undiagnostic survey data, it was decided early on to develop an empirical classification very much in the manner of Perkins. The table below gives the proposed interpretative classification for sites in the RPC database, which will only become operational by the addition of sets of criteria by which to distinguish the classes<sup>7</sup>.

#### IMPLICATIONS

A good illustration of the wider implications that may be attached to the proposed terms and criteria is the difference between a 'hut' and a 'villa rustica' or rural villa. Villas are defined as Roman buildings with (amongst other criteria) tiled roofs which indicates that they were part of a wider distributary system, whereas huts are buildings for which no such durable materials have been used. Yet in Lazio Archaic farm buildings often have a (partly) tiled roof – should such buildings be called huts or villas, or should a third class of building be added? Clearly, a farming settlement for a single family unit will move from one class to another over time, as society changes and the physical building style with it.

Table 4: proposed site type classification for the RPC database.

<sup>7</sup> The final synthetic volume on the RPC project (in prep.) will include this work.



label	Order 1	label	Order 2
rural settlement site	A		A00
		isolated hut / capanna	A02
		isolated farmstead / house	A03
		fattoria	A04
		small fattoria	A05
		large fattoria	A06
		small cluster	A07
		large cluster	A08
		hamlet / village	A09
		villa rustica	A10
		outbuilding	A11
cult place	B		B00
		sanctuary	B01
		mountain sanctuary	B02
		cave sanctuary	B03
		source sanctuary	B04
		temple	B05
		shrine / altar	B06
		votive deposit	B07
town / urban site	C		C00
		colonia	C01
production site	D		D00
		quarry	D01
		kiln	D02
		pottery kiln	D02a
		amphora production site	D02b
		latifundium	D03
		metal kiln	D04
		oil / wine production site	D05
infrastructure	E		E00
		road	E01
		bridge	E02
		mansio	E03
		statio / mutatio	E04
		ford	E05
		centuriation ditch / bank	E06
drainage / irrigation	F		F00
		cuniculus	F01
burial	G		G00
		isolated grave / tomb	G01
		grave / tomb group / cemetery	G02
unknown	X		X00
uncertain	Y		Y00
other	Z		Z00
		hoard	Z01
		maritime villa / resort	Z02
		(watch) tower	Z03

It should be kept in mind that classifications, just like authority lists, are interpretative constructs even though they may not have been intended as such. Thus, whilst the classification of field observations may proceed on the basis of objectively applied criteria, the terms used to describe the *classes* represent interpretative concepts and put the student into a specific theoretical context. In the case of the site type classifications presented above, this context is predominantly that of the formalised and structured classical landscape. Observations relating to the indigenous, and informal classical, landscapes are de-emphasised by the process of classification itself.

## 2.5 FUZZINESS

Archaeological records typically include a great deal of uncertainty of various sorts. These range from stated uncertainties in the records themselves, through implicit uncertainties in its elements (eg, a location), to inferred uncertainties arising from our assessment of the source (see also next section). The

database framework must be able to record the type and degree of uncertainty associated with any element. Fuzziness is mainly applicable to the spatial, chronological, and interpretation variables.

If a data element within an archaeological record has an *inherently* probabilistic nature (eg, the identification of a skeleton as ‘male’ or ‘female’, the assignation of a flint tool to a particular period), then the database framework should accommodate this by using a ‘fuzzy’ data type (Crescioli et al. 2000) and by incorporating rules about how to deal with varying degrees of fuzziness. Probably the main use for such a data type would be in the description of the location of an object or assemblage, since any stated location can be thought of as being the central value of a Gaussian probability curve at that location. One can envision that sites whose locations are not recorded with a 95% confidence to within 50 m of the stated location will be excluded from certain types of sensitive queries.

#### SPATIAL FUZZINESS

Spatial fuzziness, or the probabilistic nature of recorded geographical locations of archaeological observations, and its formal representation have been a concern especially since the advent of GIS. Harris and Lock (1992:118-120), for example, provide an early discussion of spatial error and fuzziness in the context of the representation of archaeological records in a GIS.

For the purposes of a regional compilation, all source observations have locations which are known with a greater or lesser precision and accuracy. The relevant database table could contain fields on whether the observation concerns a point, line, or area, on the original coordinates, projection and datum under which the element was mapped, and on the scale and method by which the element was mapped. From this information could then be derived other database fields containing the most probable location of the observation in the current coordinate system, and a measure of the uncertainty of that location. Archaeological co-ordinates may be available in any of several projections (among them geographic and UTM) and co-ordinate systems (for the RPC project: ED1940, ED1950, and WGS1984). The original co-ordinates in this table, provided by the source, may therefore have to be transformed to some standard projection and datum – for the RPC project, this standard is the *old* Italian national grid system under the Gauss-Boaga projection, datum ED1940. In addition to the spatial location, observations may have one or more administrative locations. Inasmuch as these are relatively stable, they can be derived from appropriate GIS map layers (*regione, province, comune*, sheet numbers and names of the IGM 25V and 50 map series). However, the location of older observations will often be related to a local toponymic such as a field or house name, or to a property (“on the land of ...”); this information must be stored in the table as well because it may not be possible to convert it into a spatial location in a reliable manner.

Finally, metadata fields must be added to the table in order to record information relevant to the spatial accuracy of the observation. Foremost among these is the mapping scale (referring to the scale of the *available* input maps; other scales may exist but be inaccessible to us), but indications regarding the mapping method may also be available from the source.

A single pair of co-ordinates indicates a site centroid; the site may have the further spatial attributes of size (radius, diameter), spatial precision, and spatial fuzziness. Alternatively, archaeological remains may be represented cartographically by vectors in the form of lines (eg, stretches of road, wall, or drainage ditch) or polygons. In the case of a line vector, metadata may be needed to record the width of the feature being represented; in the case of a polygon metadata are needed to record the nature of the feature (eg, whether it represents a site core, a site with ‘halo’, an agricultural field, or a survey grid unit). In both cases metadata on precision and fuzziness remain necessary.

RPC interpretations at all levels of aggregation must have spatial characteristics as well, in order to be used and analysed in a GIS environment. These spatial characteristics must be constructed (either manually or automatically) out of the spatial characteristics of the constituent observations<sup>8</sup>. Since spatial

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<sup>8</sup> And their fuzzy properties must also be inherited!

nearness is the single most important reason for aggregating observations into higher-order interpretations, the process of interpretation must include an assessment of the stated spatial location of an observation, and this may lead to a new metadata field containing the spatial accuracy of the observation. This will usually be related to the mapping method used by the source – for example, location sites by eye on 1:25,000 maps in areas where few topographic controls such as buildings and field boundaries are available can result in errors of up to several 100 meters.

#### TEMPORAL FUZZINESS

The chronological attributes of source observations come in a huge variety of terms and classifications, many of which need historical interpretation. Again, source observations must be deconstructed into elements potentially belonging to different periods within the classification used by the source. The dating evidence presented by the source must be recorded as well, for subsequent interpretation.

Table D: OBSERV\_PHASES

Obs_ID	Period	Evidence
1	Hellenistic	Presence of BG
2	Bronze Age	Guess, based on description of fabric as thick, red and with sandy temper

Interpreting these data requires us to transform the variety of dating systems and terms used into a single dating standard, as well as to assess how reliable the data in themselves are. Since typo-chronologies tend to diverge as the distance between the observations increases, and a single period term may have different chronological significance depending on where an observation is made, period terms used by the RPC project are valid only at the regional scale. Table 5 below presents the two chronological systems used in central and southern Italy against an absolute time-line. In order to effect supra-regional chronological description, we are forced to use either very broad periods or *absolute* dating. However, we do not want to lose the fuzzy nature of period terms – in terms of absolute date, ‘Hellenistic’ carries a probability function that allows overlap with the subsequent Roman period – and must therefore devise a system of fuzzy dates.

Table 5: comparison of chronological systems in use in south Lazio and southern Italy.

Abs date	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+1	+2	+3
Salento	BF / EIA			IA		Arc	Clas	eHel	LHel/IRep		Imperial			
S Lazio	BF	EIA		MIA	LIA	Arc	p-Arc	Republican			Imperial			

Interpreting the dating evidence presented by a source is often extremely difficult, and so various metadata fields are needed to record the nature and amount of uncertainty associated with any period assignment. The nature of the dating evidence can be stored in one such field. A default ‘source reliability’ might be used to indicate our confidence in the general quality of the periods assigned by the source; in specific (older) cases we may be able to adjust source terminology to modern usage; and targeted fieldwork may enable us to assign probabilistic periods to source observation (see especially the re-interpretation of the Quilici dates for Hellenistic-Roman sites in the Sibaritide, chapter 12).

## 2.6 CONCLUSIONS AND FURTHER WORK

The power (and weakness) of an RDBMS lies in the web of relations between the tables described above. One ‘site’ can have many phases, each of which can have many features; conversely, a feature can belong to several phases. Usually one source will contribute many observations, but there may also be several sources contributing information about the same site<sup>9</sup>. In other cases, it may not be certain that these

<sup>9</sup> Not about the same observation, which is equivalent to a ‘visit’ and represents a unique episode.

sources are about the same site. Several observations by the same or multiple sources may become part of one interpretative entity, but they may also become part of several ‘competing’ interpretations.

Where-ever possible, the content of the database fields described above should be entered in the form of agreed term lists or ‘authorities’, which are not part of the web of relations. The table structure outlined above is itself documented within the database as well, by means of another unrelated table containing all table names and full table descriptions in Word OLE objects. The relations between the tables are specified in the ‘Relationships’ window of MS-Access, and are themselves also documented in a table.

Much has been written above about the variable, and often lacking, quality of the data that together form the archaeological record for any region. Broadly, there are two ways of avoiding the issue: either records containing vague, inaccurate, or incomplete data are excluded from all analysis, or all such records are included in all analysis without any regard for the implications of data quality concerns. The former option is attractive because it would considerably simplify the database design and the interpretation of source data, leaving only relatively high quality data to work with; but the down side is that it may result in an unacceptably high percentage of records being rejected. The latter option is also attractive because ignoring problems with data quality simplifies the database design, data entry, and querying, but at the same time it might lead to an unacceptable ‘pollution’ of the results of such queries. The alternative pursued by the RPC project is therefore to include all records and to implement appropriate means of dealing with data quality issues.

#### FURTHER WORK ON THE RPC DATABASE

For the RPC database to become operative, the database design has to be finalised and implemented, the process of data entry and interpretation must be completed, and the project’s archaeological questions have to be translated into database queries. This work, once finished for all three RPC study regions, will form the basis for much of the final project synthesis which is currently in preparation. Initially, many of the design principles discussed above will be implemented partially or not at all because a full implementation would require more time than is warranted for the limited goals of the RPC project. The final database design (tables and relations) will therefore be much simpler than was suggested above.

Much work still needs to be done to establish and test authorities for the chronological and typological classification of source data and interpretative constructs, especially on implementing their ‘fuzzy’ properties such as the date range associated with the various diagnostic materials. Once stable classification criteria have been worked out, the process of data entry and interpretation is expected to progress fairly rapidly. However, no fuzzy GIS operations have been defined as yet to make use of the fuzzy data types that will be part of the database. More generally, the work of constructing queries that make use of the metadata information that will be generated for the database has not yet started, and this is where, ultimately, the effort of creating the database will have to pay off.

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### 3            **COMPARING DATA SETS OF THE PONTINE REGION**

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#### 3.1        **INTRODUCTION**

Tobler’s (1970) first law of geography reads “everything is related to everything else, but near things are more related than distant things.” It follows that the problems and potential of interregional comparison can perhaps best be approached by tackling the lesser task of intra-regional comparison first. Beginning at the largest possible scale, I will first attempt to compare several datasets resulting from surveys within the same landscape unit (the colluvial slopes in the northern section of the Lepine margin, see section 3.2 below). This is followed by a comparison of data across a much wider area and multiple landscape units, covering most of the Pontine region (section 3.3 below). Ultimately, these comparisons have three objectives: firstly, to explore approaches to the *formal* comparison of archaeological data sets; secondly, to

review the settlement and land use history of the Pontine region in the light of all available data; and thirdly, to review the effect that research methods have had on the results and interpretations of these surveys. The following quantitative and qualitative properties will be used in my exploration of formal methods for comparing archaeological data sets at a regional level:

- Total number & density of sites, number & density per period, ratio of count & density per period
- Absolute and relative composition of assemblages, either within sites or within other geographical units
- Site size and rank-size distribution
- Site continuity/discontinuity by period
- Site location characteristics

Given the variability in archaeological recording techniques, a highest common denominator approach implies that we must base our comparison on ‘sites’, perhaps comparing their sizes, densities per km<sup>2</sup>, and rank-size distributions across regions and the development in their size (demography) and features (function) over time. All of these comparanda must be sufficiently well-defined for us to feel confident that we are comparing like with like. However, recent surveys yield more and more ‘off-site’ data, and it may also be argued that we cannot afford to ignore such data, particularly since these intensive surveys often provide the information we need for ‘source criticism’ of the less intensive survey data. In these cases we might attempt to construct and compare ‘off-site’ density histograms summarising the intensity of ‘landscape use’ per period as inferred from off-site finds densities. However, in view of the widely acknowledged variability in the amount of material recovered in any single survey pass, such an approach might reduce us to studying and comparing the *relative* abundance of the various material groups rather than their absolute number or density. Such an approach, although it appears feasible, lies outside the scope of this chapter.

## DATA SETS

Let us now have a more detailed look at the available data sets for the Pontine region, introduced in section 2.2 above. A first coarse classification of the available survey data into four qualitatively distinct classes can be made on the basis of whether the survey was or was not site-oriented, and whether data collection was or was not systematic (see figure 2).

Large sections of the Pontine region have been surveyed in an unsystematic site-oriented manner. The topographic surveys of the *Forma Italiae* series are good examples of this; five sheets have so far been published for the Pontine Region (see figure 1). In what follows, the topographic survey covering the all of the Cora sheet plus the southern half of the adjoining Artena sheet of the IGM 25V map series (a total area of 146 square km; Vittucci 1968) will be used as an exemplar because of its overlap with the RPC intensive survey area near Ninfa.

		Site oriented	
		yes	no
Systematic	yes	Site survey, eg Norba, Lanuvium	Off-site surveys, eg Fogliano, Sezze Sampling surveys, eg Agro Pontino project
	no	Topographic surveys, eg ‘forma italiae’	Incidental finds

Figure 2: classification of survey types

Two types of systematic, none-site oriented surveys have been conducted in the Pontine region: extensive sampling surveys and intensive off-site surveys. The Agro Pontino Project surveys, by the University of Amsterdam, ran between 1982 and 1989. In three of these seasons (1984, 1986, and 1988) the surveys were conducted according to a probabilistic sampling design. Only preliminary analyses of the APP data are available, and the ceramics in particular were not recorded consistently across all campaigns (Voorrips

et al. 1991). In the field, only very dense and localised artefact scatters were recorded and sampled as a unit; subsequently, further 'sites' were defined by administrative grouping of adjacent agricultural fields but the details of this procedure are unclear (Koot 1991:124-5). The distribution maps presented by Koot must therefore be interpreted with caution, and are best understood in the context of the five vegetational zones into which the Pontine plain was subdivided (see figure 3).

Intensive and systematic off-site surveys were conducted in the period 1994-1999 by teams from the University of Groningen under the direction of Prof. Attema in the vicinity of Sezze (Lepine footslopes) and Fogliano (coastal landscape, see chapter 10 for details). The Sezze area had been chosen as an example of a landscape that had undergone 4<sup>th</sup> century BC rural colonisation, while the Fogliano area had been selected as a typically 'marginal' area. Finally, systematic intensive site-oriented rural surveys were carried out by other teams directed by Attema near Lanuvium in the Alban hills (1995), and Norba (1995) and Ninfa (1998; see chapter 9 for details) again in the Lepine footslopes. Attema chose the volcanic ridges east of Lanuvium as an example of a developed Latin landscape being Romanised in the middle Republican period, and the Norba and Ninfa areas as examples for similar Roman colonisation of a 'marginal' landscape of Lepine footslopes. These surveys provide the first quantifiable data on the pre-Roman landscapes of south Lazio.

### 3.2 COMPARISON WITHIN THE SAME LANDSCAPE UNIT: THE NORTHERN COLLUVIAL SLOPES

The Lepine footslopes between Cori and Norma are part of the northern colluvial landscape unit, and were included in the southeastern part of the area surveyed by Vittucci sometime before 1968. In the 1930s a major canal (formerly known as the Canale Mussolini but now named Canale delle Acque Alte) was built parallel to the Lepine slopes in order to collect waters from it and transport them to the Tyrrhenian sea near Torre Astura. The works related to this, and the wide 'footprint' of the canal itself, have served as a convenient boundary to the nearby Ninfa<sup>98</sup> and Norba<sup>95</sup> surveys. Both took place on the footslopes of the Lepine mountains directly northwest of the Late Iron Age /Archaic proto-urban centre of Caracupa/Valvisciolo, but the two survey areas are physically separated by a 400 m wide loop in the Canale della Acque Alte where this has followed the elevation contours to abut directly on the limestone slopes of the Lepine scarp. Here, the higher ground formed by the two fluvio-colluvial fans emanating from the direction of Cori ("Vigne Vecchie") and the mouth of the *Fosso della Valle* must have originally given way to the lower-lying land of the Pontine plain proper. Little or no colluvial soil covering has built up, which may have been the main reason why a subrecent limestone quarry was situated here as well. The whole area is dominated by the Norba promontory, and in the later medieval period was the site of the town of Ninfa.

The Norba survey (King 1995), intended to study the Roman 'colonial' villa landscape near the colony of Norba, covers part of the Lepine footslopes between Caracupa and Norba itself. The 74 hectares covered by this survey were augmented in 1999 by a further 9 ha in the area known as 'Pellicio', extending the survey just across the Canale Mussolini. The Ninfa survey had also originally been intended as a simple extension of the Norba survey in a northwestern direction along the Lepine footslopes, but quickly became more oriented toward intensive off-site recording methods as it became clear that pre-Roman material occurred in scatters in between the Roman villa sites, as well as on them. The total area of 27 agricultural fields surveyed intensively in 1998 was 91 ha. In 1999 a number of these fields and sites were re-visited in order to collect additional data.

#### SETTLEMENT DATA

The Norba<sup>95</sup> survey resulted in the discovery of 11 sites (King 1995). Only one of these (a Late Iron Age hut) dates to the protohistoric period. Archaic (6<sup>th</sup> century) material was found on four sites, each of which was also occupied in the Roman Republican period (no evidence from the intervening post-Archaic period was found). Seven more sites beginning in the Roman Republican period were also found, bringing the total to eleven, of which three were 'platform' villas. Only three of the 11 Republican sites show evidence of continued occupation into the early Imperial period.

The Ninfa98 survey resulted in the mapping of approximately 13 new sites in addition to the 12 already described by Vittucci<sup>10</sup>. These new sites range in date from the late Iron Age to the early Imperial period, so that not only was a complete pre-Roman landscape added to the classical landscape known to the topographers, but also the density of Roman settlement was proved to be nearly double that recorded in the topographic survey.

Table 3a: site counts (#), percentage (%), and average density per century/km<sup>2</sup> (d) per period for the Cora, Norba, and Ninfa surveys. Duration in centuries: EIA: 2, LIA: 1, ARCH: 1, PARCH: 1.5, REP: 3.25, EIMP: 1.25, IMP: 2.

	Cora 1968			Ninfa 1998-9			Norba 1995		
	#	%	d	#	%	d	#	%	d
Early Iron Age	-	-	-	2	4	1.1	-	-	-
Late Iron Age	-	-	-	17	34	9.3	2	10	2.4
Archaic	-	-	-				4	20	4.8
Post-Archaic	-	-	-	12	24	8.8	-	-	-
Roman Republican	6	31	2.0	10	20	3.4	11	55	4.1
Early Imperial	1	5	0.9	7	14	6.2	3	15	2.9
Full Imperial	-	-	-	1	2	0.5	-	-	-
Indet. Roman	12	64	-	1	2	-	-	-	-
<b>totals</b>	<b>19</b>	<b>100</b>		<b>50</b>	<b>100</b>		<b>20</b>	<b>100</b>	

Table 3b: site counts (#) and percentage (%) per site type for the Cora, Ninfa, and Norba surveys.

	Cora 1968		Ninfa 1998-9		Norba 1995	
	#	%	#	%	#	%
hamlet	-	-	1	5	-	-
scatter	-	-	10	50	3	25
Building scatter	-	-	-	-	3	25
villa	5	31	4	20	3	25
Platform villa	1	6	3	15	3	25
Infrastructural	3	19	-	-	-	-
terracing	6	38	-	-	-	-
Graves/tombs	1	6	2	10	-	-
<b>totals</b>	<b>16</b>	<b>100</b>	<b>20</b>	<b>100</b>	<b>11</b>	<b>100</b>

The relative absence of Late Iron Age and Archaic sites in the Norba95 survey area, as opposed to the Ninfa98 area, may be conceived to be an expression of the fact that settlement in this period was centralised at Caracupa/Valvisciolo (Attema 1993a:122 suggests an identical explanation for the volcanic landscape between Cori and Cisterna di Latina); but on the other hand it may be caused by the fact that the survey only aimed to locate Republican (platform) villas in the area. The one Late Iron Age hut site found contains evidence for both weaving and storage but was not continued in the Archaic. Indications that an Archaic sanctuary may have been present at the edge of the fluvio-colluvial fan in the Pellicio area can be interpreted in the context of the liminality models suggested for Etruria (see chapter 15 for more on this).

Some additional observations for this colluvial landscape unit can be gleaned from Attema (1993, forthcoming). In an extensive site-oriented survey conducted in 1987, one of Attema's transects ran through the volcanic and colluvial landscape between Cisterna di Latina and Cori, revealing continuous occupation from the early Iron Age onwards. However, he only discovered two sites in the Lepine footslopes: site 5 "Torretta" was a large scatter dating from the Archaic into the early Imperial period, and site 6 "Grotticelle" was an Augustan villa with prior rural use since the post-Archaic period (Attema 1993a:117-22, 269-71). A second transect ran almost north-south and covered several fields in the alluvium/colluvium below Valvisciolo/Caracupa. High Archaic finds densities here were related primarily to the settlement and necropolis of Caracupa, while material on the lower part of the alluvial fan was difficult to interpret because of post-depositional sedimentation and earth movement (Attema 1993a:122-

<sup>10</sup> A precise number cannot be given because the identification of sites with those mapped by Vittucci was uncertain in several cases, and some Vittucci sites could not be relocated. For full details, see chapter 9.

33 and catalog 1b). Finally, intensive surveys were also conducted in 1988 by Attema on the ‘proto-urban’ site of Caracupa/Valvisciolo itself and, slightly the east on the plateau of Contrada Casali near Sermoneta (Attema 1991a, 1991b, 1993a:157-80, 1993b). All of this supports the notion that a continuous developed Archaic settlement system was present along the rim of the Lepine mountains in the northern colluvial landscape.

The lack, in the Norba95 area, of any evidence from the post-Archaic period (500-350 BC) at sites occupied in both the Archaic and Republican periods may be interpreted as the outcome of – literally – ‘unsettled’ circumstances due to the Roman-Volskan conflict. Until as late as 330 BC, the Norba territory was raided by Privernates, and it is quite possible that defenceless farm sites were abandoned early on. However, post-Archaic ceramics in south Lazio are generally of a very undiagnostic nature, hampering consistent recognition in surveys, so they could not be used to establish the presence of post-Archaic sites in 1995. Fabric studies were begun to address this problem, and by the time of the Ninfa survey post-Archaic fabrics were tentatively identified (Attema & Oortmerssen 2000). Rather than settlement discontinuity, the Ninfa data demonstrate a gradual decrease both in the number and the density of sites from the full Archaic into the Republican period, which could be interpreted as a gradual consolidation into a smaller number of more substantial farms.

Rebuilding in recognisably Roman architectural style and materials, if not re-occupation, may have occurred sometime in the 3<sup>rd</sup> century BC, although the datable finds generally point to a 2<sup>nd</sup> century date for the Roman villa sites. The evidence appears to support the presence of a late Republican site hierarchy in two levels as first proposed by Attema (Van Leusen 1998). A few platform villas, located in clearly higher elevations and on steeper slopes away from agricultural land, constitute an upper rank of settlement; the larger number of other (platform or non-platform) villas constitutes the ‘standard’ rank. The apparent decline in settlement density setting in in the early Imperial period fits in well with general trends across the Pontine region (eg, Attema et al. 2001), and may be connected to the progressive loss of Roman markets for grain and olive oil.

## CONCLUSION

Comparing the results of all the available surveys, it becomes clear that less intensive survey results in the discovery of a predominantly classical landscape, because sites from this period are the most obtrusive (large and dense scatters containing both tile and ceramics, standing architecture, many diagnostic wares). Nearly all Cora68 and Norba95 sites were clearly visible for these reasons. A further hurdle to the comparison of all three data sets is presented by the apparent use of incongruent chronological and typological classifications, which studies of the ceramic fabrics involved are now going part way to resolve.

### 3.3 COMPARISON ACROSS LANDSCAPE UNITS: THE PONTINE REGION

We will now extend the comparison of data sets to include both landscape units directly adjacent to the northern Lepine footslopes, and those further afield in the Pontine region.

#### THE VOLCANIC LANDSCAPE OF THE ALBAN HILLS AND THE LEPINE SLOPES NEAR CORA

Most of the Cora volume of the *Forma Italiae* series covers the easternmost part of the landscape of low ridges and valleys of volcanic origin typical of the Alban hills, the alluvial / colluvial fan at the apex of which sits the town of Cora itself. To a lesser extent, it also covers accessible parts of the Lepine mountains and its colluvial footslopes. To the west of this topographic survey area, Attema's intensive site-oriented Lanuvium survey covered a few square kilometers of several very similar volcanic hill



systems. Of the 201 sites recorded in the Cora68 area, 134 were dated and 142 were given a site type interpretation (see table 4)<sup>11</sup>.

Table 4a: Cora68 and Lanuvio95 sites by period

\*counts based on total 'stringsquare' samples; 17 out of 40 IA sites are based on less than 5 sherds.

	Count Cora 1968	Number discontinued	new	Number continued	Density per century / km2		Density per century / km2
Iron Age	-	-	-	-	-	40 (incl eArch)	3.4
Archaic	3	-	3	-	0.02	46	5.4
Post-Archaic	4	1	2	2	0.02		
Republican	68	2	66	2	0.14	45	4.1
Imperial	21	61	12	9	0.04	-	-
Medieval	1	21	1	0	-		
Roman	54	3	53	1	-		

Table 4b: Cora68 site count by type (additional uncertain attributions in parentheses)

Type	Subtype	count
Habitation	Building	3
	Farm	9
	Farm / Villa	2
	Villa	40 (7)
	Large villa	7
	Castle	1
Infrastructure	Road	23 (2)
	Bridge	2
Water management	Cuniculus	9 (2)
	Fountain	1
	Cisterna	14 (1)
Other	Tomb, necropolis	2 (2)
	Quarry	1
	Terracing	14

The first thing that one notices is the almost completely classical nature of the landscape of roads and villas mapped and dated for the most part to the period from the late 2<sup>nd</sup> century BC to the late 1<sup>st</sup> century AD (Vittucci 1968:17). 133 out of the 134 dated sites are Roman; only one site (of Archaic to post-Archaic date) has no Roman successor. Clearly, this must result from a combination of the high obtrusiveness of, and high interest in, remains of the classical period - very much in the tradition of the earlier *Forma Italiae*. The assignment of dates on the basis of sometimes very summary evidence is hazardous, and certainly introduces a bias toward the classical periods. The protohistoric periods and the post-Archaic go almost unrecognised - only 5 sites were recorded - but a glimpse of the presence of the latter period on many later Roman sites is provided by Vittucci's (1968:17) mentioning of 'ceramica d'impasto rossiccio'. Closer dating of sites within the Roman period on the basis of the architectural evidence remains problematic, since only some of the *opus* (walling types) have clear chronological implications - and this applies *a fortiori* to the four 'polygonal' styles of terracing. 53 out of the 133 Roman sites (40 %) could therefore not be assigned to any particular part of the Roman period. Of the sites that could be assigned to a sub-period, 68 were assigned to the Republican period and 21 to the Imperial period, but continuity from the previous period was only attested in 9 of the latter. The low figures for continuity across all periods strongly suggest that sites were regarded by the researcher as single-period entities, and little notice was taken of evidence of the presence of previous or later periods.

Depending on the type and amount of evidence, farm buildings are classified as 'building', 'farm', 'farm / villa', 'villa', and 'large villa'. Altogether, there are 68 such sites. An overall predilection for structural remains, coinciding with the classical preference already mentioned above, is one of the main

<sup>11</sup> After re-interpretation of the Vittucci data by Drost (1996) and Attema.

characteristics of this data set. In addition, the survey was conducted according to topographic tradition with a view to the reconstruction of the *viabilità antica*, and mainly concentrated along a limited number of roads and paths (Vittucci 1968:19); undoubtedly, this must have contributed to the creation of spurious spatial site patterns in the form of linear clusters. Besides a large number of sections of Roman road revetment, other structural remains of note relate to water management (cuniculi and cisterns).

In the 1995 Lanuvium survey, Attema abandoned the total collection methods developed in earlier surveys in favour of more efficient artefact counting in the field and collection of diagnostics only. This has had the unfortunate effect of making it impossible to check his results by subsequent re-analysis of raw data. In preliminary analysis (Attema & Van Leusen, forthcoming), a total of 52 sites were defined in an area of 339 ha for a total site density of 13.0 / km<sup>2</sup>; table 4a shows the chronological distribution of these sites. Attema concluded that the area “showed continuity in ceramic production and supply from the Iron Age to the Roman period” and dates the incipient rural infill of the Alban hills area near Lanuvium to the 8<sup>th</sup> and 7<sup>th</sup> centuries BC, with an intensification occurring towards the end of the 7<sup>th</sup> century (Orientalising period; Attema 2000:424). This rather diffuse infill is transformed (‘crystallises’) into a fairly dense pattern of Archaic farmstead scatters in the 6<sup>th</sup> century.

It should be noted here that the fabric provenance data supplied by Attema (2000:422 and fig. 8) indicate that the survey methods employed in the Lanuvium survey were not suitable for the recognition of diffuse scatters, and also that red firing (early) fabrics were much more likely to occur in such diffuse scatters than were the later orange or pale firing fabrics. In other words, the site counts per period significantly underrepresent the number of 7<sup>th</sup> and 6<sup>th</sup> century BC sites. We again see that both the settlement chronology of the Lanuvium area as a whole and the density of settlement in individual periods, differ so radically from those of the adjacent Cora68 survey area, that a comparison only serves to underscore how much remains unrecorded even in areas that were investigated by professional archaeologists.

#### THE LANDSCAPES OF THE PONTINE PLAIN

Extending our comparison to landscape types further away, and often quite different from, what has been considered the traditional homeland of the Latial tribes, we now turn our attention to the Pontine plain proper. The geological formation of the Pontine plain is determined by an active horst and graben system. The geomorphology of the former is sculpted by the recession, in several stages each leaving coastlines and lagoons at diminishing elevations, of the sea; the gradual sinking of the latter has resulted in a net depositional environment characterised by alluvial and colluvial deposits emanating from the Alban and Lepine hinterland, and an accumulation of clays and peats in the remaining parts. On the basis of the different soil types formed in these deposits, the plain has been divided into five vegetational zones by members of the Agro Pontino project. These are convenient landscape units for current purposes as well, against the background of which the archaeological data sets for this region can be compared. Figure 3 shows the distribution of findspots by period; table 6 presents the findspot count by period. The term findspot is used advisedly because, as our source (Koot 1991:124-5) is careful to mention, the collection and recording methods employed by the Agro Pontino Survey were geared to highly diffuse and extensive lithic distributions and do not allow the definition of meaningful ceramic sites.

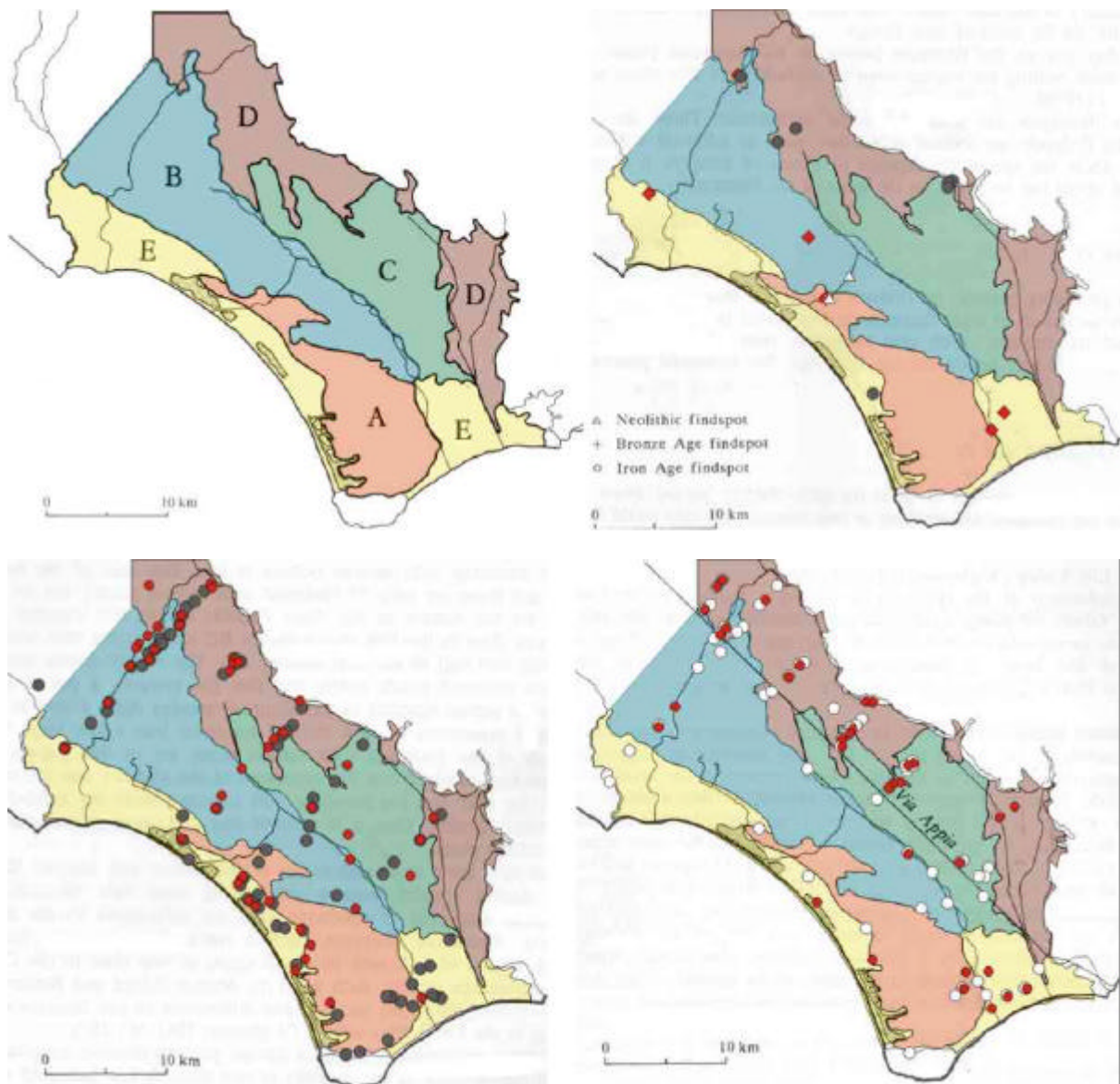


Figure 3: Vegetational zones and distribution of APP findspots in the Agro Pontino (after Loving *et al.* 1991, fig 2 and Koot 1991, fig 1-5). Top left: vegetational zones. A-aeolian sands, B-lagoonal clays, C-peats and humic clays, D - colluvium, E-beach ridge-lagoon mosaic of sands and clays. Top right: distribution of protohistoric ceramics. Triangle - Neolithic, diamond - Bronze age, circle - Iron age. Bottom left: distribution of Archaic findspots. Grey - early Archaic, red - late Archaic. Bottom right: distribution of Roman findspots. White - Campanian, red - Samian.

#### INTENSIVE SURVEYS NEAR SEZZE AND FOGLIANO

In the Sezze survey, initially some 20 mainly Roman sites were recorded in an area of 83 ha; in subsequent analysis of the off-site ceramic distributions (Feiken 2000) several more sites and a much greater time depth to the existing sites were defined. With some difficulty (recorded sites that fall outside the boundaries of the surveyed fields had to be removed first), we can calculate an overall site density of 24.1 per km<sup>2</sup> for Sezze. Two previous extensive surveys in the Sezze area (Zaccheo & Pasquali 1972, PRP94) also recorded an almost exclusively Roman (post-Archaic to Imperial) landscape before analysis of the 1995 survey data showed the protohistoric roots and Archaic predecessors of what had appeared to be a virtually pristine landscape colonised by the Romans in the 4<sup>th</sup> century BC (Feiken 2000).

Table 6: Number of APS findspots per period (from Koot 1991).

	Count	Veget. zone	Remarks
Neolithic	1	B	Ceramics recognisable only by their association with lithic scatters
Bronze Age	6	A, B, E	-
Early Iron Age	8	D, E	3 of these occur in the Sezze colluvium
Late Iron Age / Archaic	48	All (few on B)	Especially dense in the northern colluvium
Late Archaic	49	all	No change in the spatial distribution; 12 findspots are continued from previous period
Post-Archaic	37	-	Based on the presence of 'local ware'; no distribution map given
Republican	125	all (very few on B, many on C and D)	Based on the presence of Campanian ware, mostly late 4 <sup>th</sup> to 2 <sup>nd</sup> c. BC; number of findspots based on estimate, not a count
Early Imperial	36	All (very few on B, many on C and D)	Based on the presence of Samian ware; distribution similar to that of previous period

Traces of human occupation of the Fogliano survey area were present in an unbroken sequence from the Middle Palaeolithic onwards. The earliest ceramics, which are of a friable reddish-brown fabric with a sandy temper, probably date to the late Bronze and early Iron Ages, and by advanced Iron Age (c. 800 BC) ceramic scatters occur in all major geomorphological subunits of the landscape. By the beginning of the Archaic site density had doubled and essentially all of the coastal beach ridge and lagoonal landscape was in use, excepting only the clayey hinterland. In the relatively restricted spaces afforded by the long and thin beach ridges, no major changes in settlement and land use patterns are apparent throughout the post-Archaic and Republican periods, but the picture was dramatically different for the larger and more fertile landscape of aeolian sands to the southeast. Here the number of settlement sites doubled in the post-Archaic, and again more than doubled in the late Republic. The growth of a rural village here has been linked to the economic pull by a small number of large maritime villas which controlled industrial fish farming in the lagoons and along the coast. As in the Sezze area, there is little or no evidence to indicate that any of these settlements continued into the middle Empire (full details available in chapter 10).

Table 7: site counts (#), percentage (%), and density per km<sup>2</sup> (d) per period for the Sezze and Fogliano surveys. \*: includes late Republican sites

	Sezze 1994			Fogliano 1998		
	#	%	d	#	%	d
Late Bronze Age	5	9	6.0	2	3	0.7
Early Iron Age	6	10	7.2			
Late Iron Age	-	-	-	9	12	3.3
Archaic	~20	~34	~24.1	12	16	4.4
Post-Archaic	~20	~34	~24.1	14	18	5.2
Republican				12	16	4.4
Early Imperial	-	-	-	24 *	31	8.9*
Full Imperial	7	12	8.4	4	5	1.5
<b>totals</b>	<b>58</b>	<b>99</b>		<b>77</b>	<b>101</b>	

Table 7 appears to show that there is not much difference in the relative site counts by period between the Sezze and Fogliano areas, until one realises that there is a difference of two centuries between the respective dates for Romanisation – around 300 BC in the Sezze area, around 100 BC in the Fogliano area<sup>12</sup>. If one looks at the densities (counts per km<sup>2</sup>) per period, the much higher intensity (roughly six-

<sup>12</sup> The late dating of Republican material from Fogliano raises a problem in the interpretation of the post-Archaic material in the Fogliano area. If the post-Archaic date is correct - if it really is 5th and 4th century - then a middle Republican settlement hiatus opens up; if the post-Archaic material could in fact date throughout the 5th to 2nd centuries BC, then the site density for this period drops by a factor of more than 2. Moreover, we must then face the implications of similarly wide dates for post-Archaic material in other surveys.

fold) of settlement and land use in all periods except the late Republican / early Imperial in the Sezze area becomes apparent.

#### INTERPRETING THE DIFFERENCES AND SIMILARITIES BETWEEN THE DATA SETS

If we now compare the data sets introduced and discussed above, we can to some extent use the later, more intensive, surveys to re-interpret the earlier topographic and extensive survey data. For example, in the light of the protohistoric finds made in the Ninfa and Fogliano surveys we can now interpret the very low number of Bronze Age and Iron Age findspots reported by the APP survey to mean that a low-intensity rural landscape had already formed throughout the habitable Pontine area, excluding perhaps only the wet and peaty sections of the Pontine graben. In the Iron Age, but certainly by the Archaic period, a hierarchically organised social and settlement system must have existed along stretches of the colluvial landscape along the Lepine margin. Only the relative dearth of good farming land there and in the coastal landscape may have prevented these hierarchies from developing at the same pace as in the nearby Alban hills.

Similarly, the spread of early and late Archaic findspots from the APP survey confirms that simple farms spread across the landscape in this period not just in the traditional ‘core’ areas, or near the known proto-urban settlements, but all along the ‘marginal’ Pontine coast up to about 10km inland as well. It is quite possible that larger settlements, up to proto-urban rank, remain to be discovered here; in any case it now seems legitimate to assume that demographic expansion took place here as much as in the Alban area.

Although Koot (1991) did not publish a distribution map of ‘local’ wares for the APP survey, he does note that its distribution indicates that the Volscan wars did not lead to a depopulation of the plain – a conclusion now supported by the post-Archaic site densities reported by the Ninfa and Fogliano surveys. However, dating evidence is still weak for this period, and small shifts in the attribution of some fabric and ware groups could still cause significant changes in the settlement history of the Pontine region for this period.

It is only with the introduction of identifiable Roman ceramics, especially when these occur in combination with architectural remains, that we can begin to compare the older topographic surveys with the ones already mentioned above. Here, the choice of researchers to study areas centering on historically known urban sites is unfortunate since it has served only to create an impression that landscapes colonised culturally, if not physically, by the Romans surrounded, and centred on, these towns. Whilst this impression could conceivably be correct, it is equally likely that it is based on a spurious pattern caused by research and discovery biases – e.g., the tendency of topographers to cling to existing infrastructure automatically leads to higher site densities near the nodal points<sup>13</sup> (for more on such biases, see chapter 4).

For the early Republican period, high density rural settlement appears to concentrate on the Lepine side of the Pontine plain which, from about 350 BC, appears to have been colonised in the true sense, with drainage and infrastructural works enabling the colonists to farm previously marginal areas, and local and regional markets accessible along the Via Appia. The more than three-fold increase in site count reported by the AP survey for the Republican period relative to the post-Archaic must be ascribed to this colonisation of marginal land rather than to the colluvial part of the Ager Setinensis. The Fogliano survey, whilst confirming the lack of early Republican (4<sup>th</sup> – 2<sup>nd</sup> century BC) findspots reported by the Agro Pontino Project survey for the coastal landscape, resulted in the mapping of a dense late Republican (2<sup>nd</sup> – 1<sup>st</sup> century BC) patterns of farms in an area where the latter survey recorded only a single findspot. It may be hypothesised that these later farms would have occurred in clusters, tied economically and perhaps socially to the presence of large maritime villa estates bordering on the coastal lagoons. In this context Vittucci’s dating of ‘most’ Roman rural villa sites in the Cora map sheet to the late Republican

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<sup>13</sup> The clustering of rural villa sites around the colonies of Cora and Setia reported by Attema (1993, fig 148) should, for example, be re-examined in this light.

period is remarkable. One surmises that she dated Roman sites by a limited number of late diagnostic features such as the use of opus reticulatum in walls, ignoring potential indicators for earlier (middle Republican) phases. Nevertheless, if the late dates are at least partially correct, they should perhaps be interpreted as a sign that Romanisation progresses only slowly in a society which already had a strong native Latial structure.

All types of survey agree that a great (approximately three-fold) drop in site density occurred in the Pontine Region by the end of the 1<sup>st</sup> century BC. This dramatic drop continues into the middle Empire, by which time many areas contain no or very few sites at all. Differences in surveying coverage and intensity again assume great importance by the end of this period and into subsequent late Antiquity and early Middle Ages, as the chances of hitting scarce sites, and scarce diagnostic material within sites, diminish.

#### SETTLEMENT DYNAMICS AND CORE PROCESSES

It now remains to connect these interpretations to the processes occurring in the Braudelian *longe durée* in the Pontine region - centralisation, urbanisation, and Romanisation / colonisation.

If, as at the core of the Alban Hills, settlement centralisation in the Pontine region were to begin already in the Final Bronze Age, then surveys in low-lying areas may not be appropriate to detect this and surveys may have to be redirected to up- and highland areas. However, a better understanding of differential circumstances of preservation and discovery of protohistoric fabrics must be developed before we can discount the occurrence of lowland Final Bronze Age/Early Iron Age centralisation altogether<sup>14</sup>.

The study and comparison of the data from rural surveys in the Pontine region has little direct bearing on the issue of (proto-) urbanisation, except insofar as this is put in perspective by the discovery of 'hamlets' (roughly 1 – 2 ha-sized scatters) in both the Lanuvium and Ninfa survey areas. Although the criterion on which this identification is based - scatter size - is rather weak, a basic rank/size hierarchy of settlements can now be hypothesised to develop during the Archaic not just in the Alban hills, but also in the alluvial / colluvial landscape along the Lepine mountains as far south as Sezze and quite possibly in other parts of the region as well. Whilst copious evidence for the development of urban polities in the Archaic has come from the historically known centres, lesser or 'truncated' polities will have centred on places such as Valvisciolo/Caracupa and Cisterna di Latina. At this point it would be advisable as well to remind ourselves of the probable existence of several 'lost' towns in this same area, as reported by Livy (eg, Longula, Polusca, and Corioli; *Ab Urbe Condita* II 33).

A future regional study of the composition of Archaic rural site assemblages might be able to establish the degree of penetration of non-locally produced ceramics such as roof tiles, from which deductions might be made regarding the existence of core-periphery relations between the Alban hills and adjacent Lepine margin colluvium on the one hand, and the Pontine plain and coastal margin on the other. The standardisation of Archaic ceramic fabrics indicates that craft specialisation had already begun in this period; by the end of the 4<sup>th</sup> century pottery production had become centralised to such an extent that no local 'archaic' wares were produced anymore.

As has been made clear, the impact of the expanding Roman Republic within the Pontine region varied both in time and in space, depending both on the claims and resilience of the local inhabitants and on the accessibility and perceived value of the land. The intriguing fact that data sets for both the northern colluvium (Norba95 and Ninfa98), the coastal landscape (Fogliano98-9) and, possibly, the Alban hills (Cora68), appear to indicate that visible Romanisation in the form of simple rural villas (with or without platforms) took place only by the late Republican landscape calls for further investigation. There is now

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<sup>14</sup> Attema's recent research on what appears to be a series of middle to late bronze age industrial sites on the Tyrrhenian coast between Anzio and Astura, possibly involving the exploitation of fish or salt, provides an additional and strong indication that our understanding of protohistoric societies in south Lazio is far from complete.

little doubt that most Roman rural villas anywhere in the Pontine region, excepting the newly drained marshlands, were built on the site of Archaic to post-Archaic predecessors, but still no evidence either for or against the notion that native farmers might have been dispossessed in favour of Roman colonists. In this context the correct dating of post-Archaic ceramics which may straddle a period of local settlement discontinuity, assumes great importance. Certainly there are now few areas left where Roman rural expansion was either contemporary with, or centred on, the colonial towns on the Lepine scarp.

### 3.4 FURTHER WORK

My attempts at comparison of archaeological data sets have tended to reveal more about the methodological differences than about the relative settlement dynamics within the landscape units of the Pontine region. A successful comparison of results, even from two surveys conducted by the same team using the same general methodology, requires extensive standardisation of recording methods and creation of metadata. It is not clear that there are good reasons for the extreme lack of standardisation of survey methodology (an issue elaborated in Van Leusen et al., in prep.). Nevertheless, general trends now appear to have been identified by independent surveys conducted over a period of 20 years, and these in turn allow a re-interpretation of even older survey data:

- Late Iron Age/Archaic rural infill occurs not just in the Alban hills but in the northern colluvium (as demonstrated by both the Sezze and Ninfa surveys and the APP) and – to a lesser extent – in the sandy coastal landscape of the Pontine region as well (as demonstrated by the Fogliano survey). In the latter area the overall density of Archaic farmstead sites appears to be rather lower, though, than in the Lanuvium or Ninfa areas, where distances of two or three hundred meters between sites are not unusual.
- Substantial rural infill appears in the middle Republican period in both the colluvial and the peaty landscape of the Pontine graben (APP and Sezze surveys), strengthening the historical and air photographic evidence for a Roman colonisation in this area. Other landscapes remain largely unaffected until the late Republican period, though apparently for different reasons (Lanuvium and Ninfa surveys, Fogliano survey and APP).
- A drastic (three- to six-fold) reduction in the number of inhabited rural settlements is seen in all data sets in the early Imperial period.

Future research in the Pontine region should take these case studies into account both in its choice of landscape unit and in its methodology. Weaknesses in the core classifications employed for regional archaeological interpretations must be addressed first:

- Local ceramic chronotypology must be further developed through fabric classification (cf. Attema 2000, Attema et al. forthcoming) and seriation of survey assemblages, especially for the post-Archaic period.
- Site type classifications, particularly for the pre-Roman periods, should be improved through a programme of field tests involving surveys, trial trenches, and excavations at a representative sample of site types.
- Surveys should address the current lack of data for what has traditionally been considered the marginal parts of the ancient landscape; especially the up- and highlands.
- Loving and colleagues (1991) note that the original APP sampling design had been too optimistic in its estimates of the number of fields to be surveyed for conclusions to be drawn from the sampled area with the desired confidence level. Despite this and other problems with the interpretation of the results of the APP surveys, the intensive surveys conducted in the various landscape units since the early 1990s now provide a solid basis to revive the idea of a regional stratified sampling design. The

conduct of future survey campaigns within such an overarching strategy can result in a more efficient use of limited resources and should generate more easily comparable data for the region as a whole.

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#### 4 CONCLUSION

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The discussion of regional database design presented in section 2, and the case studies in intra-regional comparison of survey data sets presented in section 3, reveal that there is an altogether surprising degree of variation in the way archaeological data were collected, interpreted and analysed. These differences occur not just between the different research traditions employed historically and, to some extent, nationally, but also between data sets produced by the same team within the same region, and are likely to be present in equal measure in the other RPC study regions. Hence, it is equally difficult to effect formal comparisons between survey data sets.

At the current state of research, the discussion is necessarily concerned mainly with technical obstacles to the comparison of the data sets presented above. Issues include cross-project differences in typochronological phasing, the use of different ‘guide fossils’ and site typology, and the lack of definitions and standards (cf. Van Leusen et al., in prep.). The single most important observation that may be made here is, that the collection of data in *none* of the surveys discussed in this chapter was aimed at enabling comparisons beyond the immediate survey area.

The general lack of standardisation and formal definitions is most apparent in the fact that, although almost all surveys until very recently have reported their results in the form of site maps and catalogues, a wide variety of informal criteria for the definition of sites were applied so that we are simply not comparing like with like. Nor can finds densities be taken to be a better measure of land use intensity: as re-surveying experiments have tended to show (see chapter 8), the obtrusiveness and visibility of surface remains are extremely variable depending on material category and conditions of observation. Consequently, site and find numbers of pre-classical (and presumably post-classical) landscapes tend to be strongly de-emphasised relative to the classical landscape.

It appears that, if we want to make fruitful comparisons at any scale above the purely local, we must conduct our surveys according to specified procedural and data standards, which include a prominent role for quality control and source criticism and are codified in an appropriate database design along the lines sketched in section 2 of this chapter. As has been made clear there, implementing such a regional archaeological database is not a trivial matter, not just because of the wide range of data types that may need to be included and the extreme variability in data quality and definition, but also because seemingly uncontroversial decisions about its structure and authority lists may deeply affect the kinds of results obtainable through GIS or database queries.

Supra-regional comparisons based on relatively obtrusive remains, if they properly account for differences in research intensity, are quite likely the only type of comparison that can successfully be made at this stage. Bintliff’s comparative study of classical ‘take-off’ in Greece is a good example, but the case study presented here in section 3 demonstrates that the appearance of a demographic ‘take-off’ is not born out by closer investigation. Many landscapes had already been cultivated, and were in the process of developing regional hierarchical structures, as early as the Archaic period (6<sup>th</sup> century) before they came under significant influence from outside powers, and we should be very careful drawing conclusions from diachronic variations in either site or finds densities. A Republican rural villa may easily leave 100 times as many sherds for us to find as does its Archaic predecessor, but it cannot be concluded that it housed a significantly larger number of people.

Paradoxically, our case study also indicates that a comparison of *regional* pathways to complexity would be tantamount to ignoring many significant intra-regional differences in the history of settlement and land use. The Pontine region and the Salento Isthmus appear to be both too large to have developed a single homogeneous trajectory, and too small to encompass the clearly relevant adjacent up- and highlands



whose populations drove early centralisation and urbanisation processes, and who resisted the demographic and military encroachment of the lowland powers.

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# LAND USE / LAND COVER BIAS IN THE WROXETER HINTERLAND

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## 1 INTRODUCTION

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### 1.1 AIM

The aim of this case study, and of LULC mapping in the Wroxeter Hinterland Project, is to assess, model, and compensate for the distorting effects of land use and land cover in the discovery of archaeological sites – so-called bias modelling. These biases can be said to operate at two distinct scales of research: a) the local scale, of an area investigated by field walking survey, and b) the regional scale, of an area investigated by site-based desktop study or by aerial photography.

### 1.2 BACKGROUND

From 1994 to 1997 a 40 by 30 km area around the Roman civitas capital of Viriconium Cornoviorum (modern-day Wroxeter in the county of Shropshire, UK) was the object of a regional GIS-supported study funded by the Leverhulme Trust. A general description of the project can be found in Gaffney & Van Leusen 1996; among its many aims was the study of methods for dealing with the main biases present in the archaeological record of any area, and the Wroxeter hinterland in particular (Van Leusen 1996; chapter on biases). The current case study concentrates on just one of those biases – the varying discovery rates of archaeological remains under different types of land use and land cover ('LULC'), and the effect that changes in LULC have on the nature of that record. For a more detailed discussion of biases in regional archaeological data sets, see Chapter 4. The first specific aim of this case study is to demonstrate that such effects can be measured, modeled, and – at least in part – corrected within a GIS environment.

Whereas recent LULC is argued to be an important factor in creating patterning in the archaeological record (see Chapter 2), it is of course recognised that social actions within the landscape, and the archaeological remains resulting from those actions, are themselves also non-randomly distributed. A subsidiary aim of this case study is therefore to review the historical, toponymic, and archaeological evidence for a reconstruction of ancient (Roman) LULC in the WHP area.

Historic land use and land cover data for the Wroxeter Hinterland study area were obtained and digitised from a number of sources, not all of which proved to be of use for the current case study. The three sets of LULC data that will be presented and discussed here were obtained by the digitisation of land use maps created by the Ordnance Survey of Great Britain (OSGB) around 1928 (i.e., before the post-war industrialisation of agriculture in Britain)<sup>1</sup>; by georeferencing and supervised classification of a Landsat TM image of the area dating to February of 1992<sup>2</sup>; and by field work conducted by local volunteers in the

course of the WHP parish survey (1996; partial coverage only)<sup>iii</sup>. Changes in LULC over time can be traced by comparing these maps. These data will be compared with the distributions and characteristics of the archaeological site data obtained from the Shropshire county Sites and Monuments Records.

### 1.3 TWO APPROACHES TO THE USE OF LULC HISTORY IN LOCATIONAL MODELLING

In this case study, two distinct approaches to the use of LULC history in the regional locational modelling of sites in the Wroxeter Hinterland will be explored. Firstly (section 2), the quantitative approach that regards LULC as just one of a range of environmental variables; and secondly (section 3), the historical approach that attempts to reconstruct LULC for the periods being studied. Similarities and divergences between the two approaches will be explored in a concluding section (section 4).

At the local scale, the history of land use is likely to vary field by agricultural field, and each of these can be said to have its own ‘cultural biography’ which must be taken into account when, for example, the results of field walking surveys are being analysed. The same effect occurs as well at the regional scale, and with the site-oriented archaeological data typically available at that scale. Land use and land cover, and changes in them over time, deeply affect not just the archaeological remains themselves (post-depositional processes), but more specifically the archaeological record – i.e., the type, amount, and location of finds and sites coming to the attention of professional archaeologists.

The inclusion of historical LULC data in locational models therefore has a very great impact on results. There is evidence that LULC, through its differential effect on the chances of discovery of archaeological remains, is one of the most important variables in ‘predicting’ site location (cf. Van Leusen 1993:114-115). In their simplest form, LULC maps may be included in predictive locational models as just one more ‘environmental’ variable (cf. discussion in Gaffney & Van Leusen 1995), to be correlated with the locations of known archaeological finds. Alternatively, LULC data may be used to ‘correct’ traditional predictive models by deriving the latter for each LULC category separately, through a masking step. That this results in important changes to site characteristics, will be shown below.

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## 2 A QUANTITATIVE APPROACH

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### 2.1 PROPERTIES OF THE LULC MAPS

Table 1 gives percentages of land use for 1100 km<sup>2</sup> (88%) of the WHP study area, as derived from the 1928 mapping and the 1992 satellite image. It can be seen that some 15% of the total surface area was converted from grasslands and rough pastures to other uses; unfortunately the satellite image classification is not of sufficient quality to put much trust in the 1992 LULC percentages. There has also been a large increase in the area of built-up between 1928 and 1992, but this can not be demonstrated due to the restricted accuracy of the data used.

Higher quality data are available for a sample area of 148 km<sup>2</sup> which was surveyed by local WHP volunteers. Table 2 gives percentage coverage of each land use type within this area for the 1928 and 1996 mappings. These data clearly show the increased intensity of land use in the sample area, with over one quarter of the land converted from extensive (hay and grazing) to intensive (arable) use between 1928 and 1996. Exactly when this change took place is not clear, but it is likely to have been progressive from the post-war mechanisation at about 1950 onward.

Table 1 – Changes in land use over the period 1928-1992, Wroxeter hinterland.

land use category	1928	1992	change
woodland	6.23	8.94	+ 2.71
arable land	22.18	28.23	+ 6.05
meadowland and permanent grass	59.35	50.99	- 8.36
heath, moorland, commons and rough pasture	6.00	-	- 6.00
houses with large gardens, built-up areas	6.13	6.12	- 0.01
water bodies	0.10	1.28	+ 1.18
Unknown / no data	-	4.43	+ 4.43
<b>totals</b>	<b>100.00</b>	<b>100.00</b>	<b>0.00</b>

Table 2 – Changes in land use over the period 1928-1996, sample area.

land use category	1928	1996	change
woodland	6.03	8.75	+ 2.73
arable land	25.34	51.56	+ 26.22
meadowland and permanent grass	62.70	34.04	- 28.66
heath, moorland, commons and rough pasture	1.65	0.22	- 1.43
houses with large gardens, built-up areas	4.09	4.42	+ 0.33
water bodies	0.19	1.02	+ 0.83
<b>totals</b>	<b>100.00</b>	<b>100.00</b>	<b>0.00</b>

## 2.2 PROPERTIES OF THE SHROPSHIRE SMR DATA

At the time this study was conducted (1994-6), the Shropshire County Sites and Monuments Record (SMR) held 936 site records for the 1178 km<sup>2</sup> (38 by 31 km) study area. For the purposes of this case study not all of the many attributes of the SMR records are relevant; the two properties we will discuss here are site *discovery mode* and site *type*.

### DISCOVERY MODE

In order to trace the circumstances under which archaeological remains were discovered, an obvious first step is to use the information held in Shropshire SMR field 90 (*Form*). This field has been filled out for 810 records, and contains four relevant categories: Aerial photographic mark, Finds, Subsurface deposit, and Earthwork. The category Finds is further subdivided into *Finds Only* and *Finds Also*. Table 3 gives the counts and percentages of sites for these categories. Out of the 810 records, 28 must be rejected because information about the original discovery is lacking. ‘Subsurface deposits’ is a category almost exclusively applied to excavated deposits, which were presumably preceded by discovery in some manner other than excavation. Likewise, it is unclear whether the category ‘Finds also’ covers finds made following discovery by another method. In what follows, these categories will therefore play no role. Further information regarding site discovery was sought from SMR fields 160 (*Land use on site*) and 220 (*Description*), but it was found that the content of the former field was generally recorded *post hoc* from air photographs (severing the potential link between LULC and discovery), while the log of events provided by the latter proved to be not very informative about the circumstances of first discovery. Neither field was therefore used, and the following analysis is solely based on the content of SMR field 90, and hence the total number of sites available for analysis is 782. Of these, well over half (58%) were discovered by aerial reconnaissance, another 29% consists of chance finds of (mostly) single objects, and the remaining 13% are relatively obtrusive earthworks such as barrows and hillfort defenses.

Table 3 – Recorded discovery modes of pre-Conquest sites in the Shropshire SMR.

Discovery Mode	Count	% of all records having a discovery mode (n=810)	% of records with primary discovery mode (n=782)
AP mark	457	56	58
Earthwork	101	12	13
Subsurface deposit	14	2	-
Finds	238	29	-
- Finds only	224	28	29
- Finds also	11	1	-
<b>totals</b>	<b>810</b>	<b>99</b>	<b>100</b>

## SITE TYPE

A total of 855 out of the original 936 pre-Conquest sites in the Shropshire SMR data set have a site type attribute, as set out in Table 4. The spatial distributions of these sites are mapped against the background of the 1928 LULC data in Figure 1. Since the majority of the non-stray and non-obtrusive records in the SMR derives from aerial photographic reconnaissance, Table 5 lists site types for this discovery group as well.

Table 4 – Breakdown of pre-Conquest site types recorded in the Shropshire SMR for the Wroxeter hinterland.

Site type	Subtype	Count	% of total
Hillforts	-	18	2
Villas (Roman)	-	22	3
Enclosures	-	281	33
Pit Alignments	-	38	4
Burial Mounds	Ring ditches	73	9
	Barrows	44	5
Field Systems	-	88	10
Trackways	-	33	4
Stray finds	a.o. Flint 50, Coins 30, Early Roman 73, Late Roman 29	258	30
<b>totals</b>		<b>855</b>	<b>100</b>

Table 5 – Breakdown of pre-Conquest site types discovered by aerial reconnaissance in the Wroxeter hinterland.

AP mark type	Subtype	Count	% of total
Enclosure	Curvilinear 22, Rectilinear 88, Hybrid 18	280	60
Pit alignment	-	38	8
Linear feature	-	43	9
Field system	-	44	9
Ring ditch	-	62	13
<b>totals</b>		<b>467</b>	<b>99</b>

## 2.3 UNIVARIATE ANALYSIS

The first step in locational modeling generally involves checking ('exploratory data analysis') of the correlations between the locations of site types and the values of independent variables. Univariate locational preferences form the basis for deciding which variables are likely to be useful predictors. To begin with, distribution maps were produced of the three major discovery classes (figure 2), and one-sample univariate correlations with the three LULC maps were investigated (table 6).

Table 6a - Site List: smr290APmark (457 sites) Layer: Land Use map 1930s (reclassified)

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) water bodies	128285			13		
( 1) woodland	109538	6.2	27.7	12	8.889	1
( 2) arable land	390001	22.2	98.6	216	139.854	1
( 3) meadowland and permanent	1043602	59.4	263.8	201	14.948	1
( 4) heath and moorland	105519	6.0	26.7	5	17.610	1
( 5) other built-up areas	107855	6.1	27.3	10	10.931	1
Totals	1756515	100.0	444.0	444	192.231	4

Table 6b - Site List: smr290Only (224 sites) Layer: Land Use map 1930s (reclassified)

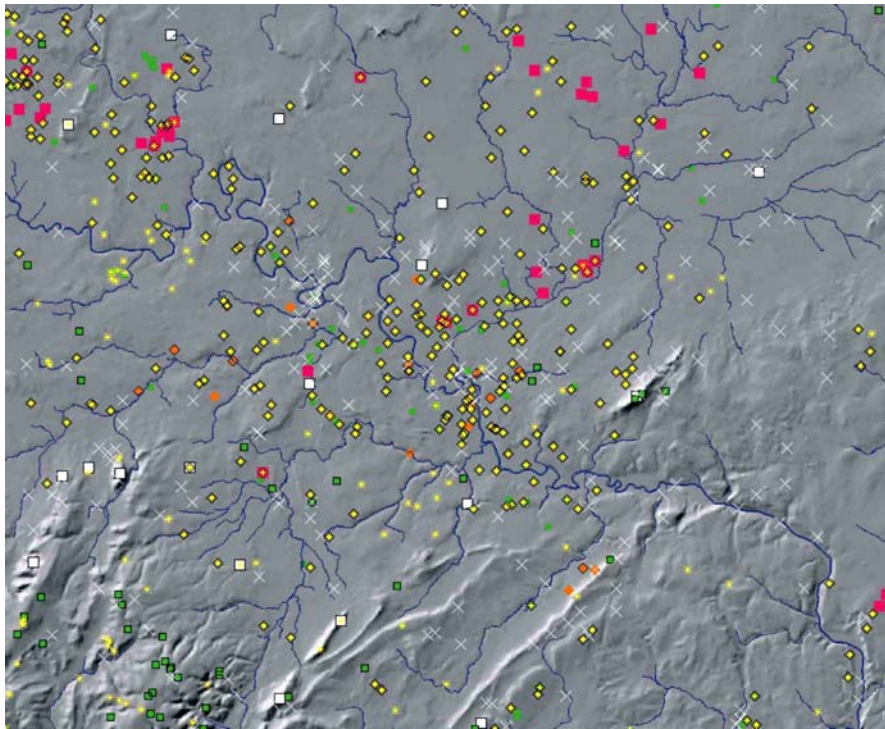
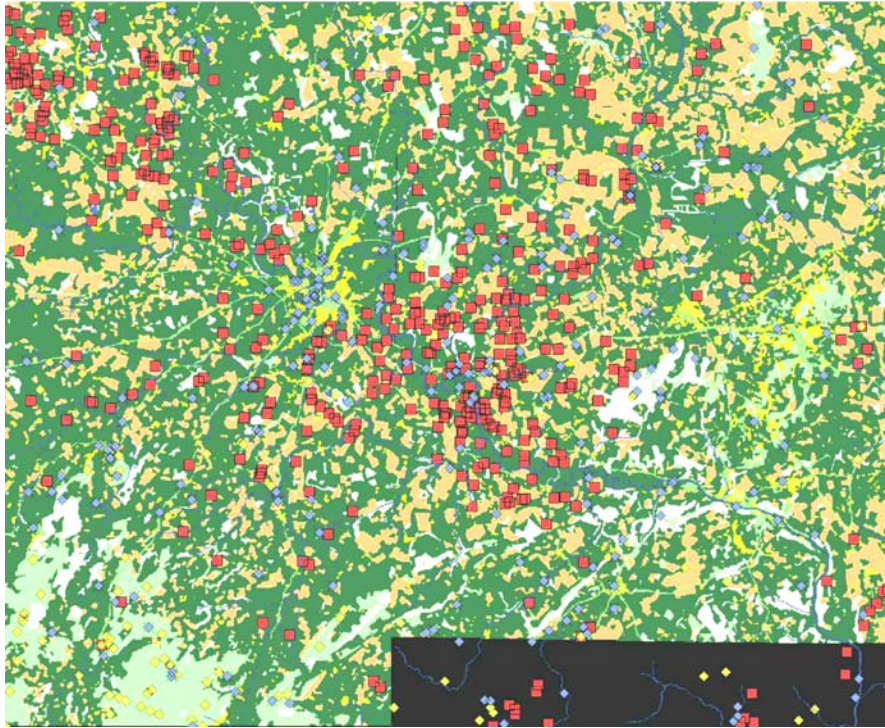
Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) water bodies	128285			15		
( 1) woodland	109538	6.2	13.0	13	0.000	1
( 2) arable land	390001	22.2	46.4	29	6.528	1
( 3) meadowland and permanent	1043602	59.4	124.2	110	1.618	1
( 4) heath and moorland	105519	6.0	12.6	14	0.166	1
( 5) other built-up areas	107855	6.1	12.8	43	70.913	1
Totals	1756515	100.0	209.0	209	79.225	4

Table 6c. Site List: smr290Earthwork (101 sites) Layer: Land Use map 1930s (reclassified)

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) water bodies	128285			11		
( 1) woodland	109538	6.2	5.6	13	9.724	1
( 2) arable land	390001	22.2	20.0	7	8.435	1
( 3) meadowland and permanent	1043602	59.4	53.5	20	20.952	1
( 4) heath and moorland	105519	6.0	5.4	47	319.984	1
( 5) other built-up areas	107855	6.1	5.5	3	1.155	1
Totals	1756515	100.0	90.0	90	360.250	4

It is already evident from figure 1 that the existing recorded archaeological sites have a marked 'preference' for arable land in the 1920s mapping. If we break the record down into groups according to discovery mode, a detailed picture emerges in which arable land use is an excellent predictor for the presence of AP marks (table 6a, cat 2), stray finds 'prefer' intensively visited and worked areas and 'avoid' the only relatively inaccessible arable (table 6b, cats 2, 5 & 6), and earthworks are preserved from the plough mostly on uncultivated heath- and woodland and, to a lesser extent, on permanent grassland (table 6c, cats 1, 3 & 4)<sup>iv</sup>.





*Figure 1 - top: SMR discovery type against 1928 LULC (N=810). Red box: AP mark. Yellow diamond: earthwork. Blue diamond: stray find. Bottom: SMR site types against 1928 LULC (N=855). White box: hillforts. Orange diamond: villa (closed=certain). Yellow star closed: enclosure; open: field system. Green box closed: barrow; open: ring ditch. Magenta box: pit alignment. White x: stray find.*

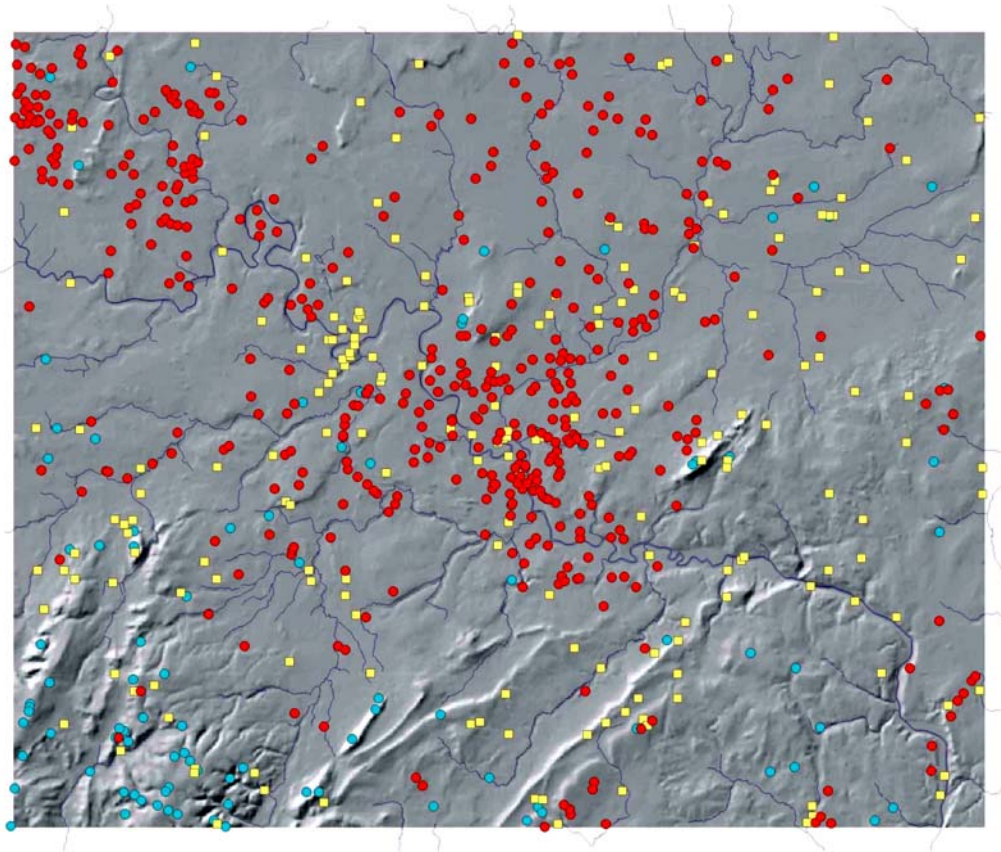


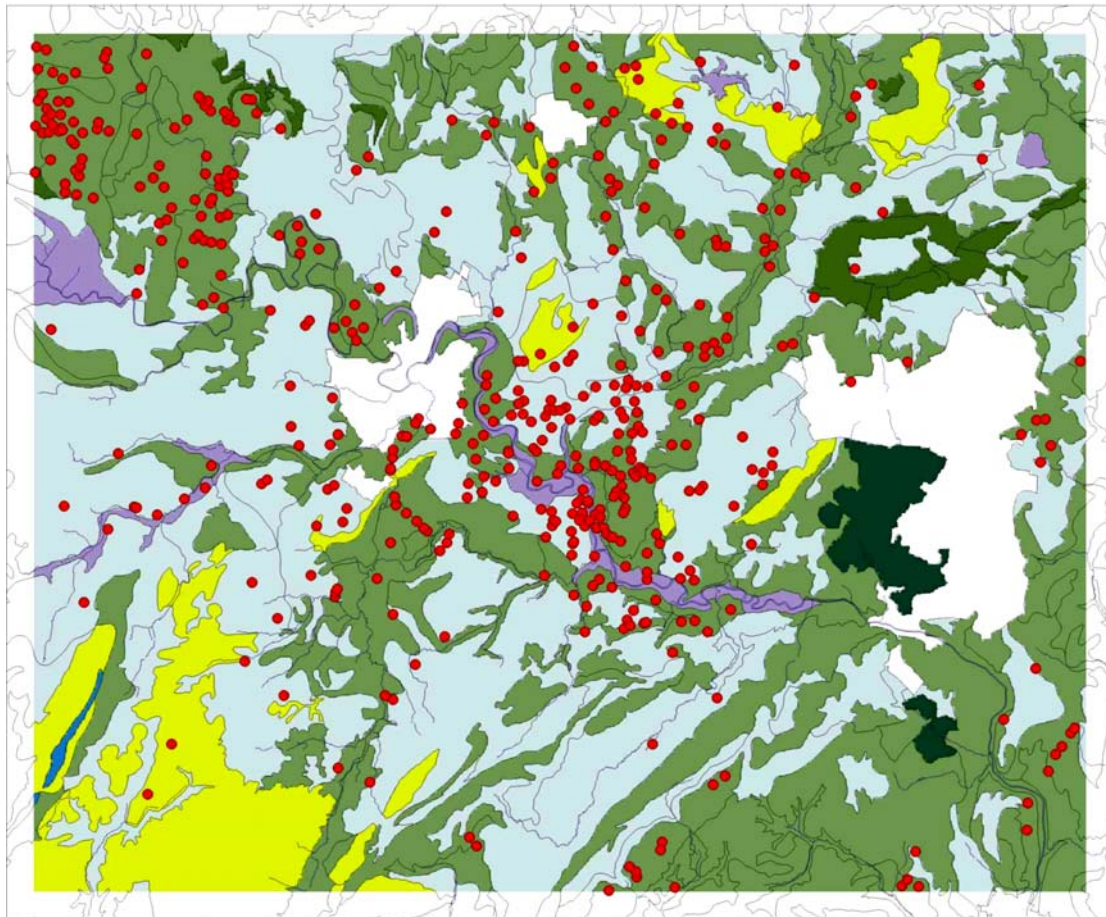
Figure 2 - Major site discovery classes for 855 pre-Conquest sites in the Wroxeter Hinterland (source: Shropshire SMR). Red dots: AP marks. Yellow boxes: chance finds. Blue dots: earthworks.

The overall preference for arable appears to be largely caused by a subset of enclosures and field systems that were identified on aerial photographs, a prospection technique which is known to introduce a bias in favour of arable land – either freshly ploughed or under a young or mature crop. Rather than interpreting the patterning we have discovered in our data as a reflection of the *original* patterned distribution of this type of site, we would suspect it to be caused perhaps by especially disruptive agricultural practices in these areas, or by a heightened soil and crop response which makes certain types of archaeological features show up better in aerial photography. Either way, recent and modern land use is heavily implicated in the formation of the pattern.

Univariate preferences / avoidances for enclosures and fieldsystems show that, already in the 1920s, these sites are characterised by avoidance of woodland, grass- and meadowland, and low density builtup (the latter presumably caused by the fact that these areas were taken out of agricultural use) and the converse strong preference for arable. This situation continues in 1992, but with a less strong avoidance of grassland, which however in 1996 returns (by which time other cats are below statistical threshold).

## 2.4 MULTIVARIATE ANALYSIS

LULC and the locations of archaeological sites are of course correlated not just through the process of discovery, but also through the land use qualities of the soils and geomorphology of the study area. This three-way correlation can be quantified by statistical measures (if the scale of the variables is at least ordinal), but it is not possible to extract causal relationships by this means. Two examples of this phenomenon are given below.



- Soil groups:
- Lithomorphic soils
  - Pelosols
  - Brown earths
  - Podzolic soils
  - surface-water Gley soils
  - ground-water Gley soils
  - Peat soils

*Figure 3 - Enclosures discovered by aerial reconnaissance (n=280) vs. soil groups of the Wroxeter Hinterland.*

Table 7 (a-e) – Chi2 result tables for site types on simplified 1928 LULC. A: enclosures (n=280), B: ring ditches (n=62), C: field systems (n=44), D: linear features (n=43), E: pit alignments (n=38).

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	128285			9		
( 1) uncultivated land	215057	12.2	33.2	8	19.108	1
( 2) arable land	390001	22.2	60.2	129	78.735	1
( 3) meadowland and permanent	1043602	59.4	161.0	130	5.972	1
( 4) built-up areas, etc.	107855	6.1	16.6	4	9.602	1
Totals	1756515	100.0	271.0	271	113.417	3

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	128285			5		
( 1) uncultivated land	215057	12.2	7.0	1	5.122	1
( 2) arable land	390001	22.2	12.7	36	43.060	1
( 3) meadowland and permanent	1043602	59.4	33.9	16	9.425	1
( 4) built-up areas, etc.	107855	6.1	3.5	4	0.071	1
Totals	1756515	100.0	57.0	57	57.678	3

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	128285			0		
( 1) uncultivated land	215057	12.2	5.4	1	3.573	1
( 2) arable land	390001	22.2	9.8	28	34.020	1
( 3) meadowland and permanent	1043602	59.4	26.1	15	4.749	1
( 4) built-up areas, etc.	107855	6.1	2.7	0	2.702	1
Totals	1756515	100.0	44.0	44	45.043	3

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	128285			0		
( 1) uncultivated land	215057	12.2	5.3	2	2.024	1
( 2) arable land	390001	22.2	9.5	17	5.818	1
( 3) meadowland and permanent	1043602	59.4	25.5	23	0.254	1
( 4) built-up areas, etc.	107855	6.1	2.6	1	1.019	1
Totals	1756515	100.0	43.0	43	9.115	3

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	128285			0		
( 1) uncultivated land	215057	12.2	4.7	2	1.512	1
( 2) arable land	390001	22.2	8.4	24	28.706	1
( 3) meadowland and permanent	1043602	59.4	22.6	12	4.955	1
( 4) built-up areas, etc.	107855	6.1	2.3	0	2.333	1
Totals	1756515	100.0	38.0	38	37.507	3

Comparing discovery method with soil type, we find that enclosure sites discovered from the air avoid peat, ground-water gley, lithomorph soils and podzols, preferring brown earths and surface-water gley soils. These associations become even stronger when we exclude areas that were not extensively studied from the air - brown earths are now even more preferred (Chi<sup>2</sup> of 19), while surface-water gleys are less favoured, and ground-water gleys are more clearly avoided. We know that this must partly be caused by visibility biases - ground water gleys being much less subject to drying out, and podzolic soils tending to be poor and therefore covered with woodland, scrub or heath (cf. Jones & Evans 1975). Of the two major soil classes in the area, surface-water gleys are slightly less workable than brown earths, and tend to occur farther away from streams and roads.

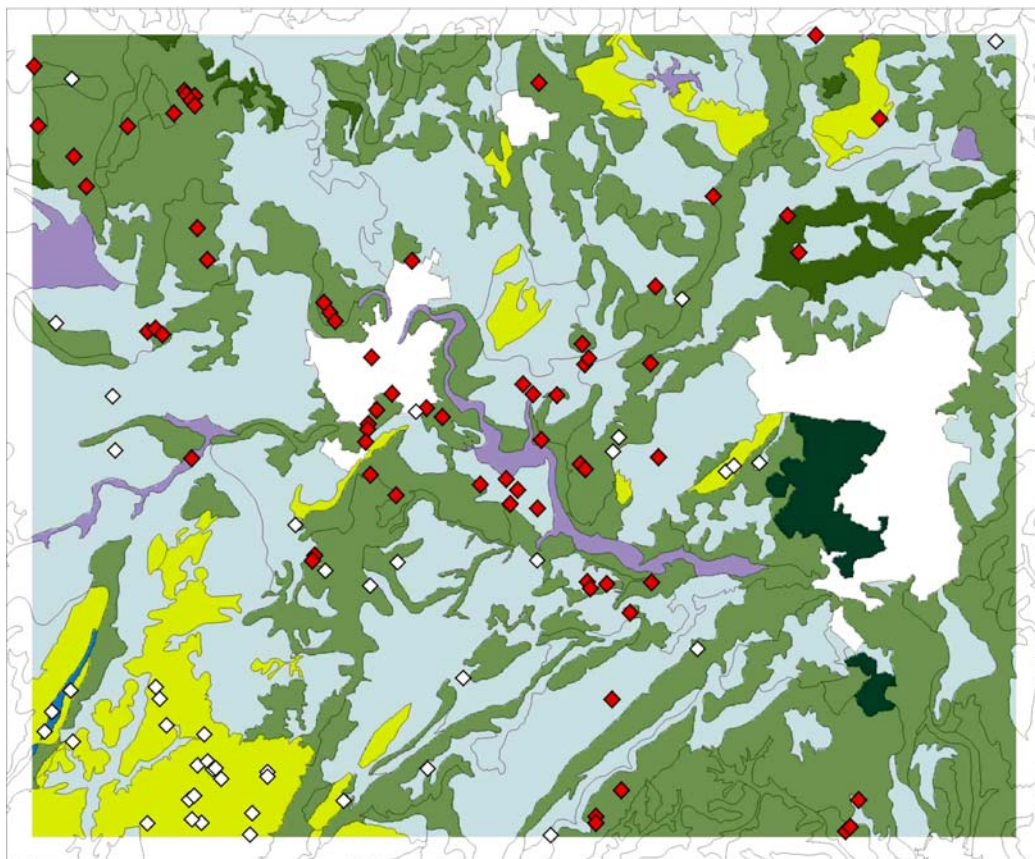


Figure 4 - Distribution of barrows (white) and ring ditches (red) vs. soil groups in the Wroxeter Hinterland. For legend, see figure 3.

Table 8 - Chi2 table of AP mark enclosures (n=280) vs soil groups.

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	31332			4		
( 3) lithomorph soils	495	0.1	0.3	0	0.311	1
( 5) brown calcareous earth	184050	41.8	115.5	163	19.550	1
( 6) podzolic soils	35748	8.1	22.4	4	15.144	1
( 7) surface-water gley soi	194997	44.3	122.4	108	1.684	1
( 8) ground-water gley soil	9758	2.2	6.1	1	4.286	1
( 9) man-made soils	7058	1.6	4.4	0	4.429	1
( 10) peat soils	7762	1.8	4.9	0	4.870	1
Totals	439868	100.0	276.0	276	50.273	6

A second example illustrating the effects of visibility on the distribution of archaeological site types are barrows and ring ditches. Set against soil types, ring ditches display a preference for brown earths although they also occur on surface-water gley soils, while barrows have a very strong preference for podzolic soils (Chi<sup>2</sup> of 92) and occur to a much lesser extent on either brown earths or surface-water gleys. Yet we know that these two data samples are drawn from one parent population - mainly Bronze Age barrows, which have been agriculturally degraded on some soils while being preserved on others.

Table 9 - A: Chi2 table of barrows (n=44) vs soil groups. B: Chi2 table of ring ditches (n=73) vs soil groups. Units with expected sites < 3 have been omitted.

A)

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	225620			5		
( 5) brown calcareous earth	736200	44.4	17.3	8	5.003	1
( 6) podzolic soils	142992	8.6	3.4	21	92.568	1
( 7) surface-water gley soil	779988	47.0	18.3	10	3.788	1
Totals	1659180	100.0	39.0	39	101.359	2

B)

Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0) no data	225620			7		
( 5) brown calcareous earth	736200	44.4	29.3	47	10.716	1
( 6) podzolic soils	142992	8.6	5.7	2	2.391	1
( 7) surface-water gley soil	779988	47.0	31.0	17	6.341	1
Totals	1659180	100.0	66.0	66	19.449	2

There are several ways in which we can approach the three-way correlation of natural environment – LULC – archaeological site location. Among the specialist multivariate tools at our disposal are 3-way contingency table analysis and log-linear analysis, but the simpler approach chosen below reduces the multivariate problem to a series of bivariate problems. First, we study locational preferences *within* each discovery class (discovery mode invariant); next, we study them *within* each LULC class (LULC class invariant).

#### DISCOVERY MODE INVARIANT

One way of studying the potential significance of such biases in archaeological records is to assume that the distribution of sites first recorded by one particular method is entirely due to bias, whereas any differences in distribution of site types within this group may be due to locational factors. The largest group of known sites by discovery mode are the AP marks, and these therefore give most scope for this type of analysis. As we saw, the Shropshire SMR contains 457 records of type AP mark within our study area. We have examined the distributions of the largest subgroups by morphology - Enclosure, Ring ditch, Field system, Pit alignment, and Linear feature (see figure 3 and table 7), and found that, whereas the distribution of enclosures and linear features are not significantly different from that of all AP marks, the distributions of ring ditches and field systems seem to be more restricted to the central lowland. Most remarkably, pit alignments display a clearly different distribution from that of all AP marks - they are located mainly in the Tern and upper Severn watershed areas! This presents us with a subject for further study: do these alignments bear any relation with topography, with the division of the landscape between farmsteads, were they wind breaks?<sup>v</sup>

## LULC CLASS INVARIANT

The inverse of the above operations assumes that LULC bias can be avoided by separately modelling site location preferences for each LULC type. Thus, if the discovery of AP marks is contingent on the presence of arable, then the distributions of site types discovered by aerial reconnaissance *within* the arable may be used to model site location preferences that do not suffer from these biases. For this, we cannot use the 1928 LULC map by itself, because it represents only one early stage in the history of modern land use in the study area. We must instead construct a map that shows the probability that any particular area will have been in arable use in the latter half of the 20<sup>th</sup> century.

I have approached such a map by adding up all arable in the three base maps (i.e., dated 1928, 1992, and 1996) and applying distance buffer zones of 100, 250, 500, and 1000 meters to that. To obtain the cleanest possible results with the given data, I further restricted the study area to that in which the aerial reconnaissance unit of the RCHME operates (west of the line x=363000). The results, presented here in figure 5 and table 10, show that AP marks are extremely strongly correlated with arable land use. All but seven out of 422 AP marks are either on, or within 250 meters of, known arable land (Chi<sup>2</sup> of 155 at 1 degree of freedom).

**Table 10 – Correlation of 422 AP marks in the Shropshire SMR to combined arable. Analysis region bounded by north: 325000, west: 336000, east: 363000, south: 294000 NGR.**

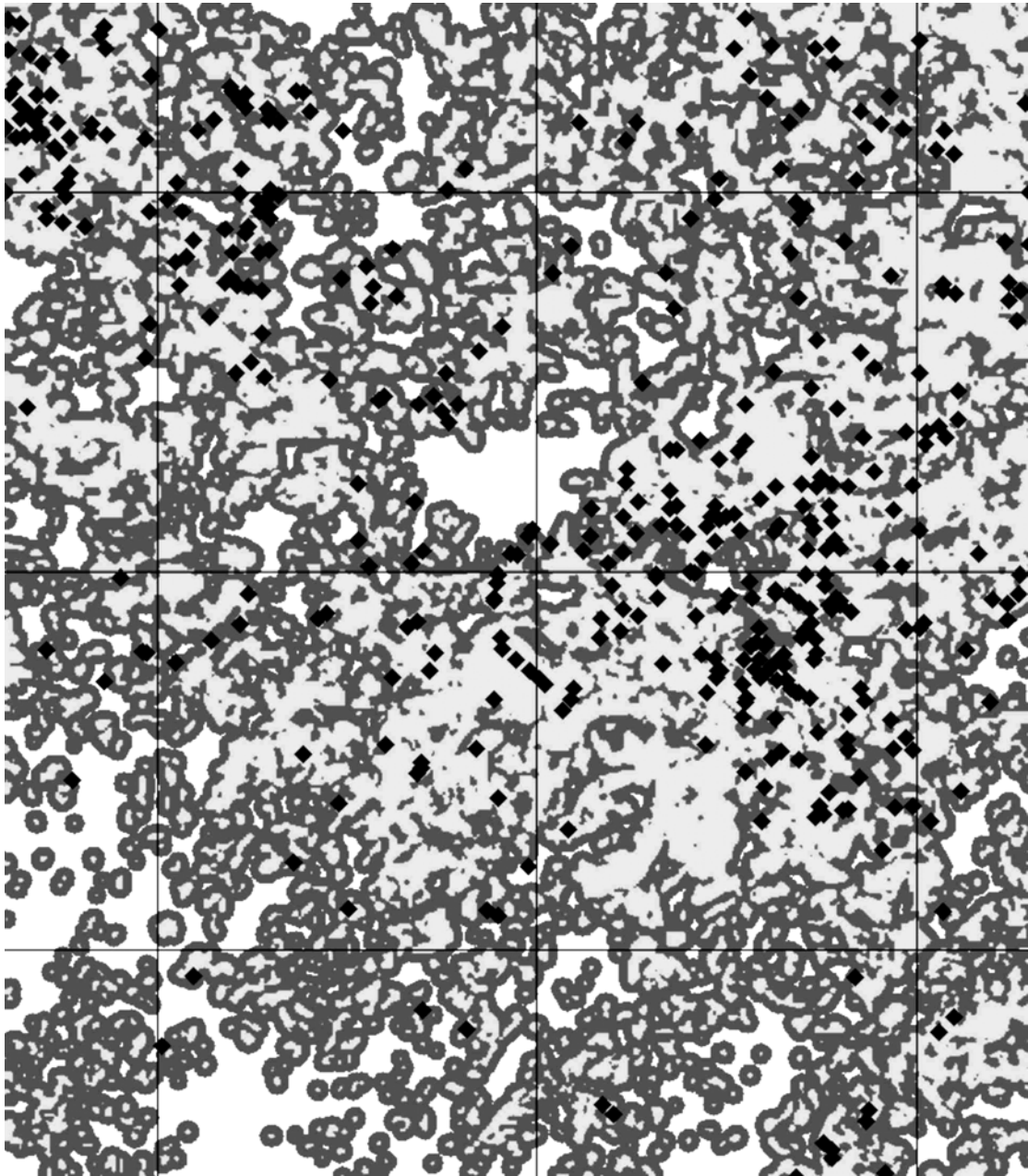
Site Characteristics	cells cover	% cover	expected sites	actual sites	chi square	degrees of freedom
( 0)	163042			7		
( 1) Arable	540100	45.9	190.6	317	83.876	1
( 2) 250 meter buffer	636058	54.1	224.4	98	71.222	1
Totals	1176158	100.0	415.0	415	155.098	1

It is probable that this correlation could be strengthened even more by taking further variables into account, such as the areas effectively excluded from observation because of flying restrictions, ancient woodland and water bodies, and pre-war built-up areas. However, the point of the exercise was to demonstrate how bias factors can be incorporated into locational models.

## CORRECTION

Having identified land use as a factor contributing bias to our recorded site distributions, it is now possible to use GIS to, firstly, quantify that bias and, secondly, compensate for it. Various GIS techniques for doing this have been proposed (Terrenato & Ammerman 1996, Van Leusen 1996), which are generally referred to as *weighting* or *evaluation* schemes.

Quantifying the bias in a distribution of archaeological sites could be done by directly assigning weights or values to each of the land use categories on the basis of its presumed effect on the visibility of sites. For example, high weights (ie, low visibility) are assigned to built-up and forested areas and water bodies, and low weights (high visibility) to arable land. Weights or values could also be derived automatically by assuming that the known distribution of archaeological sites directly reflects differential visibility – in this case, one could for instance use the Chi squared or P values for random distribution of sites as the weight. Problematic in these approaches is, that the weight variable has never been independently measured. It is important to remember, however, that these are just the extremes of a whole range of possible methods for creating a map quantifying a particular bias.



*Figure 5 – Distribution of AP marks (black diamonds, n=422) with respect to distance to arable land. Light grey: arable in 1928, 1992, or 1996. Dark grey: 250m buffer around arable. Grid line spacing: 10 kms.*

Whilst modern LULC has the unfortunate effect of biasing our recovery of the archaeological record in various ways, causing spurious patterning, that of course does not mean that no ‘real’ patterning exists in the archaeological record. A study of the ancient (in this case Roman) LULC might clarify why we find the material residue of various social actions in particular parts of the landscape. In the absence of



any direct historical or archaeological (eg, paleo-environmental) evidence, we have investigated if later historical, archaeological, and place-name evidence might be extrapolated to the remoter past, and thus bring us closer to Roman LULC. The following discussion concentrates on the evidence of most immediate relevance to LULC, while a more extensive discussion of literary sources may be found in White & Barker (1998:130-6).

### 3.1 STABILITY IN THE *LONGUE DURÉE*

A reconstruction of Roman LULC in the central Shropshire area must start with the observation that historical evidence indicates that land use in the study area appears to have been extremely stable over the centuries. Thirsk (1987:29) mapped the farming regions of England for the period 1500-1650, showing the WHP study area as open pasture used for rearing and fattening. The situation appears little changed during the period 1640-1750, with farming land use down to cattle and sheep rearing, sometimes with dairying (on fells and moorland), stock-fattening with horse breeding, and fishing and fowling (in fenland).

Shropshire and Cheshire, the core Cornovian lands, are today still some of the best cattle land in the country. Given this continuity, we may ask if perhaps it is possible to trace this emphasis on animal farming back to even earlier times. The validity of such extrapolation is supported by authors such as Williamson (1988) who projects Anglo-Saxon land management systems in the Norfolk area back into late Roman times:

*By the end of the Roman period there were around 1.3 settlements per square kilometre. (...) settlements tended to cluster near to the margins of the lighter soils of the valleys, or on the floors of the valleys themselves. Plateaus were more sparsely, but apparently quite evenly, populated, but the settlement pattern was more mobile and the settlements themselves more short-lived. (...) Settlement had been re-established in all parts of the area studied by the end of the Saxon period, and its pattern exhibits a number of similarities with that of the Roman period. In particular, the farmsteads and hamlets away from the major valleys were of lower status than those located adjacent to them; the former were tenurially dependent on the latter, and were therefore usually unnamed in the Domesday survey.'* (Williamson 1988:162-164)

Such remarks are relevant to at least the southern parts of the WHP study area, where a similar topography could have resulted in a similar settlement system. Thus, documentary evidence seems to argue that the *longe durée* LULC in Shropshire is one of animal husbandry. White further supports this with his reconstruction of the economic wealth of late pre-Roman Iron Age Cornovian society and certain striking features of Roman Viroconium itself – the probable *forum boarium* and extensive tanneries in the northern part of the town (White & Barker 1998: 79, 92).

### 3.2 PLACE-NAME ETYMOLOGY

However, a further and more specific type of evidence can be adduced by studying Anglo-Saxon charters and place-name evidence. To begin with the latter, Gelling (1992) discusses the available place-name evidence for the presence of ancient woodland in Shropshire (see Figure 6). She mapped place-names of 'leah' (modern -ley) type and found

*'...a very dense concentration of symbols in the eastern half [of Shropshire]. Two groupings can be discerned, one running from Leegomery (south of the Weald Moors) to Meadowley (west of Bridgnorth), and another occupying the south-eastern corner of the county. The River Severn was here flowing through dense woodland, some of which survived to form the basis of the early industrial activity in Coalbrookdale... Some () names have first elements (such as 'cat' in Ketley, 'burdock' in Clotley, 'fern' in Farley, 'burnt' in*

*Barnsley) which suggest a relatively underdeveloped landscape. It seems probable that in eastern Shropshire the -ley names give a fair impression of the whole extent of the Anglo-Saxon woodland, rather than just marking the core of it. If this woodland had been continuous it would have exceeded that of north Warwickshire in extent, but the place-names give evidence of an open belt running from Upton Cresset to Eardington...*

*'There is another belt of -ley names running east/west across the centre of Shropshire. Two outliers, Bradley and Farley, at the eastern end of the belt are minor names in Much Wenlock parish. West of these are Harley, Hughley, Kenley, Langley, Ruckley, Frodesley, Lydley Heys and Leebotwood. These are all 'major' names, the last two referring to places in Botwood where Haughmond Abbey was making assarts (the technical term for woodland clearings) in the second half of the twelfth century. Since leah is not likely to have been used in the sense of 'forest clearing' as late as that it is likely that some small settlements here had the name Lege from an earlier date, and that these provided bases from which the abbey developed more land (...) No other groups of -ley names in Shropshire are as extensive as these belts in the east and centre, and there are large areas in which the word does not occur at all. There was some ancient woodland north of Shrewsbury (referred to in Pimley, Albrightlee, Astley), and Lee Brockhurst, Marchamley and some minor names attest to another patch further north, between the Roden and the Tern.'* (Gelling 1992:15-17)

We argue that if '-ley' place names represent Anglo-Saxon clearings within (partly) wooded areas, then these areas were likely to have been (managed) woodland in late Roman times and possibly earlier. Such woodland occurs as a belt along the lower slopes of the Long Mynd and other high relief terrain in the south of the study area, and up through the Telford area; another belt of wooded land lies across the Severn Valley where Shrewsbury is today. Both of these woodland belts seem to be related to areas of lower accessibility, mostly related to the peculiar geology of the study area, which causes the topography to run at right angles to the main Severn corridor. Elevated areas are therefore generally less accessible and have lower soil quality. This is most clearly demonstrated by the latter woodland belt, which is aligned on the geological ridge connecting Lyth Hill, Bayston Hill, and Sharpstones Hill to the south of the Severn with Haughmond Hill to its north.

Overlaying the -leah map with the locations of enclosure sites (see figure 6) shows a strong correlation between farmstead sites and non-wooded areas. The central woodland belt separates two clusters of enclosures, with the core of the northwestern cluster somewhere near Great Ness, some 20 kms from Wroxeter. Unfortunately, the 'gap' between the clusters is occupied by modern-day Shrewsbury, with the ensuing lack of data. However, it is certain that the woodland and the high relief would together have formed a clear physical as well as a psychological barrier, even though there might well have been a wide corridor on both sides of the Severn which linked both clusters.

It is noteworthy that the northwestern cluster occupies the largest continuous area of good soils within the Severn valley and probably had good communications to Wroxeter in the Roman period. We are justified in expecting the presence of a major secondary centre (a la *Rutinium*), or perhaps a lesser one near Montford Bridge (a la *Uxacona*).

Similar reasoning applies all the more strongly to the larger south-eastern woodland belt. The relief in this area is much more dramatic, and communications with the central Severn valley much more restricted. We find that the density of enclosures increases again to the south and east of this woodland, indicating that we are here entering the *territorium* of another town, perhaps located at the Severn crossing at Bridgenorth.

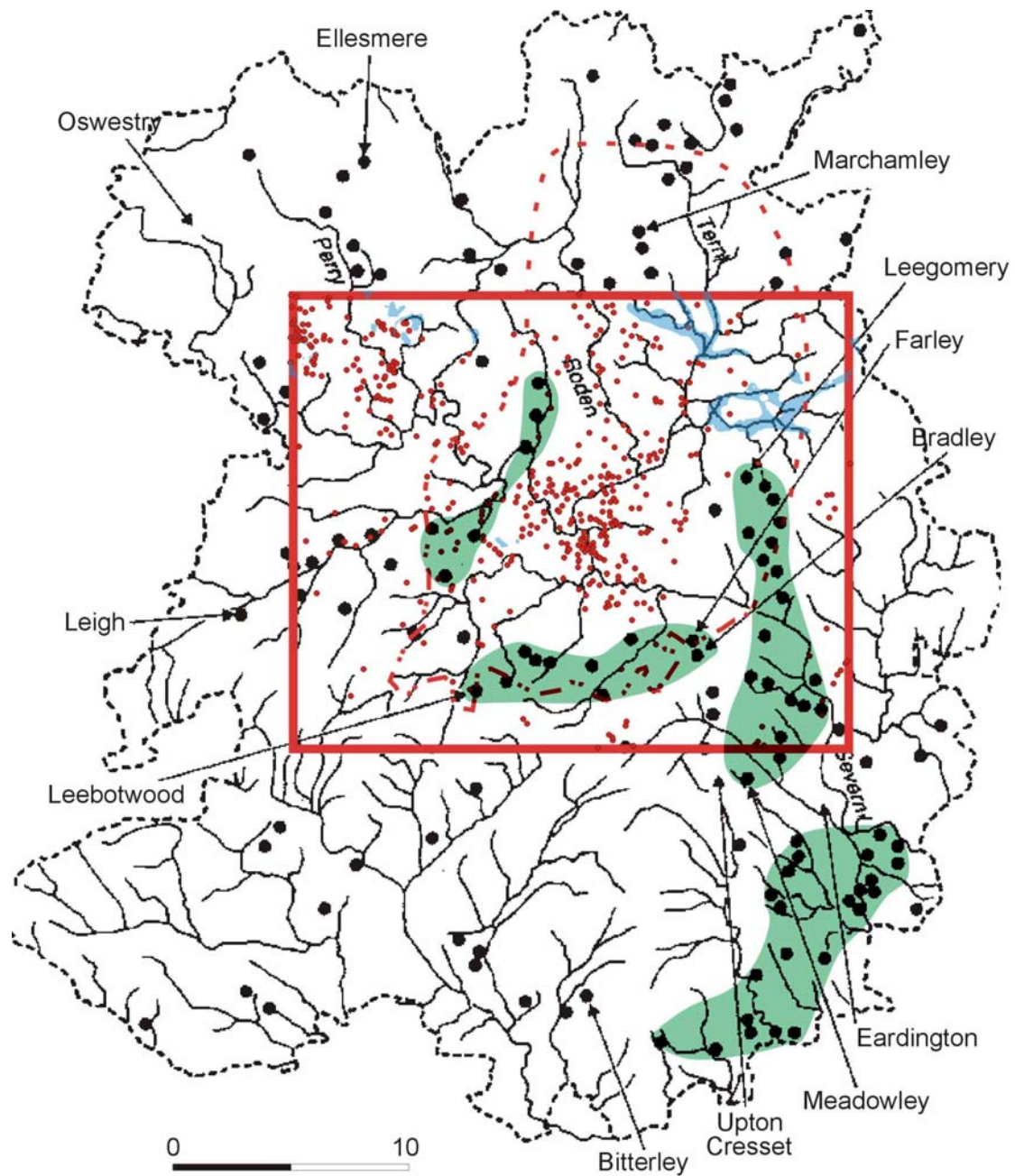


Figure 6 - comparison of the distribution of *-ley* names (black), enclosure sites (red), and charter boundaries (dashed line). Green: reconstructed woodlands. Blue: historic wetlands. (*-leah* place names in Shropshire after Gelling 1992, fig. 6; reconstruction of Wroxeter's territory in the late/sub-Roman period after Bassett 1989)

### 3.3 DOCUMENTARY SOURCES

Further and independent evidence confirming this configuration comes from documentary sources compiled by Bassett (1989). Combining certain oddities in diocesan boundaries near Wroxeter with mention of the area of 'Tren' and 'the Ercalls' and a group of people known as 'Wroconsaetna', Bassett postulates a British territory extending from the Long Mynd in the south-west of the study area to the Staffordshire borders in the north-east (see figure 6, dashed line). This putative territory can be shown to have had some residual meaning in the 9<sup>th</sup> century at the latest, with Welsh poems referring back to the 7<sup>th</sup>, which would take this territory right back to a period when Viroconium was still in existence

(cf. White & Barker 1998: 132-6). If true, this constitutes powerful confirmation of the existence of a territorial boundary following the line of the three hills mentioned above in section 3.2; to the south and southeast, Wroxeter's territory would encompass the valley and slopes facing the Severn; to the north of the Severn boundaries are less well defined but it may well be that the important wetland ecozone to the northeast was included together with most of the valleys of the Tern and the Roden (the latter if the Ercalls are to be included); the least well-defined boundary is to the north-west.

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#### 4 CONCLUSIONS

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The study of LULC for regional archaeological research can be said to have a methodological and a historical purpose. The former is perhaps best approached by the use of GIS to store and compare historical cartographic data about land use. As in the case of the WHP, such data may be derived from archival records made for military, legal or taxation reasons; from studies of agricultural productivity; and, more recently, from historic aerial photography and satellite imagery. LULC maps can then be compared and correlated to visibility and discovery mode aspects of the archaeological record. The case study presented here found that recorded discovery mode in the Shropshire SMR does indeed correlate with historic LULC, and two examples were given. It was also shown how analysis of the archaeological record *within* a particular discovery mode can flag up significant deviations.

The second, historical, use of LULC studies is here demonstrated by reconstructing a regional pattern of arable vs woodland for the late Roman period, which is supported by archival studies of diocesan boundaries and literary topographic references. Such studies are needed if we are to distinguish between archaeological patterns relating to ancient LULC, and those relating to modern LULC.

The scope of the current case study has been limited by the available time and by the relatively low quality of the data available from the Shropshire SMR. However, it does demonstrate the feasibility of this type of study, its potential for the understanding of patterns in the archaeological record; and it explores some ways forward.

#### ACKNOWLEDGEMENTS

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<sup>i</sup> OSGB 1928, *Land Utilisation Survey of Britain*, 1:50,000. Map sheets 60: Shrewsbury and Welshpool, 61: Wolverhampton, and 70: Bishop's Castle.

<sup>ii</sup> Landsat TM floating quarter scene 5/203/023 obtained from NERC data centre.

<sup>iii</sup> Details of the original data sets and processing steps are recorded in ATMPROC.DOC and DATA.DOC.

<sup>iv</sup> Incidentally, this picture is further biased by a set of barrow observations contributed by a special earthwork survey of the Long Mynd area.

<sup>v</sup> Current thinking holds that some later alignments at least (tentatively dated to the Iron Age – Medieval period), consisting of smaller pits, functioned as boundary markers. Nothing is known about the alignments consisting of large pits, which may date to the Bronze Age.

# SETTLEMENT HIERARCHIES, TERRITORIAL DIVISIONS, AND VISUAL DOMINANCE\*

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## 1 INTRODUCTION

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The late protohistoric (Late Bronze Age/Early Iron Age) settlement pattern in the south, as in central Italy, has been interpreted as one indicative of the transition of pastoral ways of life to one dominated by agriculture and increasing hierarchisation of society, culminating in the rich graves of Iron Age elites in all areas of Italy and in evidence for early urbanisation in many regions but apparently developing first in Etruria and Lazio. Among the causative factors, the presence of exploitable mineral resources has been suggested (Vanzetti, forthcoming); the persistence of tribal structures in the Sibaritide seems to confirm this idea which may be combined with that of a difference in demographic ‘carrying capacity’ due to geological and climatological differences which translated into different potentials for land use and the relatively late take-off of urbanisation.

Late protohistoric centralised settlement has been interpreted as evidence of a territorial division in which each settlement laid claim to essential landscape resources, with an initial phase of peer polity interaction being followed by one in which a single settlement obtained hegemony and others are relegated to 2<sup>nd</sup> rank (Rome in Lazio, Torre Mordillo in the Sibaritide). The further development of this system seems to have been aborted in the Late Iron Age and the Archaic/Classical period in the south when economic life re-oriented on the successful colonies; in central Italy it was the hypertrophic development of Rome which disturbed the equilibrium.

Peer polity interaction is an inherently unstable system because it will be upset whenever any of the polities gets preferential access to resources. Rome, as a ‘border’ polity of the Latial league, could enlarge its territory through conquest to its north and west, and through its position on the Tiber could control and profit from river-borne and coastal trade. These options were largely closed to the ‘central’ polities of the Alban hills. However, in its developed form the peer polities of the Pontine, Sibaritide, and Salento regions were modelled using Thiessen polygons (Bouma & Van ‘t Lindenhout 1998, Peroni 1994:282ff. and 1996, Burgers 1999) under assumption of equality and a simple rank-size hierarchy consisting of just two levels.

Because of the research interests of the culture-historical paradigm (*Formazione delle città*, urbanisation, and colonisation; see chapter 2) and the limitations inherent in site databases collected before the advent of modern ‘landscape’ surveying (chapters 4 and 13), theorising about settlement patterns has been limited

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\* These case studies are concerned with two of the three study areas only; case studies involving the rank-size analysis and X-tent modeling of late Iron Age to Archaic settlement in the Salento Isthmus could not be completed in time for this thesis.

to the top of the settlement hierarchy in the three study areas. Even in regions with a relatively high-quality data base, typological classifications of these settlements have had to be based on locational characteristics or size of inhabited or defended area. For example, Guitoli (1977:22-25) classified the protohistoric to Archaic settlements of Lazio into 'coastal', 'crater-rim', 'military-commercial', and 'minor' groups; he gave no size-rule to support these classes. By contrast, Guidi (1985) applied a rank-size analysis to the same set of settlements, estimating settlement size from the area bounded by natural defenses, and concluded for the late 7<sup>th</sup> century BC (orientalizing period) that there was evidence for the development of a three-level hierarchy with Rome at the top, Ardea and Gabii at level two, and other towns dependent on these three at level three.

Settlement size plays a central role in all models of late protohistoric and archaic societies in Italy, from Etruria and Lazio to the Salento and the Sibaritide. In the large majority of cases, sizes are estimated on the basis of three assumptions: finds from slopes and valley floors originate from hilltops and plateaus; these hilltops and plateaus were entirely rather than locally inhabited; and habitation is assumed to be continuous even if some phases are not well represented at a settlement (Vanzetti, forthcoming). Moreover, given the current state of research many settlements of significant size still remain undiscovered. For these reasons, any *specific* models of territorial organisation based on rank-size criteria must be regarded as weak.

Whatever the problems in establishing the size and rank of protohistoric settlements, the locations of what has been regarded as the upper-rank settlements are generally described as 'dominant', expressing their elevated, easily defensible positions and large viewsheds within which essential landscape resources such as transhumance routes were located. This opens up the possibility of studying the viewshed properties of these settlement systems and the landscape that they are part of. In order to explore further the issues raised in this introduction, three interrelated case studies are presented here in two chronological sections. The following section presents a protohistoric and pre-colonial case study regarding accessibility, visual contact, and territorial structure in the Sibaritide and the Pontine region; the final section presents a case study of the Roman colonial landscape in the Pontine region. The hierarchisation of protohistoric settlement systems on the basis of size and locational characteristics is examined with reference to Peroni's (1994) models for southern Italy, the territorial organisation of Late Iron Age to Archaic early states is explored through visibility and accessibility analysis with reference to Bietti Sestieri's (1985) models for Lazio; and the role of strategic considerations in the location of early Roman strongpoints in the Pontine region (south Lazio) is considered through an investigation of 4<sup>th</sup> century BC colonies on the Lepine scarp, in the context of Livy's historical references.

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## 2 SETTLEMENT AND TERRITORY IN PROTOHISTORY

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### THE SIBARITIDE

The locational characteristics of the larger settlements of the south Italian Bronze and early Iron Ages are generally understood to be a function of both local (defensibility, available area, presence of sufficient agricultural land) and regional criteria (a 'commanding' position, sufficient distance from neighbouring settlements, access to both low- and highlands). However, there is a measure of vagueness in the way these criteria are applied. In the case of the Sibaritide, a review of the literature reveals the following suggestions for the operationalisation of geographical models of Middle Bronze Age to Early Iron Age societies:

- *Defensibility* - This is taken to require a cape- or promontory-like geomorphology; candidate locations should be accessible from one direction (upslope) only, the other directions being characterised by steep slopes. No specifications are given for the amount of steepness considered sufficient.

- *Available area* - Depending on whether a settlement is thought to fulfill mainly habitation or defensive functions, the criteria for available area may specify a lower or an upper limit, or both. Except in cases where the area of a settlement has in fact been measured from evidence of walls etc, the available area can only be specified as a contiguous block of land of less than a specified slope, e.g. 16 percent.
- *Presence of sufficient agricultural land* - The two factors making up this criterion are 'sufficient' and 'agricultural'. The amount of land to be considered sufficient for a specific settlement depends obviously on the amount and type of produce being consumed or traded from there. From the Middle Bronze Age onwards, a spreading of dry farming techniques into the uplands has been proposed by Barker (1985), while in the Final Bronze Age olive culture is added to the range of agricultural techniques. In the Sibaritide the soils of the marine/fluviat terraces are considered fair agricultural land for dry farming of grains and vegetables, as long as slopes are not so steep as to cause erosion. However, given the relatively small size of even the major settlements of the Bronze and early Iron Ages, this factor is unlikely to have much restricted settlement location. Kleibrink suggests that the 25 ha of agricultural land available near the settlement of San Nicola (Peroni & Trucco 1994, site 31) would be sufficient for it. The remaining land, including that located on lower quality soils and on slopes, could have been used for olive culture.
- *A 'commanding' position* - This criterion is not specified by the authors, but is usually interpreted as signifying that the settlement should have an unusually large viewshed and/or an unusually complete 'near' viewshed. A second potential characteristic of a commanding position is that of easy access to whatever is being 'commanded', but the latter remains unspecified except as a minimum or maximum vertical distance of the settlement from the nearest valley floor. For the Sibaritide one can think of: summer and winter grazing and other economic interests; settlements, cemeteries and other social interests; the coast, long distance routes and other strategic interests.
- *Sufficient distance from neighbouring settlements* - From the Middle Bronze Age onwards, and accelerating toward the Final Bronze Age under the influence of technological change and demographic growth, the undifferentiated settlement system of the Early Bronze Age in the Sibaritide is thought to have crystallised into a hierarchical system of major and minor settlements. The territories of the major settlements are bounded by the valleys of major streams; where such streams are close together the operative criterion may be 'social' distance as well as size of territory. In the Sibaritide in the Early Iron Age this distance appears to be on the order of 15 km; major settlements of the Salento Murge typically are some 12 km apart in this period. These central villages would begin to function as redistribution centers from the Late Bronze Age onwards, as is shown by the evidence for storage of large amounts of agricultural produce at Broglio di Trebisacce (Levi 1999:229). The minor settlements in this system are thought to have strategic functions: either to provide safety from attack or cattle raids from the direction of the uplands, or to control the crossings of the *litoraneo protostorica* over the main river valleys.
- *Access to both low- and highlands* - The economic unit of which the settlement is the archaeologically most visible part would have included parts of the coastal plain and the uplands as well as the footslopes. In addition to the summer and winter grazing for livestock, sufficient untended and wooded land would have been needed for hunting, gathering, fishing, fowling and the extraction of wood, clay and other natural resources. For example, analysis of the animal bones excavated at Broglio di Trebisacce indicates hunting on a small scale and animal husbandry of cattle, sheep, goats and pigs; the livestock was kept for milk, labour, and wool rather than for meat; exploitation of the coastal environment is evident from the occurrence of tortoise remains (A. Tagliacozzo in Peroni & Trucco 1994: 56?-652). Social life would have demanded access to cult places such as caves, springs, and mountaintops. In the Sibaritide the karstic cave sites, e.g. the ones in the S. Marco and Pollino mountains, are situated upslope of the settlements, which they visually dominate. Kleibrink (forthcoming) posits a major change in the cultic landscape of the Sibaritide following the Middle Bronze Age, in that the ancestor worship as practised from at least the Neolithic until the Middle



Bronze Age in caves, gave way to more public ceremonies in the Late Bronze Age, in which the leaders were involved in votive deposits of metal implements in lakes, rivers and near springs and mountain passes. The main infrastructure in the Sibaritide would have consisted of short transhumance routes following the spines of the major hill systems until joining inland long distance routes such as the ones postulated by Quilici (De Rossi *et al.* 1969:59-67); other routes would have connected the settlements themselves. Kleibrink (forthcoming, par 2.7) suggests that the higher settlements on calcareous outcrops will have been under the control of the lower, larger, ones and linked to intensive pastoralist movement.

In all this, a number of other potential settlement location factors have not yet been mentioned: access to and control over routes along the Crati and Coscile valleys into the hinterland and the opposite (Tyrrhenian) coast of Calabria; the presence of a favourable microclimate; and the presence of a pre-existing cognitive landscape. The significance of access to the coast, at least from the Late Bronze Age onwards, has been said to lie in the general growth of overseas contacts with the eastern Mediterranean. And indeed, as Kleibrink writes, the archaeologically attested exchange of objects and technology indicates that during the Late Bronze Age overseas contacts were frequent (Peroni 1994:24) and presumably profitable for both the Italic peoples and the traders from the eastern Mediterranean. However, a more plausible reason may be found in the needs of pastoralism: could access to winter grazing in the plain, which at this time would have been a heavily wooded and seasonally flooded marginal area with soils generally too stony or clayey for paleo-technic agricultural use – have been so vital as to be the determining element in settlement type and location choice? The role of the cognitive landscape in settlement location is suggested by M Kleibrink (forthcoming, par 4.2), who posits a ‘tabu’ landscape around the San Marco cliffside near Cassano all Ionio, where ancestor worship is said to have taken place in caves up to and including the Middle Bronze Age. During the Late Bronze Age, while ritual dedications in caves severely declined, votive deposits of metal objects became much more popular all over Italy (Bianco Peroni 1978/1979). Evidently the focus of cultic life shifted from ancestors in far-away places to nature gods and places that could be reached more easily from the settlements.

IMPLEMENTATION

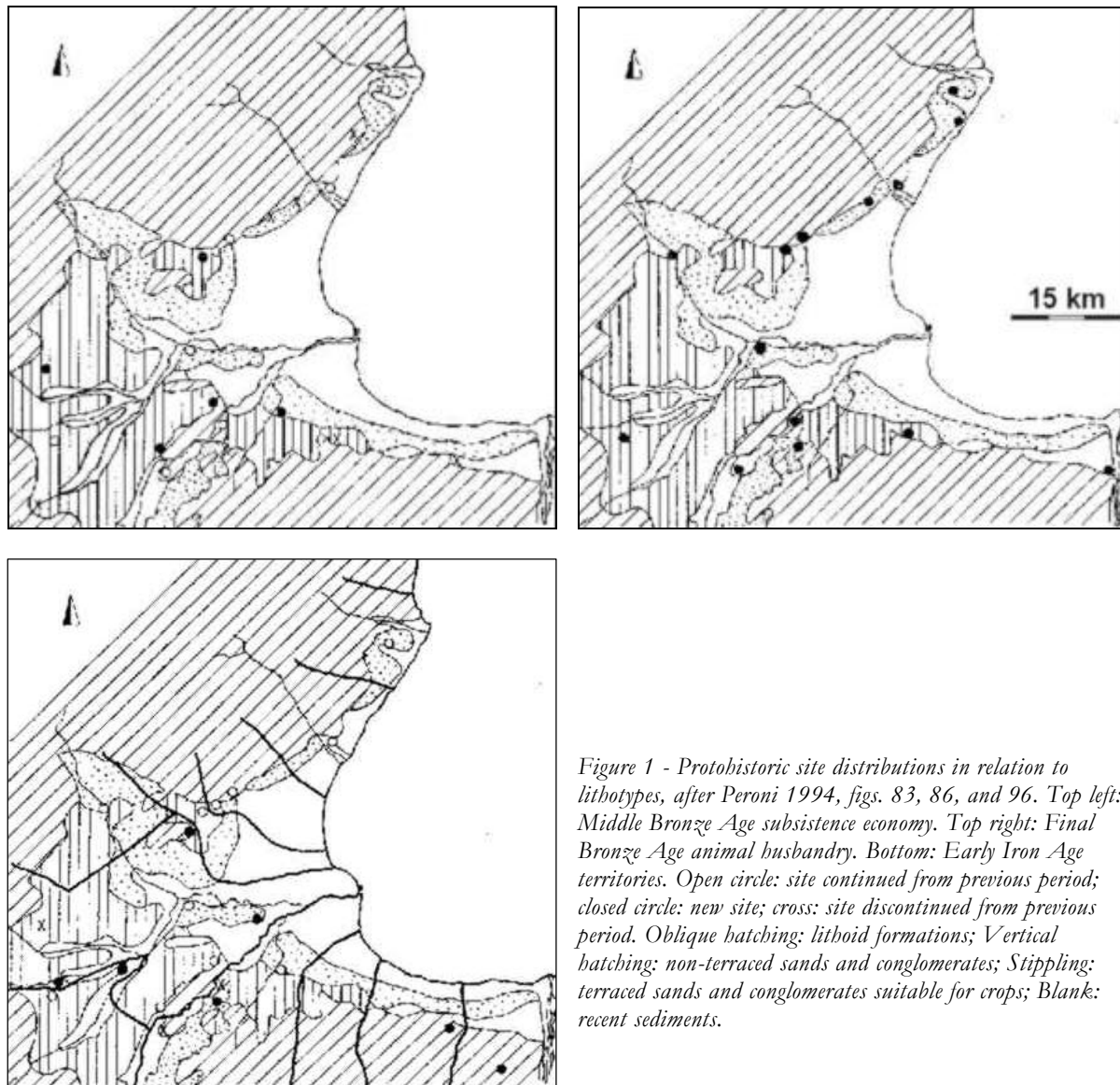
Our database consists of sites listed by Peroni & Trucco (1994); both habitation and cemetery sites are here taken into consideration. For the Middle Bronze Age (1600 - 1300 BC) there are ca. 17 of these, for the Recent Bronze Age (1300 - 1150 BC) ca. 19, and for Final Bronze Age/Early Iron Age (1150 - 900 - 700 BC) ca. 38. As shown in figure 1, in the Middle Bronze Age the Sibaritide foothills - marine and fluvial terraces consisting of sands and conglomerates – are thought to have been in use for cereal cultivation and some cattle breeding; in the Recent Bronze Age land use may have shifted back toward pastoralism tending toward higher elevations, mainly in the interior, a tendency continuing in the Final Bronze Age. In the Early Iron Age new settlements emerge mainly in the interior, possibly for strategic reasons but as we shall see this may also be related to a stonger emphasis on agricultural territory. Peroni (1994, fig. 96) suggests that in this period peer polities developed as well, most of which controlled territories incorporating sections of the plain, foothills, and upland.

Table 1: Classification of protohistoric settlements in the Sibaritide (D'Angelo & Oràzie Vallino 1994).

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	5	7	8	9	15	23	31	33	34	36	2	6	11	12	14	21	27	30	35	32	1	3	24	28	10	13	22	25	4	17	26	18	19	20	16	29		
1	x	x	x	x	x	x	x	x	x	x																												
2											x	x	x	x	x	x	x	x	x	x																		
3																					x	x	x	x														
4																										x	x	x	x									
5																				x										x	x	x	x	x	x	x		
6																				x														x	x	x	x	

Underlying Peroni's phase maps is a site type classification by D'Angelo and Oràzie Vallino (in Peroni & Trucco 1994:827-8), who established the following classes for protohistoric settlement in the Sibaridite:

1. settlement and cultivable land in a well-defended area
2. elevated sites in protected conditions, but with little cultivable space – hence suitable for small communities only
3. settlement in a well-defended position, but with cultivable unprotected land nearby – some suitable for large communities, some for small
4. settlement and cultivation possible, but only limited natural defences present
5. sites with properties mainly useful for pastoralists<sup>1</sup>
6. sites whose main function lies in their viewsheds



The totals by class are as follows: class 1: 10; class 2: 10, class 3: 4; class 4: 4; class 5: 7; class 6: 6. Classes 1 and 3 would contain the top-ranked settlements, classes 2 and 4 are minor centres, and 5 and 6 are special

<sup>1</sup> Not specified, but possibly a location along, or near nodal points in, the network of transhumance routes was meant.

purpose sites. The table below lists their classification of 36 sites in the Sibaritide. Note that the classes are not separated by unambiguous criteria – the difference between classes 1 and 4 is in the quality of the natural defences, that between 1 and 3 in the presence of cultivable land outside rather than inside the defences, that between 2 and 6 (presumably) in the quality of the viewsheds. In all this, it must be remembered that the actual archaeological evidence from many of these sites can be as little as a handful of sherds.

#### ZONES OF VISUAL CONTACT

On the basis of the distribution of these site types in the landscape, pairs of settlements occupying single hill systems have been identified, consisting of one larger settlement situated at lower altitude and with sufficient agricultural land nearby, and one smaller defensible settlement at a higher altitude<sup>2</sup>. An example of the former type is the site of Monte S.Nicola, occupying the saddle and sides of two hills overlooking both the coastal plain and the valley of the Raganello river at an altitude of about 500m asl. If we assume that the protohistoric settlement pattern was largely based around a pastoral land use pattern (with transhumance route between summer and winter pastures following the radial ridges and streams of the Sibaritide, and valleys forming obstacles rather than routes), then sites such as Monte S.Nicola should have certain viewshed characteristics. In particular, the locations of any hilltops from which, coming from the summer pastures in the uplands, winter pasture in the plain first comes into view. We can model such locations by calculating viewsheds from several points in the plain.

The general context for Peroni's models of protohistoric settlement systems is provided by the physiography of the Sibaritide, in particular its radial geomorphology and hydrography. Within such a landscape, areas with similar viewshed properties can be modeled without having recourse to the locations of known sites and using 'background' visibility properties instead (see also chapters 6 and 16). Such areas can be defined by simple criteria and can be organised hierarchically, for example:

- all locations from where a significant part of the coastal plain or the major valley floors can be seen; this includes the plain and valleys themselves, the edges and slopes of terraces, and the higher slopes of the Pollino and Sila ranges which face the plain
- all locations from where no part of the plain or valley floor can be seen; this includes the highlands, secondary river valleys, and the interior of the terraces

To explore such a model, four unrestricted viewsheds were calculated for points lying on the coastline at the mouths of the Raganello and Crati rivers and at two other points to the north and south<sup>3</sup>, plus seven more viewsheds of 10km radius based on four points located on the plain along the base of the foothills and three points within the major valleys of the Coscile and Crati. When combined, these viewsheds do indeed define the intended visual zones (see figure 2a). By including known protohistoric settlements in this model, their degree of association with single zones or, conversely, their liminality with respect to these zones can be assessed and interpreted. Liminal sites should be located near the edge of a visual zone but still within the visible area. Protohistoric sites which lie on the outer edge of zone B can be interpreted as essentially inland sites situated as close as possible to the coastal plain; protohistoric sites that lie on the outer edge of zone C might be related to transhumance routes and the point where these begin to descend into the plain; sites on the inner edge of zone C are 'foothill' sites situated for visual control of the largest possible area of the coastal plain; and sites that lie within the secluded parts of zone C are 'plain' (presumably agricultural) sites with no significant viewshed characteristics. A first inspection of the model presented in figure 2a suggests that it might indeed be possible to group protohistoric sites according to such viewshed properties; a better controlled and more detailed study will, however, be necessary to substantiate this.

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<sup>2</sup> Authors disagree as to the hierarchical relation between the pair. Peroni regards the higher site of each pair as the main settlement; Kleibrink the lower. This is not important for the GIS analysis and in the end may be a meaningless difference as both sites of a pair can be said to form integral parts of one socio-economic system.

<sup>3</sup> These points are located at co-ordinates 2650373/4412196; 2647225/4404081; 2651038/4398140; and 2652413/4390424.

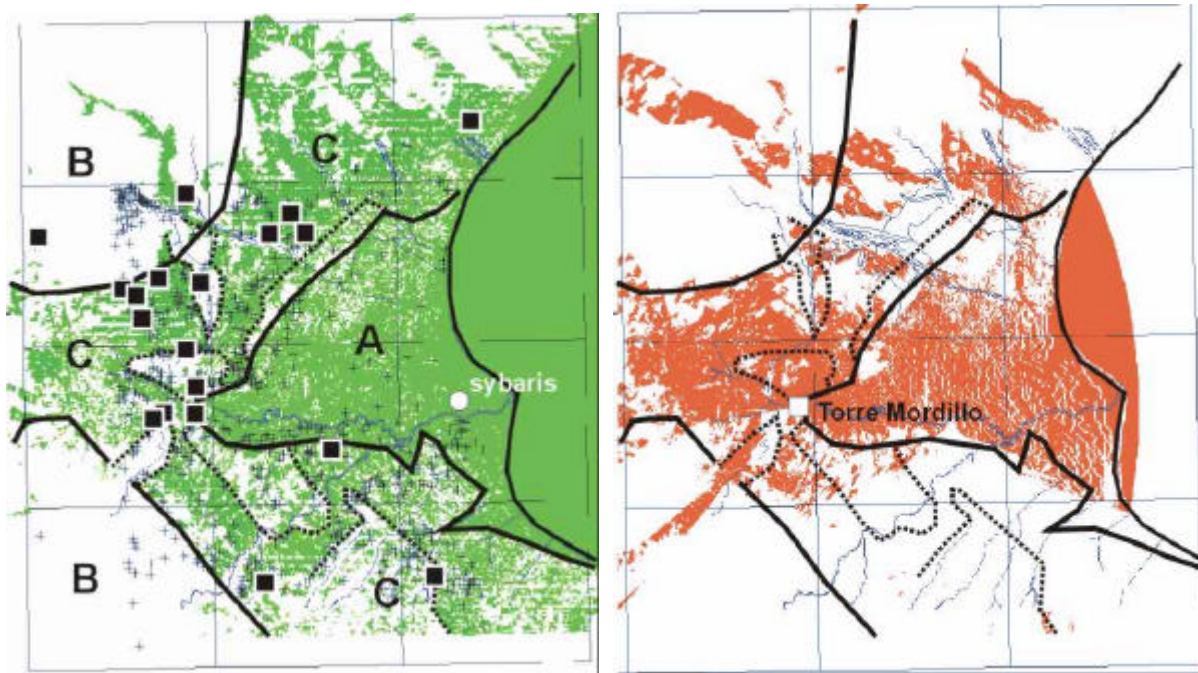


Figure 2 - Left: Visual Zones of the Sibaritide, based unrestricted viewsbeds from four points on the coastline, four points along the inner margin of the coastal plain, and three points within the major river valleys. A: coastal plain and lower slopes, B: highland zone, no visual contact with the plain, C: foothill zone with areas of visual isolation (dotted lines: terraces and valleys). Boxes/diamonds: protohistoric sites. Plus signs: Hellenistic/Roman sites. Grid lines represent the boundaries of IGM topographic map sheets of the 1:25,000 series 25V. Right: 25km radius viewsbed from the important protohistoric settlement site of Torre Mordillo.

The utility of the concept of visual zones can be further explored by comparing them to the viewsbeds of individual protohistoric sites. Figure 2b presents one such viewsbed, calculated from the site of Torre del Mordillo, probably the most important indigenous settlement at the time of the first Greek colonisation<sup>4</sup>. It can be seen that the sites has a very large viewsbed, covering both the coastal plain and much of the major inland valley floors and slopes. Because of its relatively elevated position on the rim of a marine plateau, its viewsbed also includes several of the ‘secluded’ areas not visible from lesser elevations.

When the locations of Hellenistic/Roman farmstead sites in the Quilici dataset are included in the model as well, it becomes apparent that the linear clustering observed by Quilici is related to specific geomorphological settings, for which explanations may be sought not just in viewsbed properties but also in microclimatic variations. Finally, the significance of zones which tend to be ‘hidden’ from most of the plain and valleys (or conversely, from where these areas cannot be seen; indicated by dotted lines in figure 2a) could be further explored. Examples of such areas are the plateaux of Caccavato/Praineto north of the Coscile river and Lauropoli in between the Coscile and the Raganello, and the valley of the Eianina at S. Marco. Interestingly, Kleibrink in a forthcoming article suggests on the basis of other evidence that the latter area might represent a protohistoric ‘tabu’ landscape (Kleibrink, forthcoming).

#### THE ALBAN HILLS

The sites and monuments of the Alban hills were the subject of spatial studies by topographers early on. Settlements, cult places, and ‘tombe principesche’ from the later Iron Age onwards were related to historical and infrastructural evidence, and interpreted in the context of the ‘formazione delle città’, the

<sup>4</sup> By reason of its size and commanding position on a plateau overlooking the confluence of the Crati and Coscile rivers.

formation of early city states. Such studies have continued more recently (cf. Bietti Sestieri 1985, Chiarucci 1996, Arietti 1996), with the emphasis shifting towards models of the spatial organisation of the indigenous Latial societies. The spatial organisation of the landscape of the Pontine region has most recently been investigated diachronically in five phases between 700 and 300 BC by Bouma and Van 't Lindenhout (1998) with the help of Thiessen polygons. These authors identify a general diachronic trend, beginning in the Tiber Valley and continuing in the Pontine region, of centralization towards a smaller number of increasingly urbanised settlements and an attendant simplification in Thiessen polygons. Bouma and Van 't Lindenhout conclude that the Iron Age Latial system of peer polities was still intact during the Archaic period (6<sup>th</sup> century), and began to collapse only towards the end of the 5<sup>th</sup>.

As in the single-period models advanced by earlier writers, this diachronic approach is based on some very shaky assumptions regarding the status and contemporaneity of (proto-) urban polity centres. The dangers involved can be illustrated by these authors' discussion of cult places in the context of their location in a territorial centre, on a territorial boundary, or inside a territory (1998:97-100). In particular, there is a potential circularity of argument involved in the fact that any particular set of Thiessen polygons is the consequence of a *decision* to regard a certain group of sites as 'equal' within a settlement hierarchy; the polygons or their characteristics cannot then be used to prove that this was the case. More-over, their argument that the presence of a cult place in a settlement is supporting evidence for its function as a polity center is weak because it assumes that the absence of cult places is not due to the chances of discovery. Again, their conclusions are often based on the appearance or disappearance of single centres in the network of polygons, and so are very sensitive to the chance presence or absence of occupation evidence for any single period. This sensitivity of Thiessen polygons to changes in the set of 'seed' settlements is demonstrated by overlaying Franco Arietti's alternative hypothetical territorial model of the central Alban area in the later Iron Age on that of Bouma and Van 't Lindenhout (Arietti 1996, fig. 3): applying different criteria to decide which protohistoric sites were territorial centers, Arietti adds the centers of Labigi, Lanuvium and Alba Longa (postulated at Castel Gandolfo) to the list used by Bouma and Van 't Lindenhout with obvious consequences for the sizes and shapes of the resulting territorial division (see figure 3).

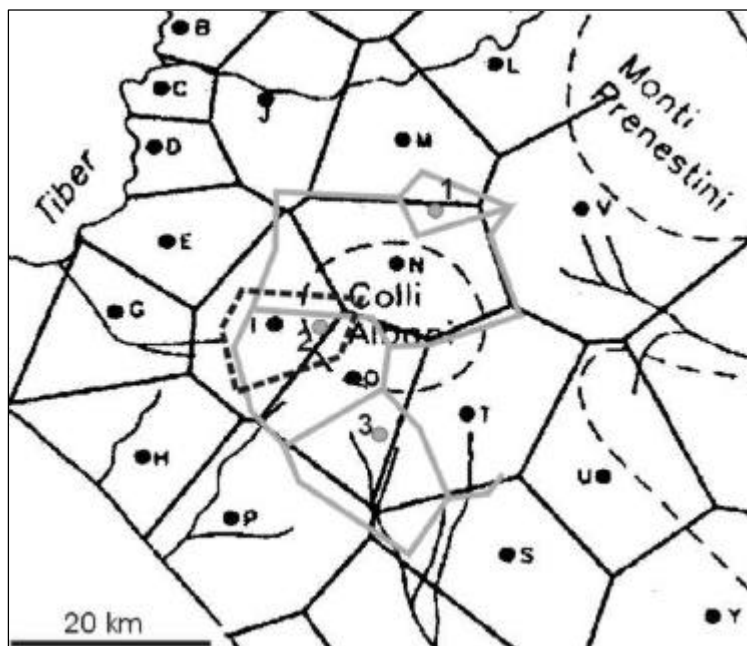


Figure 3: Hypothetical protohistoric territories of the Alban hills. Thiessen polygons and central places after Bouma & Van 't Lindenhout 1998, fig. 2-5 (in black) and Arietti 1996, fig. 3 (in grey).  
Topography: B Fidenae, C Antemnae, D Rome, E Laurentina/Acqua Acetosa, G Castel Decima, H Lavinium, I Frattocchie, J La Rustica, M Gabii, N Tusculum, O Ariccia, P Ardea, T Velletri, S Cisterna, U Cori, V Palestrina, Y Caracupa/Valvisciolo, 1 Labigi, 2 Castel Gandolfo, 3 Lanuvium.

Whilst Thiessen polygons can be 'weighted' to reflect the differing sizes or populations of the polity centers in a peer polity system, they were never intended to model the territories of a hierarchical set of centers. For such a case, central place theory and X-tent models (Renfrew & Level 1979) are more appropriate. Guidi (1985), applying a rank-size analysis<sup>5</sup> to the settlements of south Lazio in four chronological phases (corresponding to the 10<sup>th</sup>, 9<sup>th</sup>, 8<sup>th</sup>, and late 7<sup>th</sup> centuries BC), estimates settlement size from the area bounded by natural defenses. For 7<sup>th</sup> century south Lazio he concluded (1985:232) that there was evidence for the development of a three-level hierarchy with Rome at the top, Ardea and Gabii at level two, and other towns dependent on these three at level three. If the large number of minor sites for which no size data are available were included, he argues, then the rank-size graph would take on a 'primoconvex' shape which indicates a high level of integration for the larger sites but a low level for the smaller ones. These results suggest that the assumptions underlying the territorial analysis by Bouma & Van 't Lindenhout and Arietti are not well supported. Given the lack of discussion of these issues, it appears that these authors are not aware of the extreme sensitivity of the Thiessen polygon technique to even small changes in the input data set.

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### 3      ROMAN COLONIES OF THE LEPINE SCARP

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As the influence of Rome over affairs in the Pontine region grew in fits and starts during the post-Archaic period, and intermittent conflict with neighbouring tribes became more disruptive, so the development of the indigenous Latial peer-polity system was replaced by one of a core-periphery system in which the Pontine plain first became the scene of a drawn-out conflict between the expanding early Roman state and the rather less clearly defined, but equally expansive, hill tribes, and later that of Roman demographic and agricultural expansion. Attema (1993:231) suggested that the Roman colonies of Cora, Norba, and Setia may have played an important role in the later Republican 'colonisation' of the Lepine side of the Pontine plain. The presence in this area of a large number of so-called 'platform' villas which appear to be of very similar date and design argues, he wrote, for a planned process of agricultural re-organisation and exploitation, probably targeted at the production of olive oil and grain for the Roman market. The position of the colonies themselves, located on the rim of the Lepine pre-mountains with magnificent views across the Pontine plain to the sea and along the coast as far as Antium and the Monte Circeo, expresses the control exercised over this agricultural area.

#### HISTORIC-LITERARY REFERENCES

However, these towns and other ones existed long before the late Republican period, and in order to understand why they are located on the Lepine margin we have to trace these origins as far back as we can. The main source for information about this early period is Livy's *Ab Urbe Condita*, from which we can gather the following information about each of these towns:

- *Anxur* (Terracina) - was captured and sacked by the Romans in 406 BC during precautionary campaigns against the Volscans (IV 59). Four years later its garrison was overrun again by the latter, re-taken by the Romans in 401 BC, but again under Volscan siege in 398 BC (V 8-16). In 329 BC Rome sent 300 colonists to the town, each getting 2 iugera of land (VIII,21).
- *Cora* (Cori) - a Latin town, Cora joined the Aurunci against Rome in 503 BC, but was quickly defeated by her (II 17). By 496 BC the town was under Volscan control because these were forced at that time to send 300 hostages from Cora and Pometia to Rome as pledges against attack (II 22). The territory of Cora was raided by the Privernates in 331 BC (VIII,19).

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<sup>5</sup> Rank-size analysis (Zipf 1949) can be used to examine the degree of socio-economic integration of a settlement system by setting out the sizes and 'ranks' (based on size and ordered by rank) of all settlements in a graph. An idealised rank-size graph will have a log-normal shape; deviations from this line indicate higher (concave graphs) or lower (convex graphs) levels of integration.

- *Circeii* - in 491 BC Volscans led by an exiled Roman expelled the Roman settlers sent there in 510 BC by Tarquin (see *Signia*), 'liberated' the town and handed it over to Volscan control (II 39).
- *Anagnia* (Anagni) and *Ferentinum* (Ferentino) - east of the Sacco (Tiber) river, Ferentinum was taken by Rome in 412-411 BC, and given to her Hernician allies (IV 52). In 308-7 BC the Hernici of Anagnia declared war on Rome but those of Ferentinum did not. The former were quickly defeated (IX 42).
- *Norba* (Norma) and *Setia* (Sezze) - taking advantage of the weakened state of the Volscans following an epidemic, Rome sent out fresh settlers to Norba in 493 BC, which became a fortified point for the defense of the Pontine region (II 34). Setia was in Volscan hands (Dion. Hal. 6.61) before Rome sent a colony there in 382 BC (Vell. Pat. 1.14). The territories of Norba and Setia were raided by the Privernates in 358 BC (VII,15), 342 BC (VII,42), and 331 BC (VIII,19).
- *Privernum* (Priverno) - Latial allies, the Privernates continued to raid the territories of neighbouring Roman colonies in 358 BC (VII,15), 342 BC (VII,42;VIII,1), and 331 BC (VIII,19). Although relatively quickly defeated by Roman armies each time, and deprived of two thirds of their territory in retaliation (VIII, 1), only the siege and capture of Privernum in 330 BC (VIII, 19-20) appears to have finally ended the conflict.
- *Signia* (Segni) - in 510 BC the Roman king Tarquin sent some surplus population out to Signia and Circeii, both to increase Roman territory and to provide points of resistance to attack 'by land or by sea' (I 56). This appears to have not been a very successful venture, because already in 496 BC the town had to be re-established with additional settlers (II 22). Inhabitants of the town attack fleeing Hernici after their defeat by a Roman army in 362 BC (VII,8). Still a Roman colony in 340 BC, Signia was apparently ruled by Latin allies (VIII,3).

From this brief overview it becomes apparent that no historic evidence predates the very end of the 6<sup>th</sup> century; that none of the towns mentioned was actually *established* by colonisation from Rome; and that most or all were therefore pre-existing Archaic and (by analogy with other areas) Iron Age settlements. Late Iron Age and Archaic hilltop settlements such as certainly existed at Signia, Circeii, Norba, and Cora were populated by a patchwork of indigenous lowland and highland tribespeople, apparently maintaining some kind of political equilibrium punctuated by low-level raiding, presumably for cattle and prestige (see also examples cited in Attema, in press). This would explain why these settlements would have been located in places which afforded both safety and control over land and cattle.

Starting with the post-Archaic, groups of Roman colonists were sent out in an opportunistic manner to safeguard Rome's political and military interest. The towns of the Lepine margin, 'outposts' from the viewpoint of Rome, bore the brunt of the conflicts with the Volscan tribes which lasted throughout the 5<sup>th</sup> and the first half of the 4<sup>th</sup> century BC. More than once their allegiances swerved from safety under Roman hegemony to independence of it; in addition to this, some Latial tribes continued to raid each other's territories, as is shown most clearly by the case of Privernum which, from its southerly position may have felt itself to be as much akin to the Volscan way of life as it was to that of the Latial League. While the objectivity of Livy's accounts may be questioned, it seems clear that the conflict between Latins and Volscans is acted out on the medium term, the *conjoncture* as defined by Braudel, and can be understood perhaps in terms of the upland boom-bust cycle cited by Bintliff (1997:30-32; cf. chapter 2).

Most of the Lepine margin must have been effectively incorporated into the Roman state by the mid-4<sup>th</sup> century when, in 358 BC (VII,15) she added the Pomptine and Publilian tribes – territorial units in which citizens were enrolled for census, taxation, and military levies – and, following the final defeat of the Privernates and the settling of their territory with colonists, the Oufentine tribe in 329 BC. By the end of the 4<sup>th</sup> century the military Via Appia was completed as far as Anxur. The platform villas identified by Attema (1993) appear only after this *de facto* incorporation into the Roman state was completed.

## VIEWSHED ANALYSIS

In view of the above, the long-term Roman ‘policy’ was not to *establish* colonies on the Lepine margin, but to ensure that the important central places became or remained allied to her, an allegiance that could at times be strengthened by sending out colonists for reasons as much to do with demographic pressure at Rome as with strategic interests (providing early warning and protection from Volscan raiding parties and containing a local population which could not be trusted to choose Rome’s side in a conflict). It is not unlikely that both sets of factors combined to determine which 4<sup>th</sup> century sites were deemed to be most important.

The 4<sup>th</sup> century BC Roman colonies of the Lepine scarp provided bases from which both agriculture and husbandry in the plain and uplands could be protected from Volscan inroads. But they also acted as visual manifestations of Roman power in the lands of her former Latial allies. Their viewsheds might therefore include areas in both the plain and the upland; especially the Lepine mountain passes from which raiding parties might arrive. At the same time they must be positioned close by valuable cropland and grazing herds to be able to protect these against sudden attack. Hence, if we model viewsheds for these colonies we must take into account upland characteristics such as the location of mountain passes as well.

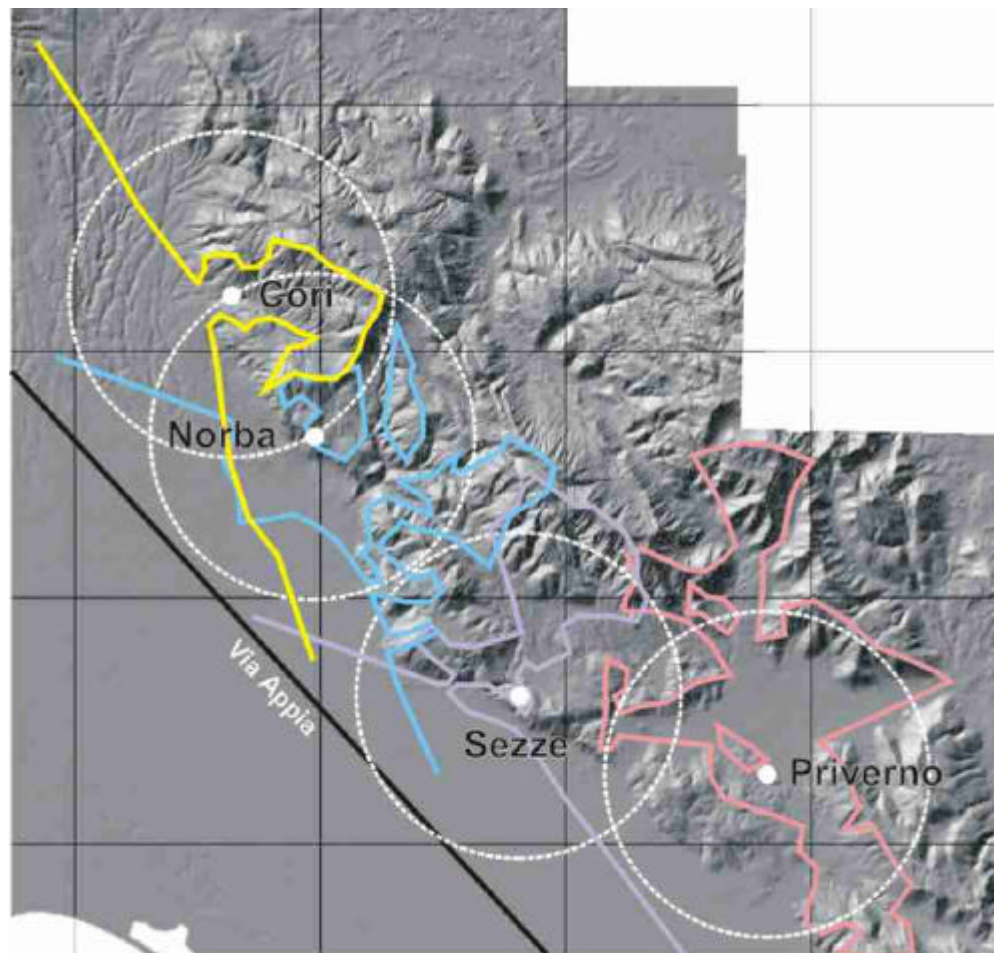


Figure 4: Higuichi viewsheds of three Roman colonies at Cori, Norba, and Sezze, and of protohistoric Priverno on a shaded elevation model of the Lepine mountains. Black line: Via Appia. Higuichi radius of 6600m indicated by white broken line. Grid spacing: 10 km.

Higuichi viewsheds were recently introduced in archaeological research by Wheatley and Gillings (2000) as a way of enriching traditional viewshed studies. Amongst other characteristics, Higuichi proposed



that viewsheds should contain information about the *distance* and *bearing* to the objects in view. With respect to distance, Higuchi viewsheds are subdivided into a short range (< 360 m) sector in which objects are individually distinguishable and have a direct sensory impact, a middle range (360 – 6600m) sector which constitutes the ‘pictorial’ landscape where vision is paramount, and a long range (> 6600m) sector which contains the ‘vertical backdrop’ and horizon features. The distances at which each of these sectors begin and end are variable, because they are relative to the typical tree size for the area under study, but in the following description of Higuchi properties of the three Lepine colonies I simply use Wheatley and Gillings’ figures. Their middle range viewsheds are depicted in figure 4.

Cora is located on the western edge of the Lepini where it borders on the volcanic landscape of the Alban hills, on top of a small hill situated at the mouth of a small drainage basin (391 m asl). Its views to the north and southeast are obstructed by neighbouring higher hills. A viewshed from 2346428,4612210,400 shows that the whole of the Alban massif and the Pontine plain as far as Monte Circeo over 45 km to its south can be seen from Cora, and its direct hinterland, up to 6 km distant, is also relatively well covered. The Roman colony of Norba is situated on a promontory of the Lepine scarp, with steep slopes on three sides but open to the interior, where several small streams and their tributaries form a modest agricultural hinterland before descending into the plain at Valvisciolo. The highest point on this promontory, the ‘acropolis’ hill, is at 490 m asl. The viewshed taken from this approximate point, which is located almost 600m from the Lepine scarp (2350125,4606607,492), is especially large toward the east and south-east, and again the view across the Pontine plain includes both Monte Circeo and the Alban hills. However, from this location one cannot see the nearby footslopes and valleys of the Brivolco stream system. As field observations have shown that long stretches of the lower Lepine slopes are visible from its perimeter wall, an improved Norba viewshed model should clearly be based on multiple viewpoints along its perimeter<sup>6</sup>. Setia is located on a small hill next to the place where the Fosso Brivolco descends into the plain, at about 280m asl (no elevations mapped within the town; over 250m above the plain), and is naturally protected on all side by steep slopes. A viewshed taken from the approximate location of its central church and a height derived from that of a neighbouring hilltop to the southeast (2358047,4595884,310) extends into the upper valley of the Brivolco and into the pass leading east past Roccagorga, all within 5 kms of the town. There is no viewshed due east. Toward the sea, there is an almost 180 degree unrestricted view taking in the Pontine plain and coastal landscape, with the Monti Ausoni and Circeo at up to 30 kms distance as a backdrop; however, views in both directions along the Lepine scarp are restricted by the hills directly to the west and east, and the characteristic shape of the Alban massif is not visible from the town.

The most easily accessible route between the Pontine plain and other parts of Italy to the east and southeast is through the Lepini via the valleys of the Amaseno/Oufente. These valleys are surrounded by several hilltop settlements probably dating back to the Iron Age: Roccasecca dei Volsci, Maenza, Roccagorga and Priverno among them. A viewshed from Privernum (2368018,4592839,139 and 160) was used to set off the other three views. It turns out that all of the major valleys here can be seen very well from this location, even up to the pass between the Lepini and Ausoni, leading to Campania. There is no view into the Pontine plain and, possibly significantly, no significant visible upland within the Higuchi distance which the Romans might have needed to control by the installation of a colony following the siege and capture of Privernum in 330 BC.

Summing up, the colonies have an excellent view of the plain, including the both the Via Appia and the centuriated agricultural zone along it, but the viewsheds do not indicate that the lower Lepine slopes and the ancient *pedemontana* route along it were of immediate concern. Toward the hinterland the colonial viewsheds are complementary and mutually exclusive (that is, together they cover the whole of the western side of the Lepine mountains, but they do not overlap); these viewsheds, and the fields and pastures within them, are mostly within the Higuchi distance of 6600m and would therefore have afforded strong visual control over the whole area. The hypothesis that the 4<sup>th</sup> century BC Roman colonization in the Pontine region was mainly strategic in nature is therefore upheld.

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<sup>6</sup> As was done in the case of the Roman fortress and town at Wroxeter, see chapter 16.

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## 4 CONCLUSIONS

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A general conclusion that can be drawn from the case studies presented here, is that current economic and cognitive models of the ordering of settlements and the landscape in protohistory (and, for indigenous societies, even for many centuries afterwards) are of a very non-specific and intuitive nature. Bias modeling (chapter 6) and corrective fieldwork (chapter 8) will be needed to test the many assumptions on which these models are based.

- The developed Iron Age settlement pattern in the Sibaritide and Salento Murge displays remarkable similarities in the geomorphological location and spacing of the settlements, located some 10-12 km apart in defensible hilltop positions. It must be doubted that regular access to sea-born trade had a major role to play in this, because the pattern continues into the Murge upland, and may in fact be more strictly related to control over high quality agricultural and pastoral resources. This hypothesis can be tested by targeted fieldwork in the Lepine uplands and the inland reaches of the Sibaritide.
- Current typologies of protohistoric settlements in central and southern Italy are insufficiently clear, detailed, or supported by evidence to allow the definition of hierarchical and contemporaneous levels with any degree of certainty. The basis for constructing territorial divisions, whichever method is chosen for it, is therefore lacking.
- The ‘colonial’ settlement pattern in southern Italy was centred on the coast rather than on the hill country, and combined accessibility by sea with the presence of a substantial agricultural hinterland. In contrast, Rome’s early colonies were as much or more intended to fulfill strategic functions, so their locations meet other criteria of dominance – namely that of control over routes of attack and advance. The fact that the viewsheds of the Roman colonies on the Lepine margin are both complementary and fall within the Higuchi ‘middle range’ distance creates support for the idea that these towns were located as much to control movement across the Lepine up- and highlands, as to control and protect communications and agricultural resources in the Pontine plain.
- As a tool for archaeological spatial analysis of territories, Thiessen polygons have been used extensively. The case study presented in section 2 demonstrates the weaknesses of the technique in specific archaeological situations. The use of GIS and cost surface analysis allows the technique to be refined by replacing the simple gravity model of space with one in which each centre can have its own ‘weight’ determining the relative size of its polygon, and in which characteristics influencing the accessibility of the terrain are used to determine the location of territorial boundaries instead of horizontal distance. Rank-size studies such as the one by Guidi (1985), although based on unreliable settlement sizes, when combined with X-Tent modeling techniques provide a more credible alternative to Thiessen polygons; another advantage is that they can be used to implement central place models as well as peer polity models of society.

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# WHP CASE STUDIES IN VISIBILITY AND FRICTION\*

Two of the case studies presented here were originally developed in the context of the study of Romanisation and urbanisation in the Wroxeter Hinterland, an area centring on the modern-day village of Wroxeter in the middle Severn valley (Shropshire, UK); the third case study arose from my work on the methodology of ‘cognitive landscape’ analysis presented in chapter 6 of this thesis. All three are presented here together not just because they cover the same geographic area, but also because the GIS techniques on which they are based – line-of-sight and friction modelling – are related and tend to be used for answering related archaeological questions (for a full technical discussion of these techniques and questions and a review of the relevant literature, see chapter 6). For an introduction to the Wroxeter Hinterland Project, see chapter 3 of this thesis; aspects of centralisation and Romanisation in the Wroxeter hinterland have been sketched elsewhere by White and Van Leusen (1997) and again by White and Barker (1998).

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## 1 VISIBILITY AND CONTROL

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Some aspects of the Iron Age – Roman transition within the territory of the Cornovii can be modelled using only the highest-ranked settlements of either period. Cornovian society, especially in the later pre-Roman Iron Age, is thought to have become increasingly sophisticated and to have been dominated by an aristocracy based on control over land, livestock, and mineral resources (especially salt). The Wroxeter hinterland is well supplied with hillforts (some 40 in all if we include the ones that lie just outside the WHP study area; most are presumed to date to the Iron Age although only a few have been investigated), which has been taken to indicate that the tribe was politically fragmented and was organised in clans around chiefs. However, an alternative view now takes ground (White & Barker 1998:36) that the hillforts are expressions of conspicuous consumption in a society that had few other outlets for its wealth. Whichever the case may have been, certainly the hillforts would have functioned as places of refuge and control, and viewsheds from these hillforts may therefore tell us something about systems of control and defence in the pre-Roman Iron Age.

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\* These case studies were prepared in 1996-7 as part of the Wroxeter Hinterland Project (WHP), directed by Vince Gaffney at the University of Birmingham Field Archaeology Unit (BUFAU). They are based on pre-Conquest digital site data supplied in December of 1996 by Ms Penny Ward of the Shropshire County Council on the basis of the Shropshire Sites & Monuments Records. The data were subsequently checked and enhanced for the WHP by my colleague Roger White. I am particularly grateful to Dr Gaffney, who set out many potential lines of research for me to follow and who himself with a student developed models for the urban resource landscape around Wroxeter (Goodchild 1999). It should be noted that visibility/accessibility modeling has moved on since these case studies were first conceived, and chapter 6 should be consulted for more recent work in this area. Also note that DEM interpolation artifacts, visible in figures 16.3 to 16.6 as stripes or ‘steps’, have not been removed before the analysis. To implement a decision as to whether sites should be visible in these areas, the individual viewshed maps can be put through a simple neighborhood filter.

The indigenous ordering of the landscape of Britain was upset from the middle of the 1<sup>st</sup> century AD by Roman military encroachment. The land of the Cornovii was first invaded by the Romans by the end of the 40s (AD), and the tribe seems to have come to terms with the conquerors without putting up significant resistance. While the main Roman force arrived in Cornovian territory north of the Wrekin, a smaller force may have followed the Severn valley from the southeast and put up a vexillation fortress on the Severn at Leighton just south of the Wrekin; archaeological evidence indicates that the Wrekin hillfort was attacked and taken from there. Several temporary campaign forts were constructed in the area of Wroxeter, which controlled the main routes across the Severn, in the following years. One of these is an auxiliary fortlet on the Severn just south of Wroxeter which may have secured the main Severn crossing; by the mid-50s the legionary fort at Wroxeter itself was established, probably by Legio XIII *Gemina* from Mancetter (Warwickshire). The early Roman military strategies may be studied via viewshed analysis of both the vexillation fort at Leighton, the legionary fortress at Wroxeter itself, and the auxiliary fort to its south. As the legionary fortress developed into a town and civil *civitas* capital after 30 years of predominantly military use, its viewshed may tell us much about its impact within a landscape that had never seen such a population centre before.

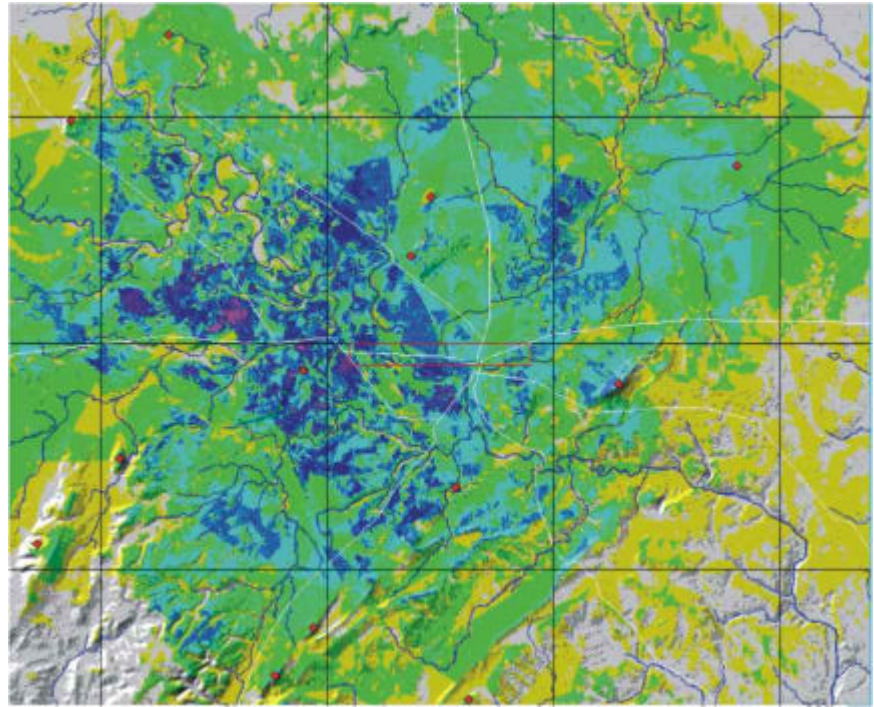
### 1.1 IMPLEMENTATION

We have prepared a similar analysis for the WHP area by regrouping the traditional types of hillforts and multivallate enclosures into more meaningful sets of large (over 2 hectares) and small (less than 1.5 hectares) multivallate enclosures (see table 1; for a more detailed discussion see section 2 on cost surface analysis).

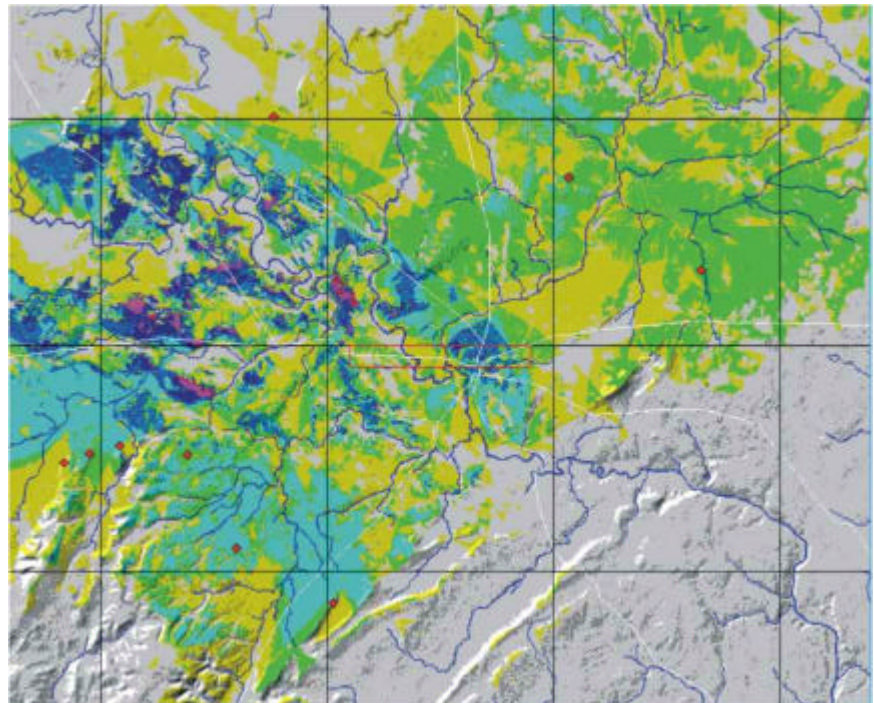
Table 1: 21 multivallate enclosures of the Wroxeter Hinterland, ordered by size. PRN: Primary Record Number. Source: Shropshire County Council.

PRN	Name	Situation	Enclosed area (ha)
1108	Wall Camp	marsh	very large (14)
1357	Castle Ring	hilltop	large (3.8)
113	Ebury Hillfort	low hill	large (3.6)
129	The Berth	marsh	large (3.1)
1438	Stevenshill	promontory	large (3)
1050	Earls Hill Camp	hilltop	large (1.4), with annexe (1.6)
1069	Wrekin camp	hilltop	large (2.6)
226	Caer Caradoc	hilltop	large (2.6)
357	The Ditches	hilltop	large (2.4)
60	The Burgs	low hill	large (2.1)
135	Haughmond Hill camp	hilltop	large (2)
1087	Nesscliff Hill Camp	hilltop	small (1), with annexe (1)
2000	Hurley Brook rect. enc.	no hill	small (1.2)
1055	Pontesford Hill Camp	low spur	small (1.1)
3970	-	no hill	small (0.75)
1740	Nills Hill	low spur	small (0.4)
1048	Callow Hill Camp	hilltop	small (0.4)
2418	Bomere Heath	no hill	small (0.25)
1256	The Lawley, north	hilltop	very small (0.15)
472	Cotwall No. 1	low hill	very small (0.15)
2828	"British Camp"	no hill	unknown

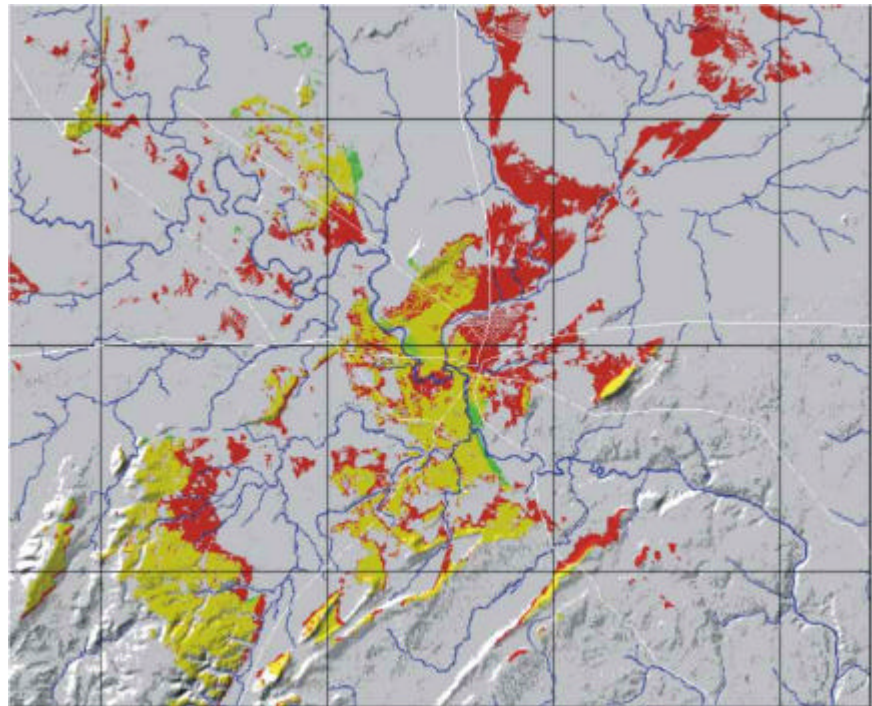
Adding the viewsheds of sites within these two groups to obtain the cumulative viewsheds (see figures 1 and 2), it is clear that the areas most intensively viewed are all in the central upper Severn valley and its main tributaries, with the maxima occurring on the western side of the Severn. These results are mildly helpful in interpreting the results of the Thiessen polygon calculation, which argue for a system in which three pairs of hillforts are spaced along the main basin, dominating opposite sides of it (see section 2). The site of Wroxeter is in fact very near the point where four of these territories meet, making it 'neutral territory'. As it is also near one of the main Severn fords, we suggest that this location was well suited to function as a (periodic?) trading post/market/fair, and forms a logical precursor to the legionary fortress and town.



*Figure 1: cumulative 15km radius viewsbeds of large multivallate enclosures (red diamonds) on shaded DEM overlain with major streams and Roman road system (white lines). 8 by 1 km box in the centre of the study area indicates zone which cannot suffer from edge effects. In this and all further figures, grid spacing is 10 kms unless otherwise stated.*



*Figure 2: cumulative 15km radius viewsbeds of small multivallate enclosures (red diamonds) on shaded DEM overlain with major streams and Roman road system (white lines). 8 by 1 km box in the centre of the study area indicates zone which cannot suffer from edge effects..*



*Figure 3: the multiple viewshed from the fortlet (5m viewing height, green) is almost completely subsumed (yellow) into that from the fortress (7m viewing height, red). The partly reconstructed pattern of Roman roads is overlaid.*

Roman military campaigns into the region used two major routes, one from Greensforge in south Staffordshire following the southern bank of the Severn via Morvill and Much Wenlock, crossing the Severn near Cressage, the other from Mancetter following the later Watling Street via Red Hill and curving north of the Wrekin. The precursor auxiliary fortlet to Wroxeter, discovered by aerial photography and subsequent partial excavations (St Joseph 1951, Houghton & Wells 1978), is located not on the elevated site of Wroxeter itself but nearly a mile to the south, right on the bank of the Severn and some 15 metres lower. Given the military purpose served by this fortlet and the later fortress, viewsheds based on them may well tell us what they were intended to control (see figure 3).

As expected, the viewshed from the fortlet is much smaller than that from the fortress. Whereas the fortress, like the later town, has an uninhibited viewshed over two-thirds of the compass, the auxiliary fort's view is limited to just over half the compass. What is more, the fortress viewshed nearly completely encompasses the fortlet viewshed, so whatever the reason was for placing the auxiliary fort where it is, it cannot have been the viewshed. We may therefore speculate that the fortress was placed directly on the river bank for tactical reasons (campaigning across the Severn) rather than strategic ones (control of movement in the area).

In a separate analysis, a series of viewsheds were calculated from Wroxeter in order to explore its relations with the known hillforts in the study area. In order to circumvent the problem of the low resolution (50 metres) DEM, the viewing position was chosen at 5 metres above ground level at the highest point within the town walls. The result is depicted in figure 4 above and shows that the bulk of the effective (ie ignoring small patches and far off hillsides) viewshed is to the west (from due N to due S) of Wroxeter, and extending some 7.5 kms from the town in those directions. In order to explore the possibility that the viewshed from Wroxeter might be enlarged when taking into account multiple viewing points (watch towers) along the town walls, another viewshed was calculated using the whole of the town walls as the seed area, and setting the viewing height at 5 metres (figure 5). We find that the viewshed is enlarged by 48.5 km<sup>2</sup> (a 43% increase over the 112.4 km<sup>2</sup> viewshed of figure 4), to cover areas to the northeast and directly across the Severn to the west and southwest of the town. The viewshed for the legionary fortress preceding the town is essentially identical to the latter. Most of the hillforts within a 15 km radius, whether they were occupied during this period or not, are found to lie within this enlarged

viewshed. However, since hillforts that posed a threat to the Romans were forcibly abandoned after the Conquest, it is not clear that these results have any significance beyond that which was already proven, namely that the location of Wroxeter was in common view and therefore a good 'neutral' place to hold markets.

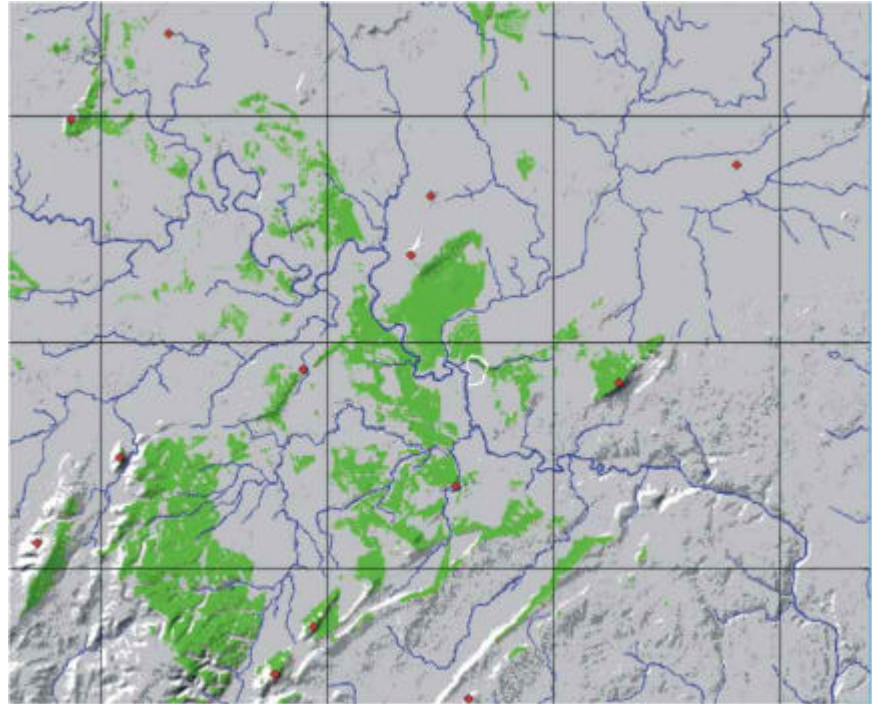


Figure 4: unrestricted viewshed from the highest viewing point within Wroxeter. Red diamonds: large multivallate enclosures.

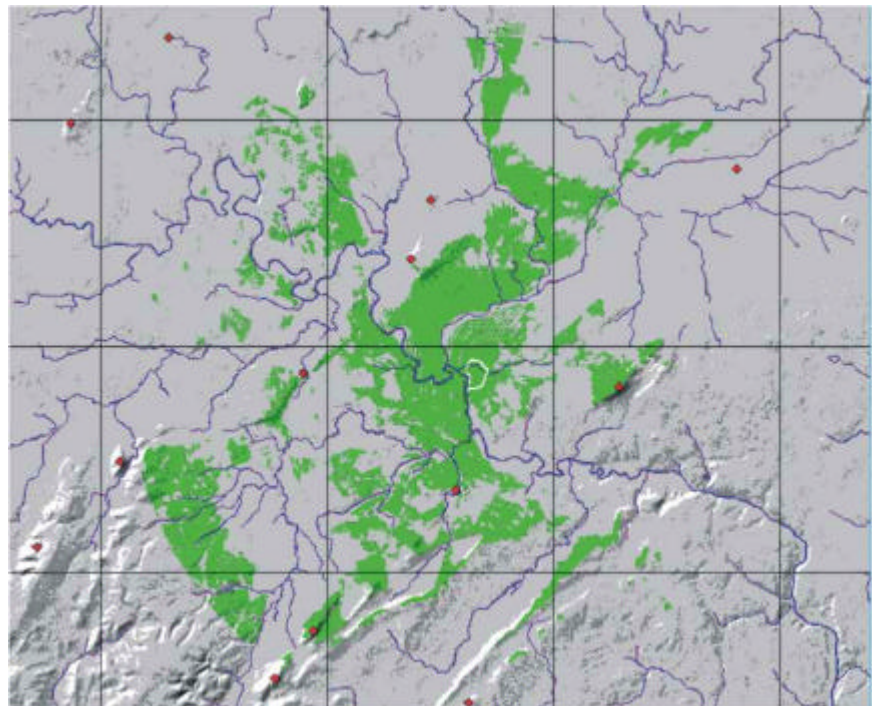


Figure 5: 15 km max viewshed from Wroxeter wall circuit. Red diamonds: large multivallate enclosures.



## 1.2 DISCUSSION

From figures 4 and 5 it is not immediately clear how many of the 13 large multivallate enclosures within the study area fall within the Wroxeter viewshed. In fact, both in the unrestrained viewshed of figure 4 and the 15 km radius viewshed of figure 5, only 4 out of 13 are 'visible'. Field observations have shown this result to be incorrect for at least some of the hilltop locations, and point out a weakness in the line-of-sight technique employed: locations on the visible horizon are not reliably included in the viewshed. One possible technical solution (not pursued here) might be to expand the viewshed by the addition of 'horizon' cells; these can be identified by the fact that they a) must lie next to cells that are within the viewshed, and b) must be further away from the viewing point than any neighbouring viewshed cell.

Overlaying the partly reconstructed pattern of later Roman roads on these maps of indigenous hillfort, Roman military, and Roman civilian viewsheds, we can also observe that many sections of road fall within the viewsheds. However, this appears to be due to the generally favourable position of Wroxeter within the bowl-shape of the Severn valley rather than to any conscious decision to build the roads in such a way that they would be visible from the fortress and town. Simulation studies will be presented in section 3 below to support the weakness of the statistical arguments generally adduced for deliberate placement of archaeological feature (see also the example of the Arroux valley Celtic hillfort system discussed in chapter 6, Madry & Rakos 1996).

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## 2 STRUCTURATION OF THE LANDSCAPE

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The social, political, and economic organisation of space in the Wroxeter hinterland area throughout the Late Iron Age and the Roman period can be studied from many angles, some of which are amenable to GIS analysis. Specifically, the distances and effort involved in travel and transport can be studied through cost surface analysis (CSA), and have ramifications into such areas as political control, economic spheres of influence, and the social ordering of space. CSA techniques may be used to implement, and improve upon, some classical types of archaeological analysis, including buffer, cluster and distance analysis, tessellation of space, and site catchment analysis. They have also been used to explore some entirely new concepts, relating to landscape accessibility and optimal routes and networks. In chapter 6 I have reviewed the literature and current approaches on this subject; here I will present case studies based on WHP data and problems.

### 2.1 CATCHMENTS AND TERRITORIES

Although, in archaeological theory, site catchment analysis is a quite complex and flexible concept, the definition of actual catchments (exploitation zones) has been approached generally in a very straightforward manner as a circular area centred on the site focus, with a radius determined experimentally or ethnographically (Chisholm 1968). Catchment boundaries could also be defined by travel time instead of radius, but implementing this requires some way of taking into account the nature of the intervening terrain, and in the absence of GIS has required considerable legwork in the past.

Traditional methods for constructing catchments remain, however, limited by their reliance on plane geometry and choroplethe cartography. GIS-based techniques, in contrast, allow the simple 'flat' geographical space to be supplanted by a complex friction surface incorporating many relevant properties of the terrain, and the distance-based rule for defining the catchment to be replaced by a time- or energy expenditure based rule accumulating costs / encountering resistance as it moves further from the focus. In order to lead up to these more complex techniques, I will first discuss some simple variants.

## DISTANCE-DEPENDENT TECHNIQUES

The calculation of catchments is only a preparatory step to the actual catchment analysis, which should be based on archaeological theory. For early prehistoric societies this will often be foraging theory; however this does not apply to the largely settled agricultural and pastoral landscape studied by the WHP. More relevant is Bewley's (1994: 65-8) work basing the economic basis of farming settlement sites in the Solway plain on estimates of soil workability as derived from its moisture capacity and texture. Deriving a circular catchment area within a GIS is a trivial operation, and reporting and tabulating the presence of resources within each catchment (typically the goal of this type of analysis) can be automated. Following Bewley's classification, we used such a method to derive soil workability data for a 200m radius area around a sample of 111 enclosures within 5 to 7 km of Wroxeter (figure 16a). Comparison of the workability characteristics of these catchments to those of the sample area as a whole (figure 6b) shows that soil workability did not significantly affect the siting of enclosures within the sample area. We could speculate on the causes - some or many of the enclosures might specialise in cattle raising rather than arable; some or many might be Roman in date and might therefore have had access to heavy ploughs - but that is not the aim of this case study. Generally, such speculation points in one of two directions: either soil workability was not among the most significant factors affecting enclosure siting, or the chosen method (circular catchments) is too coarse. The latter direction could be pursued by modeling for 'a sufficient amount of workable soil (e.g., 2 hectares) within a specific maximum distance (e.g., 400 m)' from the enclosure sites; this type of model was in fact implemented for the Wroxeter hinterland by Gaffney and Goodchild (Goodchild 1999).

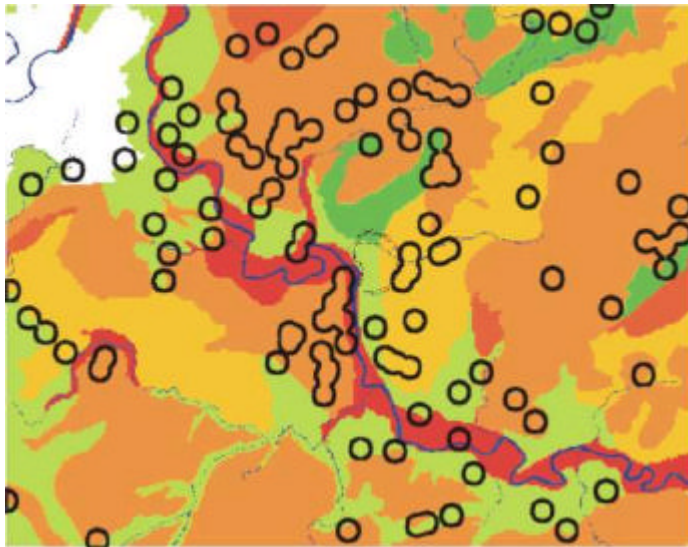


Figure 6a: Soil workability and 200m radius catchments for 111 enclosed sites in a 14 by 11 km area around Wroxeter. Workability classes according to Bewley 1994: dark green easiest – dark red heaviest.

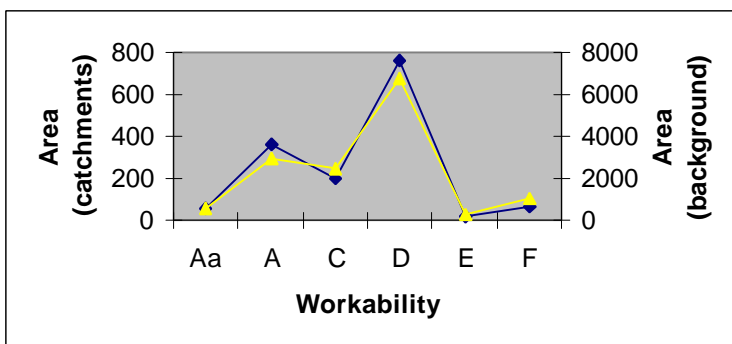


Figure 6b: comparison of workability characteristics of enclosure catchments (dark line) to background (light line). The graph shows a slight avoidance of very heavy soils and an equally slight preference for light soils. Workability classes according to Bewley 1994: Aa very easy, A easy, C average, D slightly difficult, E moderately difficult, F extremely difficult. Area on both vertical axes in hectares.

The binary (inside or outside) result obtained with this type of catchment can also be improved upon by defining multiple distance-based ‘buffer’ zones around sites (or, as will be shown below, around line or area features). This opens up the possibility of deriving distance-dependant relationships between sites and resources. We have employed buffer analysis to look at the most plentiful site group in the study area, that of the enclosures, on the basis of Whimster’s (1989:35) system of morphological classification of crop mark enclosures in the Welsh Marches. Whimster noted a (slight) tendency of rectangular enclosures to cluster around Wroxeter; presumably this signifies or expresses some kind of economic, social, or cognitive link, such as increased demand for agricultural produce or increased status attached to ‘Romanised’ forms of settlement, focusing on the civitas capital itself. Whimster therefore tentatively dates these rectangular enclosures to the Roman period, and the dating has received some support from excavated evidence elsewhere (Bewley 1994). We can begin probing this hypothesis by checking that the clustering is in fact present, and a simple one-sample test for randomness confirms that this is the case – rectilinear enclosures do indeed cluster around Wroxeter more than curvilinear ones (figure 7a).

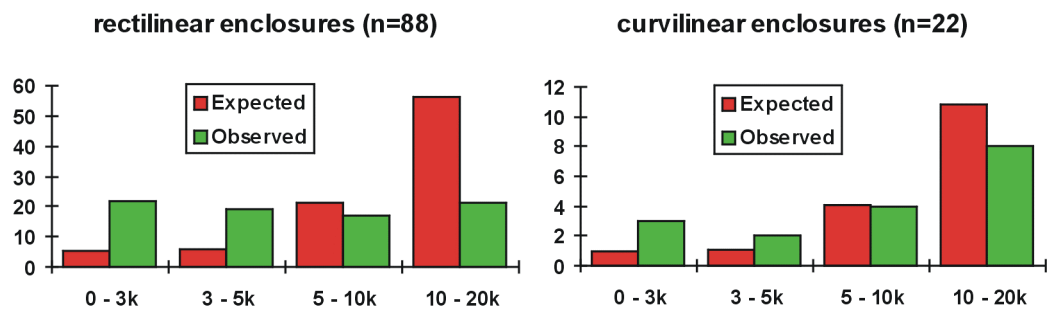


Figure 7: Expected/Observed number of a) rectilinear enclosures, b) curvilinear enclosures per distance buffer from Wroxeter.

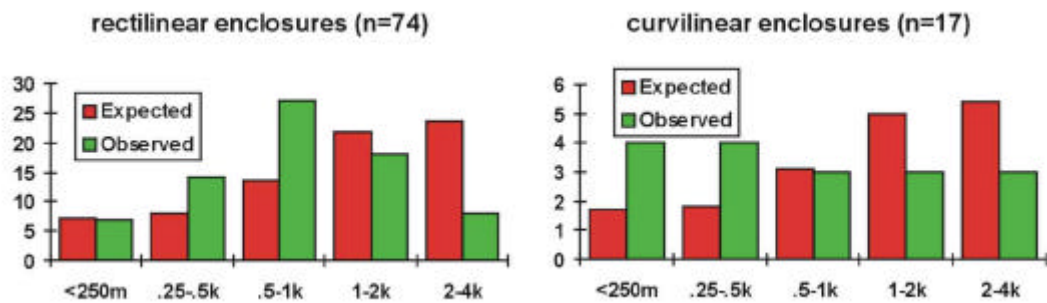


Figure 8: Expected/Observed number of a) rectilinear enclosures, b) curvilinear enclosures per distance buffer from major streams.

Having established the fact of the clustering, we must now probe deeper for possible explanations. Since the clustering is a property of *both* types of enclosed sites, and curvilinear enclosures are thought to predate the establishment of the town at Wroxeter, we must look for other *additional* causes for the clustering to occur. We may find such causes by examining other environmental and social factors, and by examining potential bias factors. As a first approach, univariate preferences indicate that nearly all enclosures occur on relatively flat land, of good to medium workability, and not far from major streams. When we map the former two factors using the map algebraic function

$$\text{Good\_land} = \text{if}((\text{SLOPE} \leq 6) \ \&\& \ (\text{WORKABILITY} [\text{A} - \text{D}]))$$

And limit our subsequent analysis to these area of good land, we can examine the relation of the various types of enclosures to major streams (see figure 8 above). It now becomes clear that rectilinear

enclosures were preferentially placed at a certain distance (ca. 500 m) from the nearest major stream, but could easily occur up to about 3 km from such streams. Curvilinear enclosures have a more direct but also weaker preference for closeness to streams.

Obviously, if rectilinear enclosures are indeed Roman in age, it may well be that a constellation of proximity factors (to streams, to roads, to other enclosures, and to the market at Wroxeter) would have been at work to 'direct' the choice of a new settlement location. Other rectilinear enclosures may have been 'Romanised' versions of existing enclosed sites, for which a different constellation of location factors would be relevant (esp. the cultural, political and social ambitions of the inhabitant).

Since nearly all enclosures have been discovered by aerial photography, our models should also account for the possibility that systematic biases related to modern crop sensitivity land use account for the observed distance relationships. As I have shown elsewhere (chapter 14, section 2.3), there is a strong univariate correlation between crop and soil marks and modern land use.

### TESSELLATIONS

If catchment radii or buffer distances are extended until all available space is divided, a territorial division or tessellation of the landscape results. Archaeological arguments for suspecting the existence of such tessellations abound, albeit the type of tessellation differs by period. For the advanced Iron Age, the sociopolitical structure of Wroxeter hinterland is thought to have been dominated by the sites known as hillforts and perhaps also by multiple-ditched enclosures, and we may therefore be able to model chiefdom territories using some method akin to Thiessen polygons. For the Roman period, a central place model of market functions puts a ring of secondary markets at about 15 km from the main market and civic center at Wroxeter, and introduces the element of ranking in the derivation of territories.

Ruggles and Church (1996) provide a thorough discussion of the theory, problems and possibilities involved in creating more realistic Thiessen polygons, but in fact the major problem in most studies is how to decide on a set of contemporaneous, equivalent sites to base the analysis on (see also my critique of the tessellations applied to the Archaic polities of the Alban hills area, chapter 15). The definition of potential late Iron Age chiefly residences within the Shropshire SMR is problematic in this respect. Within the Wroxeter hinterland there are three known multivallate enclosures which are not recorded as 'hillforts' (PRN's 472, 1055, and 2000; see table 1), even though one of them is situated on a hilltop; conversely, many sites recorded as 'hillforts' are not actually located on hilltops at all - notably, the 'lowland hillforts' at Wall Camp and the Berth at Baschurch. Given that hardly any of these sites has been excavated, functional interpretations remain largely a matter of conjecture, and a less subjective partition could be based on the size of their internal area (table 1). We can then distinguish groups of larger (2 to 4 ha) and smaller (0.15 to 1.2 ha) multivallate enclosures; Wall Camp, at 14 hectares, and Bury Walls (12 hectares but just outside the study area) are clearly outliers.

Plotting these two groups on a map of the study area (figure 10), we can see a crest of smaller multivallate enclosures around the fringes of the Long Mynd upland (southwestern corner of the study area), with the larger ones situated more toward its interior. The smaller sites would combine high status (as evidenced through the effort spent on earthworks) with accessibility (= nearness to agricultural land and infrastructure?), and might be residences of chieftains. The set of larger multivallate enclosures are fairly evenly spaced across the landscape, with closer pairs occurring at Caer Caradoc/The Lawley and Haughmond Hill/Ebury Hill. An argument can be made for the idea that these two pairs are either not contemporaneous or not of the same type, and that we should perhaps exclude the lesser of each pair (i.e., Haughmond and the Lawley) from our territorial analysis.

Constructing Thiessen polygons on the basis of the reduced set of larger multivallate enclosures and a simple slope-related cost surface, we obtain a division of the landscape with some interesting properties (see figure 9). Firstly, three pairs of hillforts occur at regular intervals opposite each other along the main Severn corridor, with Wroxeter itself very near a common boundary between four of these. Although pairing has been observed elsewhere (Bowden 1989), the siting of opposing pairs across a river is not

attested elsewhere, and is likely to be due to the particular physical geography of the study area. Given the locations of known fords in the Severn, some of the boundaries between these hillfort territories converge near Wroxeter, a result substantiating theoretical arguments for expecting the location of markets and religious sites at or near territorial boundaries.

Secondly, hillfort territories to the northeast (Wall Camp) and southwest, with the possible exception of the Lawley, are *not* oriented toward the Severn. Obviously these are marginal territories, the size and shape of which will be influenced by edge effects (in particular, the presence of other large hillforts outside the study area, such as Bury Walls). But the pure fact that these territories are visually and physically isolated from the main Severn valley must make effective control that much harder, and it is unlikely that they played a significant role in controlling the area. Further corrections can be applied by assuming that territorial divisions followed the natural division of the landscape into watershed basins (figure 10)<sup>1</sup>.

## 2.2 MODELLING IRON AGE/ROMAN TRADE NETWORKS

Within the WHP we have attempted to take the tools of cost surface analysis further, using drainage or shortest path calculations to construct a hypothetical Iron Age organic road network that complements the known network of Roman roads. An extensive and intricate network of routes of various types must have existed in the Iron Age landscape around Wroxeter. Not only were there established paths between settlements, but there most also have been paths between settlements and central places such as the hillforts, markets, and cult sites. Since cattle breeding now appears to have been the mainstay of both the Iron Age and the Romano-British economy of the Cornovii, we must also expect to find networks of wider trackways running between upland pasture and lowland settlement and market areas. Such droveways are thought to have followed ridgelines in order to avoid, as far as possible, difficult terrain and intrusion on farming land. Where cattle droves run through farming land, the movement of the animals would have been restricted by parallel hedgerows or fences for which we have ample air photographic evidence. The Shropshire SMR holds 33 trackway records, 10 of which are doubtful and none of which have been dated with any degree of certainty. However, some can be assigned to the Iron Age/Roman period on morphological grounds. A large number of these parallel linear crop and soil marks are directly associated with enclosures and field systems. This is to be expected because crops would need to be protected from cattle being taken along the tracks/droveways; outside these farming areas, the trackways would not need any defined boundaries and could widen out considerably, making them archaeologically invisible. Although the Roman military road network may to some extent have followed and fossilised the main existing routes through the area (see especially the reconstruction of infrastructure by Bassett 1990), we cannot assume that this network is representative of Iron Age infrastructure in any sense. The object of this case study is therefore to reconstruct the Iron Age infrastructure on the basis of what we already know about the locations of enclosed settlements. GIS models based on cost surface analysis can be used to investigate the presence and properties of such networks, either by directly probing relevant existing archaeological records, or by generating hypothetical transport networks based on least cost principles.

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<sup>1</sup> A stream map and a watershed basin map can be constructed through the application of a drainage algorithm on a DEM; by inverting the DEM the same algorithm can be used to generate ridge lines. Any resulting basin not fully within the study area will suffer from edge effects.

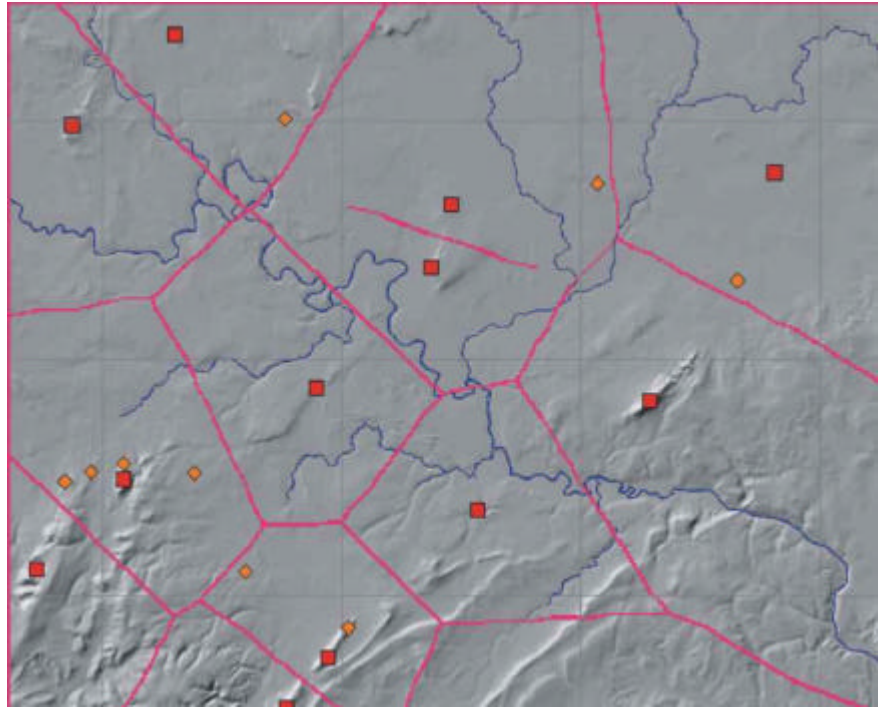


Figure 9: Distribution of smaller (diamond) and larger (box) multivallate enclosures in the study area, with a Thiessen network generated on the basis of the larger enclosures.

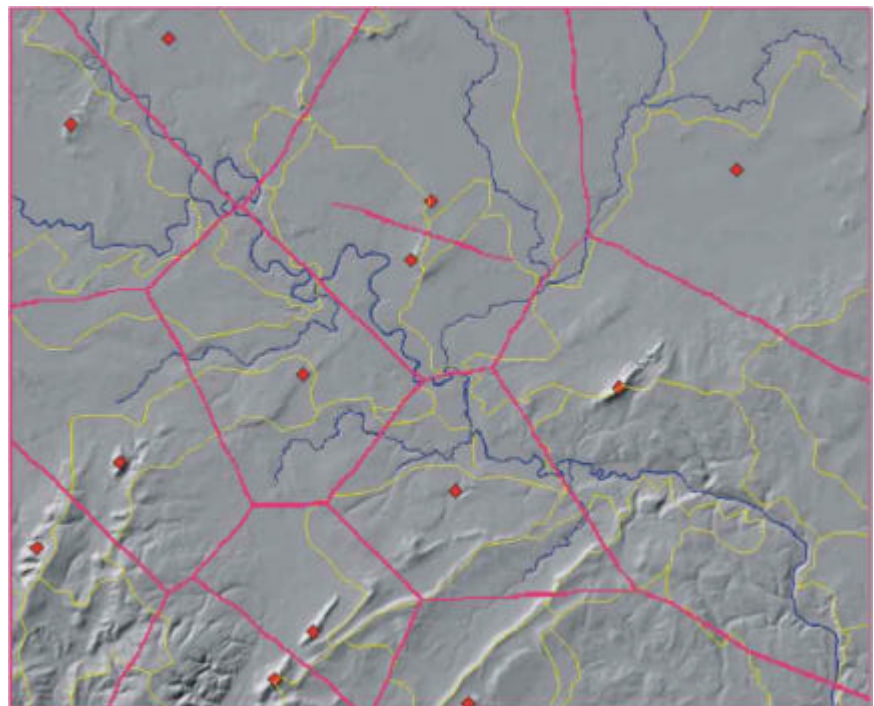


Figure 10: Distribution of larger multivallate enclosures in the study area, with major watershed basin boundaries generated from the DEM (yellow lines).

## Least cost networks

The calculation of multiple least cost paths through the Wroxeter hinterland requires the definition of start and end locations, which in turn depend on the system being studied:

- Our first approach was to use Wroxeter itself as a single ‘end’ point given strong indications that it had been the location of an important fair/market during the later Iron Age. ‘Start’ points varied depending on which type of route was being modeled; for the regular traffic of people and goods start points were taken from the locations of known settlement sites (enclosures).
- A second set of route networks was generated using the larger multivallate enclosures as end points and all enclosures as start points, in order to simulate the infrastructure of the Late Pre-Roman Iron Age settlement system.
- Finally, a third set of networks was generated with end points chosen to represent the developed Roman trade system. This includes, in addition to Wroxeter itself, known secondary roadside settlements at Westbury, Church Stretton, Bridgnorth, Red Hill (*Uxacona*) and the lost settlement near Harcourt (*Rutunium*).

Below we describe the process involved in generating the first of these networks, with a single end point at Wroxeter. This is followed by a discussion of the other networks.

## NETWORK GENERATION

The following calculation of the Wroxeter cumulative cost surface (‘cost to market’) and of the subsequent least cost paths (‘cost from start point’) is based on a cost surface obtained using the Pandolf formula for the physiological expenditure  $M$  (metabolic rate in Watts) involved in moving over natural terrain, which incorporates total weight (body plus load) moved, a terrain factor describing ease of movement, and percent slope:

$$M = 1.5W + 2.0(W + L)(L / W)^2 + N(W + L)(1.5V^2 + 0.35VG)$$

The **grade G** was mapped as percent slope, a derivative of the 50 metre resolution DEM obtained from the OSGB for the study area. Because the slope calculation is non-directional, no distinction has been made between downslopes and upslopes; my discussion in chapter 6 shows that this has a minor effect on the quality of the model.

The **terrain factor N**, a cost surface (figure 11a), is constructed on the basis of terrain features known to influence movement - marshy areas, roads, and streams of various widths, with a default value equivalent to the presence of a dirt road assigned to the remainder of the study area. This default value is important in that it assumes the presence of an existing intricate network of paths throughout the area, so that the need to create an entirely new path (which would entail higher energy expenditure) would hardly ever arise (an assumption I have argued for in chapter 6). Coefficients for these terrain features were mostly taken from Marble (1996:5, quoting Machinova 1996 and Givoni and Goldman 1971). We assumed that for small loads the Roman roads would not have a much lower coefficient than ‘organic’ ones. Givoni and Goldman (1971), for example, assign terrain coefficients of 1.0 and 1.1 respectively for metalled roads and unmetalled paths. Although this slight difference in cost resulted in many least cost paths running parallel to each other because of the effective lack of an energy penalty over large stretches of the study area (see, for example, figure 15), it is preferable not to attempt to ‘correct’ for this by artificially lowering the coefficient of the Roman roads or raising that of the default value.

Modelling the terrain factor **N** revealed several implementation problems. The main problem in the calculation of **N** proved to be the presence of a major river with tributaries in the study area; it was also noted that in order to properly model seasonal variations in the accessibility of some land types (river

alluvium and peat bogs) it would be necessary to calculate different versions of N. Stream coefficients had to be set relatively high (88 for the Severn, 22 for the larger streams, and 5.5 for the smaller ones) in order to prevent the least cost paths from crossing them repeatedly. We were also forced to include information about fordable places in the Severn in order to differentiate between these and other stretches of the river; fortunately, a cartographic record of Severn fords was available (Pannett 1989). This map identifies



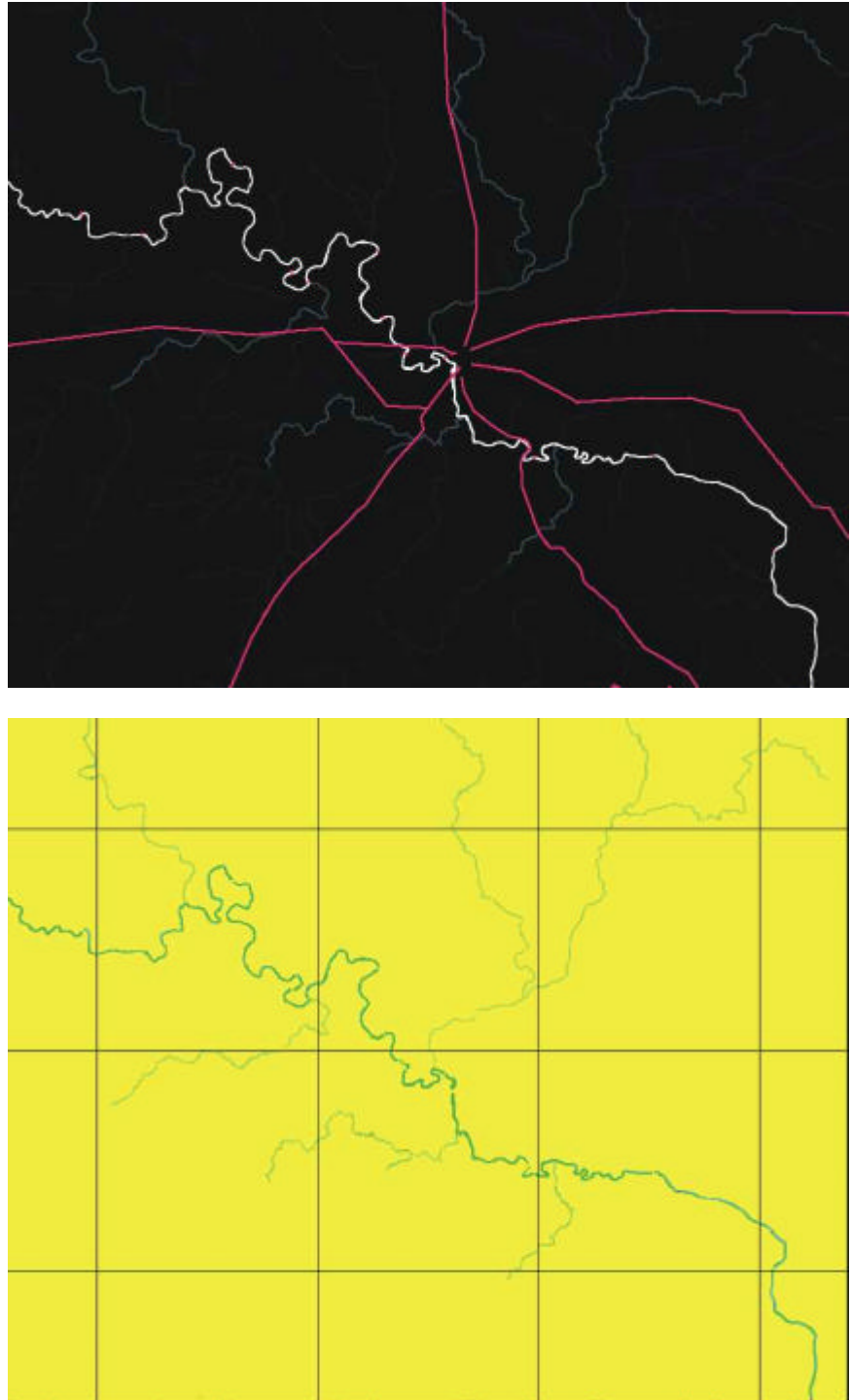


Figure 11: a) Terrain Factor  $N$ ; b) Energy cost surface  $M$  in Watts for the Wroxeter Hinterland. Darker tones indicate higher cost.

nine good fords between Apley (below the Ironbridge Gorge) and Hayes on the Welsh border, in addition to four lesser fords between Mytton and Cressage (in the centre of the study area), all of which were assigned a value of 1. It was found that the incorporation of these detailed terrain features in our calculations caused the resultant least cost routes to converge more on each other, on occasion skirt around bends in streams, and make more use of the Roman road network. Finally, an unexpected technical problem had to be circumvented. It turned out that, in the raster based GIS used, the cost accumulation algorithm and the drainage algorithm both perform a local search of 8 neighbouring cells to locate the lowest cost neighbour, whereas linear terrain features with a width near that of the map

resolution (25 metres) were represented by a single *corner-connected* line of cells (see figure 13). This resulted in the 'skipping' of the important high cost terrain features by both the cost and the drainage algorithms, and forced a rerun of the whole analysis - this time with all streams, roads and fords widened by 2 cells so no more 'skipping' of high cost linear features was possible.

The other variables involved in the determination of M were kept constant, with **weight W** at 70 kg, **load L** at 4 kg, and **velocity V** at 4.8 km/h. Using these parameters the formula to calculate metabolic rate in watts (M) becomes:

$$M = 105 + 0.483 + 74N(34.56 + 1.68G) = 105.483 + 2557.44N + 124.32NG$$

The resulting cost surface M, illustrated in Figure 11b, forms the basis for a series of cumulative cost surfaces centering on the intended 'end point(s)'. In order to model a single route network converging on Wroxeter, a cumulative cost surface was calculated using M as cost and NGR 356485 / 308705 (the main forum entrance at Wroxeter) as the end point coordinate (figure 12). Cycling through a list of enclosure site locations used as 'start points', this surface is then drained and the resulting least-cost paths added together using map algebra to yield an 'organic' or 'natural' network for travelling from these sites to Wroxeter. This network indicates not just where, but also how intensively used, routes were. One example of a least cost path is illustrated in figure 14; the full network is depicted in figure 15.

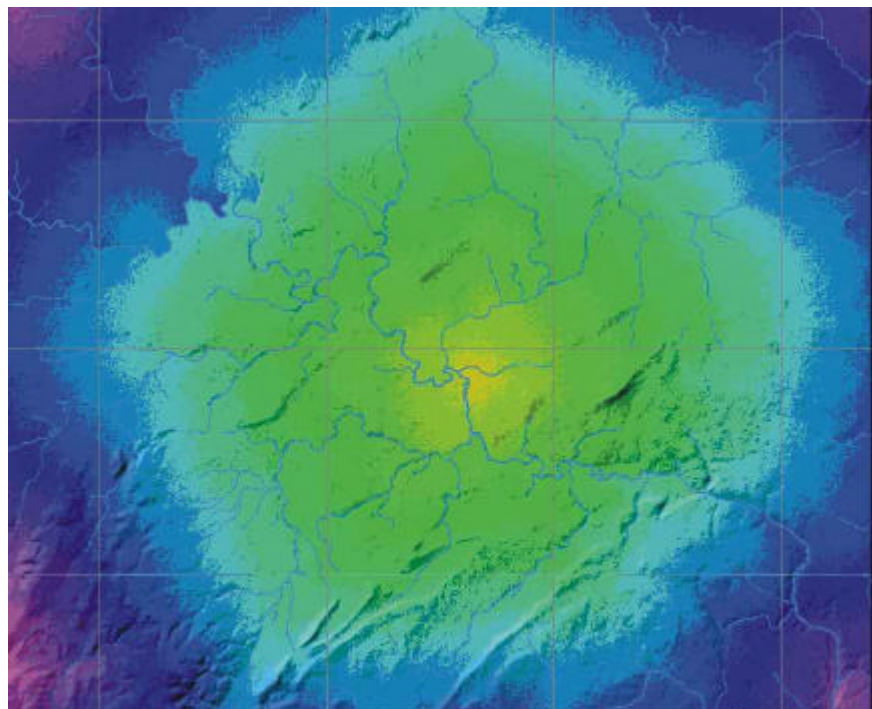


Figure 12: Cumulative energy expenditure surface for Wroxeter, using shaded background.

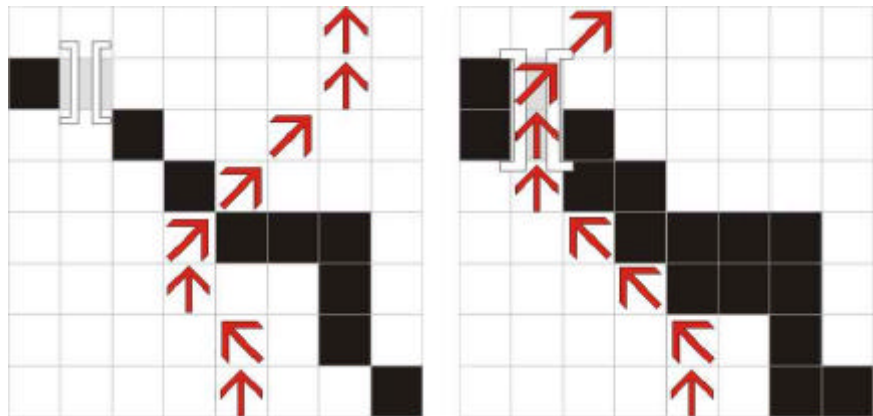


Figure 13: The representation of linear terrain features in a raster cost surface can introduce significant errors in the resulting cumulative cost surfaces and least cost paths, depending on the algorithms used for cost accumulation and drainage. In this example, on the left, a least-cost path can 'jump' a one-cell-wide cost barrier such as a river if the algorithm allows diagonal moves; on the right, the problem has been fixed by widening the cost barrier - forcing the algorithm to look for low cost crossing points such as fords.

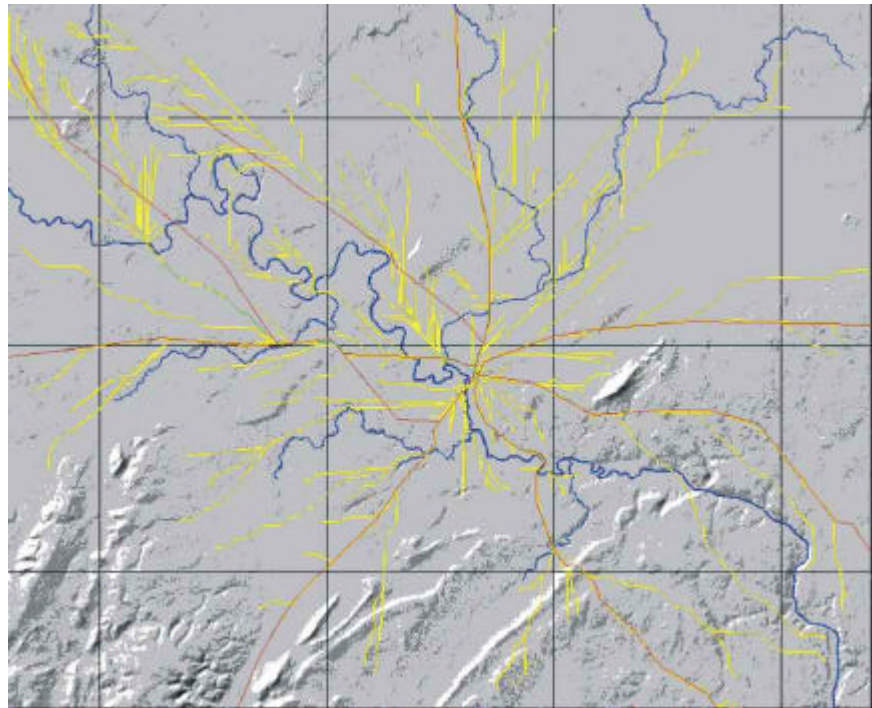


Figure 14: Simulated route network based on least cost paths through the cost surface of figure 12, streams and Roman roads included.

The resultant network has some gratifyingly realistic aspects. In particular, it shows avoidance of streams and convergence of routes, and the organic routes generated in the upper Severn valley coincide approximately with the lines of presumed roads into north Wales (north-western part of the study area).

#### ROMAN SECONDARY MARKETS NETWORK

We can now investigate an alternative model of travel between enclosed settlements and markets, by adding to the single 'end point' (market) at Wroxeter five more end points located at known or presumed second-level settlements in the study area – at Harcourt, Westbury, Church Stretton, Bridgenorth, and Red Hill. In this model we will assume equality of 'attraction' (that is, of cumulative travel costs)

between Wroxeter and these other sites. The implementation of this model again starts from the cost surface N and the energy surface M (figure 11); the cumulative cost surface (figure 15) uses the six sites mentioned above as start points; and the cumulative least cost network (figure 16) again uses all enclosures as start points.

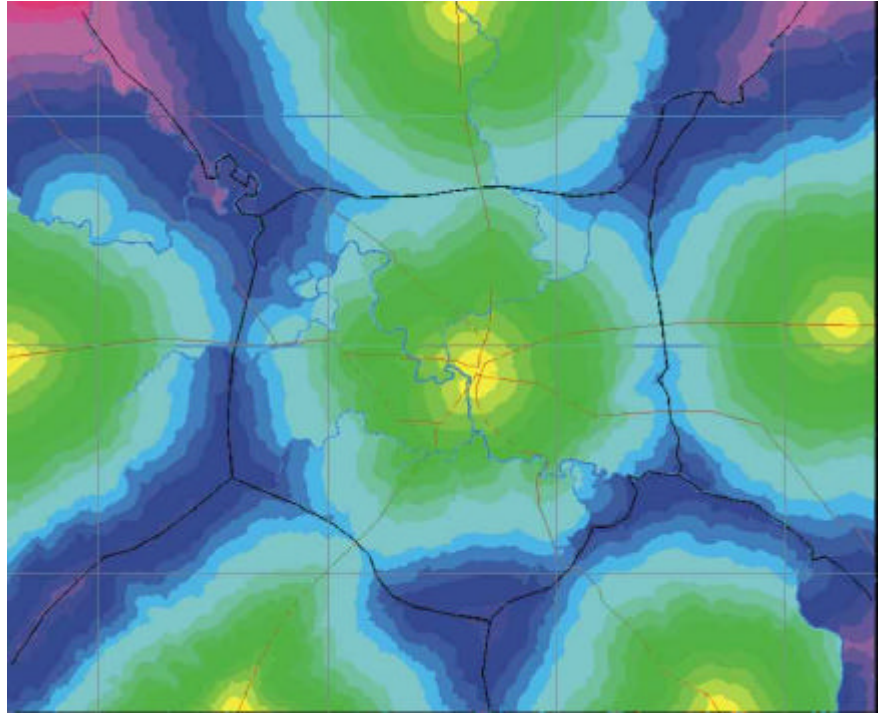


Figure 15: cumulative cost surface for primary and secondary markets in the Wroxeter Hinterland. Maximum cost boundaries (black), streams (blue) and roads (red) overlaid.

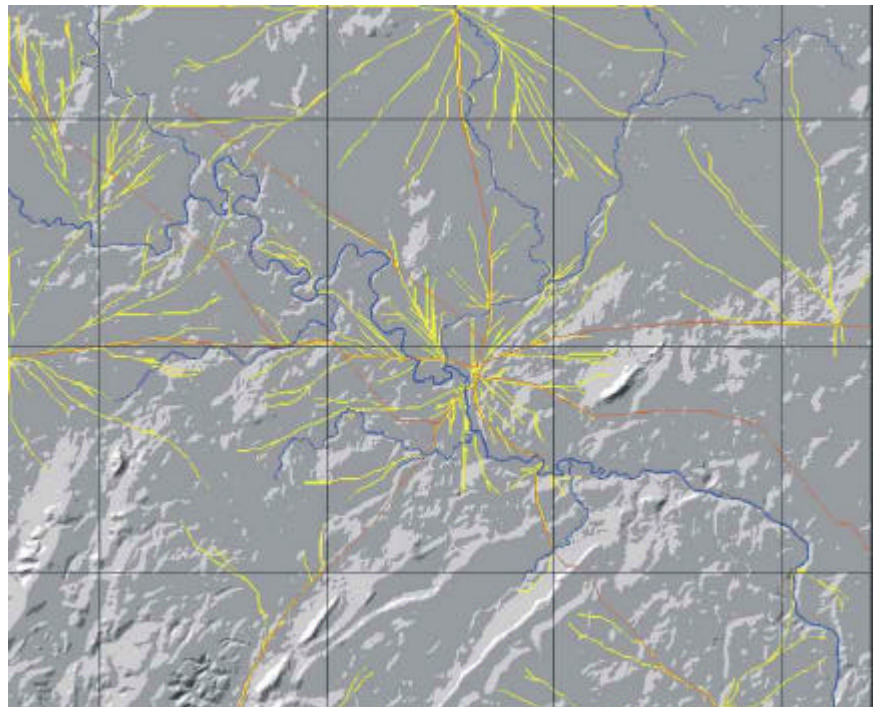


Figure 16: least cost network from all enclosure sites to primary and secondary markets.

Again the influence of terrain costs on territories and paths is clear. The ‘territorial boundaries’ (maximum cost lines) in the cumulative cost surface tend to follow streams, and the fordable places in the Severn exert a strong ‘attraction’ on paths (see, for instance, the convergence of paths near the ford at Strawardine - top left of study area). Also notable is the divergence between the simulated route and the hypothetical Roman road where it crosses the Tern directly north-west of Wroxeter. Whereas the line of the Roman road to the north of the Severn (postulated on the basis of regularities in 19<sup>th</sup> century field boundaries) requires the presence of an additional bridge across the Tern, the simulated least cost path takes a shorter route and uses the existing Tern bridge some 2.5 km to the south.

This model may be refined still further by adding constraints in the form of known nodes and paths. It has, for example, been suggested that the site of Meole Brace a few km to the west of Wroxeter is important because it is located at a node in the Roman road network, with excavated evidence for redistribution functions (Ellis et al. 1992). Likewise, the known trackways of the Wroxeter hinterland can be used as ‘attractors’ in the cumulative cost surface. Even if the hinterland infrastructure in both the Iron Age and Roman period was largely organic (and there is no reason to believe otherwise), routes may be expected to follow natural lines from settlement to settlement, and to interconnect with the Roman road system. We may therefore expect nodes to occur where natural routes connect with formal roads and other routes routes, and may derive some idea about the relative importance of these nodes by the number of individual least cost that intersect there. Such simulations will not be very accurate but should still indicate areas where we might look for small markets or shrines, and will allow us to re-study the archaeological records from this perspective.

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### 3      **EDGE EFFECTS AND BACKGROUND INDICES**

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Cumulative viewshed analysis is a tool often used to investigate and interpret the ‘social’ placement of archaeological sites and monuments in the landscape. The placement of these sites and monuments in areas of relatively high or (less often) low visibility is often seen as proof that they were intentionally put there. A more sophisticated approach first calculates a ‘background’ CVI which describes the ‘natural’ visibility of all parts of the terrain, then investigates whether the viewshed properties of the sites of archaeological interest are significantly different from this, therefore presumably intentional. However, the quantitative study of viewshed intensity gives rise to several further more or less subtle distorting effects which must be taken into account. Two of these – the edge effect and the influence of viewshed radius on the relation between elevation and CVI - are demonstrated here.

#### 3.1      **EDGE EFFECTS**

The edge effect has been discussed in general terms in chapter 6, and in the case study presented in section 1 above its maximum reach was visualised as a box outlined in red (figures 1 and 2), but no attempt was made to further quantify it. In the following such an attempt is made, employing an idealised circular raster ‘world’ with a radius of 20 km and a resolution (cell size) of 500 by 500 m. The total number of cells within this area is 4977. Three cumulative viewshed indices (CVI’s) were generated using 50 (1%), 250 (5%), and 500 (10%) samples of randomly chosen seed cells and a 10 km viewshed radius (see figure 17a). It may be observed that the relatively large viewshed radius yields a consistent area of high visibility near the centre of the world even with a very small sample of ‘seeds’. As the number of seeds rises, so the CVI approximates the ideal distribution which would have resulted from a 100% seed sample; but the 10% seed sample used for the right-hand CVI is already clearly sufficient for investigating the edge effect.

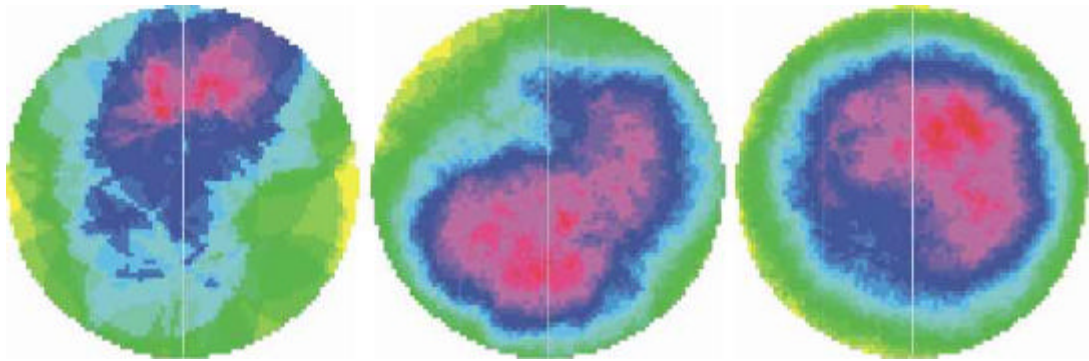


Figure 17a: Cumulative Viewshed Indices for a flat test universe of radius 40, using viewsheds of radius 20 and random samples of 50, 250, and 500 viewpoints. Min=yellow, max=red. Grid spacing: 20 cells.

In order to obtain a graph of the relation between CVI values and distance from the edge, a normalised index of edge distance (EDI) was constructed in which 0 represents the edge and 100 represents the centre of the world. Next, the median CVI per EDI value was tabulated and is represented in the graph below.

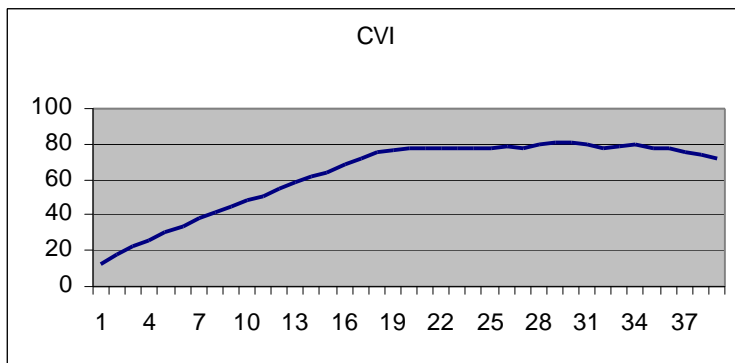


Figure 17b: graph of edge distance index (EDI, horizontal) against cumulative viewshed index (CVI, vertical) for the right-hand universe in figure 18a. Above a distance of 20 (one viewshed radius), no edge effect occurs.

The three CVI images come progressively nearer the ‘ideal’, where all areas over one viewshed radius (20 cells) from an edge have an identical CVI. It is noteworthy that even a 5% random seed sample can yield a CVI that still deviates significantly from this ideal – so we cannot accept this as a rule of thumb (contra Lake et al. 1998). Within the circular and ‘flat’ universe used for this test, the edge effect diminishes linearly with distance, as predicted. With a 10% sample of ‘seed’ cells, CVI rises steadily from 12% at the edge to 77% at one viewshed radius from the edge, then holds steady at about 80% before dipping to 72% at the center of the universe due to the random nature of the seed locations. The absolute CVI at the edge of the universe and on the ‘plateau’ depends on the precise combination of viewshed radius and average distance between seed points used, and a formula could be derived to predict both, but in a viewshed study of a real terrain both parameters would obviously be significantly and unpredictably lowered.

### 3.2 VIEWSHED RADIUS EFFECT

The further away from the viewer, the more likely it is that an object will be masked by intervening terrain, hence the more elevated it has to be in order to be seen. With increasing viewshed radius the

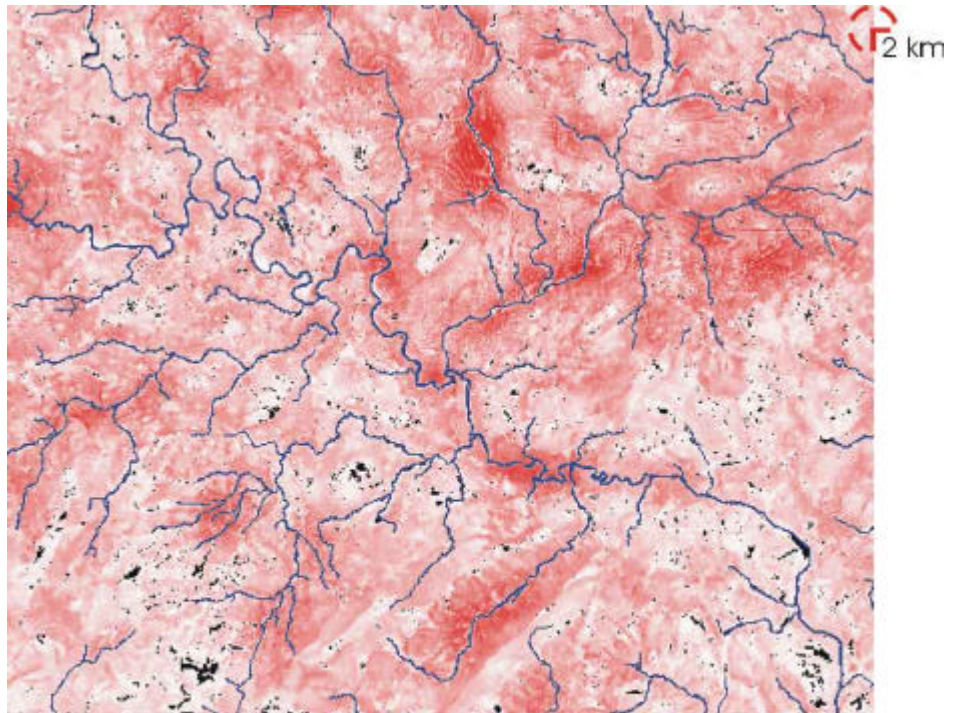


Figure 16.22a - Background CVI for the Wroxeter hinterland, based on a ~1% random seed sample of viewpoints with a 2km viewshed radius. Total number of cells in region: 471,000.

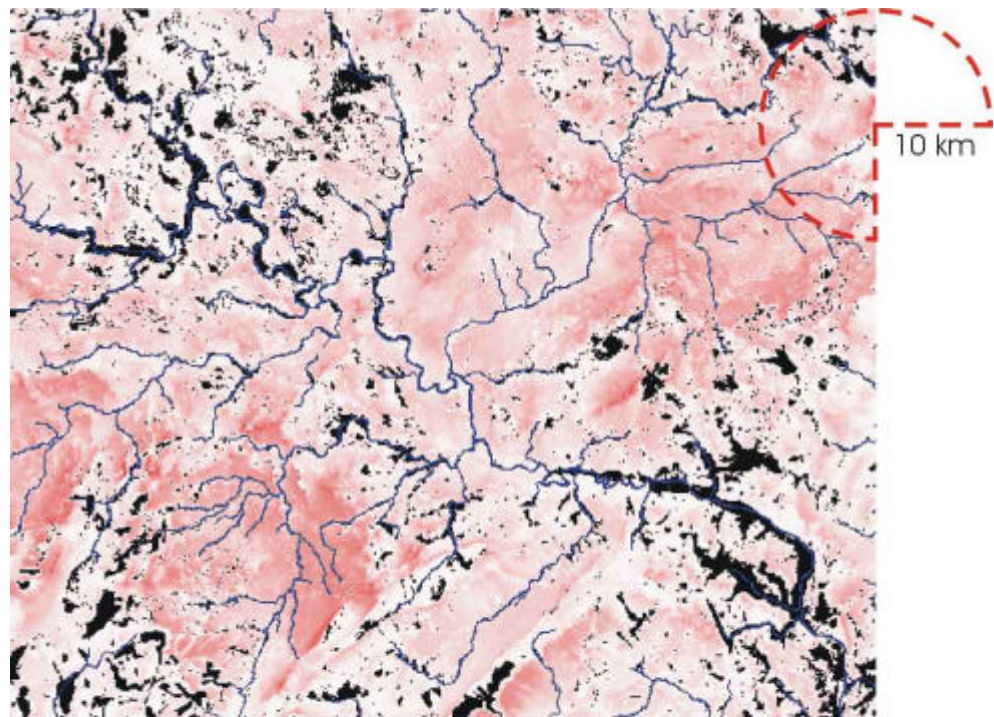
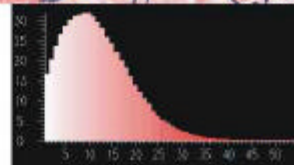
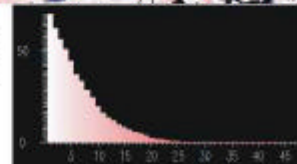


Figure 16.22a - Background CVI for the Wroxeter hinterland, based on a ~0.1% random seed sample of viewpoints with a 10km viewshed radius.



amount of terrain far from the viewer increases exponentially whereas the amount of terrain near the viewer remains constant; therefore elevated locations will obtain a higher CVI at larger viewshed radii. In order to investigate and demonstrate the effect of changing viewshed radius on the types of geomorphological units preferentially 'seen', digital elevation data from the WHP were used to calculate several random 'background' CVI's at varying radii.

This showed up some important effects straight away. The cumulative short-range (2 km) viewshed generated from a set of 5,000 points (approximately 4 points per km<sup>2</sup>) contains visibility values ranging from 0 (completely secluded) to 54 (highly visible), but these are not randomly distributed. In fact, they correlate directly with the size of the convex and concave geomorphic units in the study area, especially when these are larger than an individual viewshed (say, over 4 km<sup>2</sup>). Conversely, a cumulative long-range (10km) viewshed generated from 500 points (approximately 1 point per 6 km<sup>2</sup>; random3.los) shows the high visibility index, not surprisingly, correlating with high ridges and hillsides, an effect which would be expressed even more strongly if, as is current practice in many GIS studies, the viewsheds were unconstrained.

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#### 4 CONCLUSIONS

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As a consultation of chapter 6 will make clear, the case studies presented in sections 1 and 2 no longer represent the 'state of the art' in GIS modeling of visibility and accessibility. The modeling of 'energy and resource landscapes' in a GIS environment with the help of cost surface techniques has become increasingly sophisticated in the last few years. Cost is now measured in real terms as energy expenditure in Watt or kCal; cost surfaces have become anisotropic to reflect the importance of the effect of direction of movement on costs; the interpretation of visibility and accessibility models is now informed by a better understanding of statistical complexities; and, last but not least, the limitations of the underlying theory are now beginning to be understood.

Further work will be needed in order to develop sufficient understanding of 'background' visibility and accessibility indices such as the ones developed above in section 3, and by Llobera (2000). Of equal importance is the testing of GIS-generated models, firstly by a comparison with extant historic, archaeological, and cartographic data, and thereafter by targeted fieldwork.

Although the simulations presented in section 3 do not constitute conclusive proof, it would appear that simply by increasing the viewshed range used, the higher visibility values will concentrate on areas of higher ground, ridges and peaks. Any sufficiently large sample of archaeological viewpoints will tend to generate a cumulative viewshed similar to these simulated ones, depending on the viewshed radius used. Furthermore, any such viewshed based on points located on or near ridges and peaks will further emphasise the visibility of other ridges and peaks. These results, together with those obtained in similar simulation studies that found little correlation of viewshed intensity with elevation (Franklin & Ray 1994), need further evaluation. Cumulative viewshed analyses must take such effects into account, or they become nothing more than vehicles for our prior convictions.

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INTERPRETING FIELD SURVEY  
RESULTS IN THE LIGHT OF  
HISTORIC RELIEF CHANGE:  
THE FOGLIANO BEACH RIDGES  
(SOUTH LAZIO, ITALY)\*

Hendrik Feiken & Martijn van Leusen

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1 BACKGROUND

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The Pontine region, a low-lying and partly marshy area along the coast of south Latium, was taken up into the Roman power sphere in a slow process completed only midway through the 4<sup>th</sup> century BC, which is why the preceding period 500 - 350 BC is named 'post-Archaic' rather than 'early Republican' (Attema 1993). Much of it appears to have been marginal to the major political and economic developments of the time, and this translates itself into the relatively low density of surface ceramics reported in field surveys (Attema et al. 2001, Van Leusen 1998). Low finds densities present us with particular interpretation problems because of the relatively large influence of biases in the type and amount of research conducted, the visibility of the surface, statistical effects, and geopedological circumstances (Van Leusen 2001). It is the effect of the latter factor that we have attempted to study in more detail, using the landscape of ancient beach ridges around the Fogliano lagoon as our study area (figure 1).

This feasibility study into the use of historic elevation data for the mapping and correction of biases in the archaeological record was conducted as part of the Regional Pathways to Complexity (RPC) project<sup>1</sup> in the Pontine region (south Lazio, Italy). The general aims of the RPC project are, first, to understand indigenous versus externally-induced growth in complexity (especially urbanisation), and second, to conduct detailed surveys in marginal areas to understand the scope and nature of dynamics that are mostly known from urbanised sites. Specifically, the case study presented here is part of the project's methodological focus on GIS approaches to the detection of spatial patterning in the archaeological record. One reason for concentrating on the Fogliano area is that it has been subject to two major surveys in the last two decades (Voorrips et al. 1991; Attema et al. 2001), and the surface record is therefore relatively well known; the other reason is that the Pontine plain as a whole was subject to major

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\* This chapter is a slightly revised and updated version of a study first presented as a paper at the 28th Annual Meeting of CAA in Ljubljana (Slovenia, April 2000) and subsequently published in Stancic, Z & T Veljanovski (eds), *Computing Archaeology for Understanding the Past. Proceedings of the CAA2000 conference* (BAR S931): 205-211. Oxford: Archaeopress.

<sup>1</sup> The RPC project was conducted jointly from 1997 to 2001 by the Groningen Institute of Archaeology and the Archaeological Institute of the Free University of Amsterdam. It studies protohistoric landscape and settlement dynamics in three Italian regions - the Pontine region, the Salento Isthmus, and the Sibaritide. Processes of centralisation, early urbanisation and colonisation are its main themes (Attema et al. 1998).

restructuring in the late 1920s and 1930s by the Italian government in a so-called *Bonificá*. These works have changed many parts of the landscape, and must therefore be taken into account if we are to interpret and understand our survey data. A detailed elevation survey of the Pontine plain was made in 1927 by the Italian Military Topographic Institute (IGM), allowing us to compare the post-World War II relief to the relief that was present before the *Bonificá*.

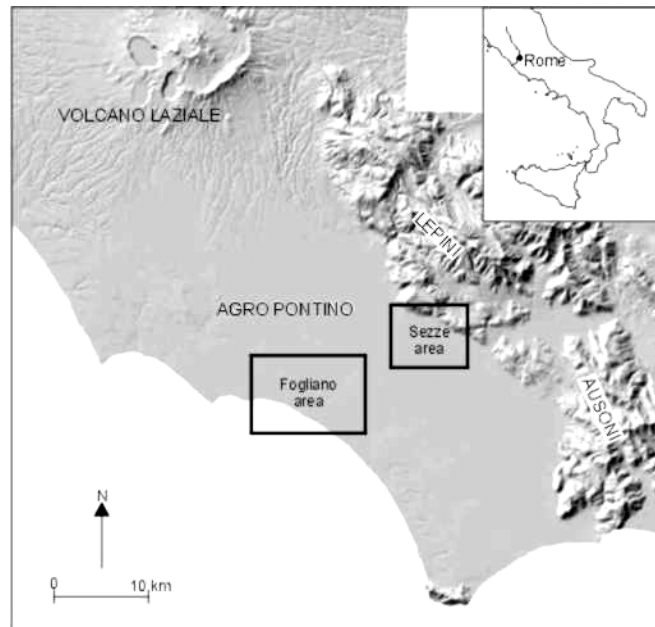


Figure 1 - Location of the Fogliano study area within the Pontine region (Lazio, Italy).

Before we proceed to describe the feasibility study itself, a brief overview of the settlement and land use history of the area is in order. The landscape of ancient beach ridges around the Lago di Fogliano must have attracted humans from earliest prehistory, and flint artefacts dating from the Middle Paleolithic onwards were found during the surveys. This material seems to concentrate mostly along the banks of the larger water courses and the lake itself, and one can imagine the water rich environment being very well suited for fishing and fowling. However, throughout this period and into the late 2<sup>nd</sup> millennium BC human presence would appear to have been quite rare and impermanent, the earliest indications for agricultural activity and the use of ceramics dating to the Bronze Age<sup>2</sup>. Figure 2 shows the probable settlement locations for the protohistoric period (running from the Bronze Age up to the beginnings of Roman influence in the Pontine region, around 500 BC) as derived from the finds densities of the RPC survey, on the background of the 1928 DEM. The absolute number of finds from this period tends to be very low for most of the area surveyed - on the order of 1 to 5 finds per hectare. Settlement in this period seems to be concentrated on relatively well-drained capes and banks along the larger streams, where access to natural resources would have been easiest and preconditions for paleotechnic agriculture were positive (Kamermans 1993: 100-4; see also Attema et al. 2001). By the end of this period (6<sup>th</sup> century BC), the number of settlements begins to grow.

Figure 3 shows the post-Archaic, Roman Republican, and early Imperial sites identified by the RPC survey, again covering a period of approximately one thousand years (500 BC to AD 500). The number of settlements has greatly increased, but this occurs mostly between 200 BC and AD 200 - the late Republican and early Imperial period. Settlement is concentrated on the relatively level and agriculturally

<sup>2</sup> The evidence for this comes from an unpublished pollen core from Fogliano (pers. comm. E. van Joolen), and from the unpublished finds database of the Agro Pontino Project (Voorrips et al. 1991).

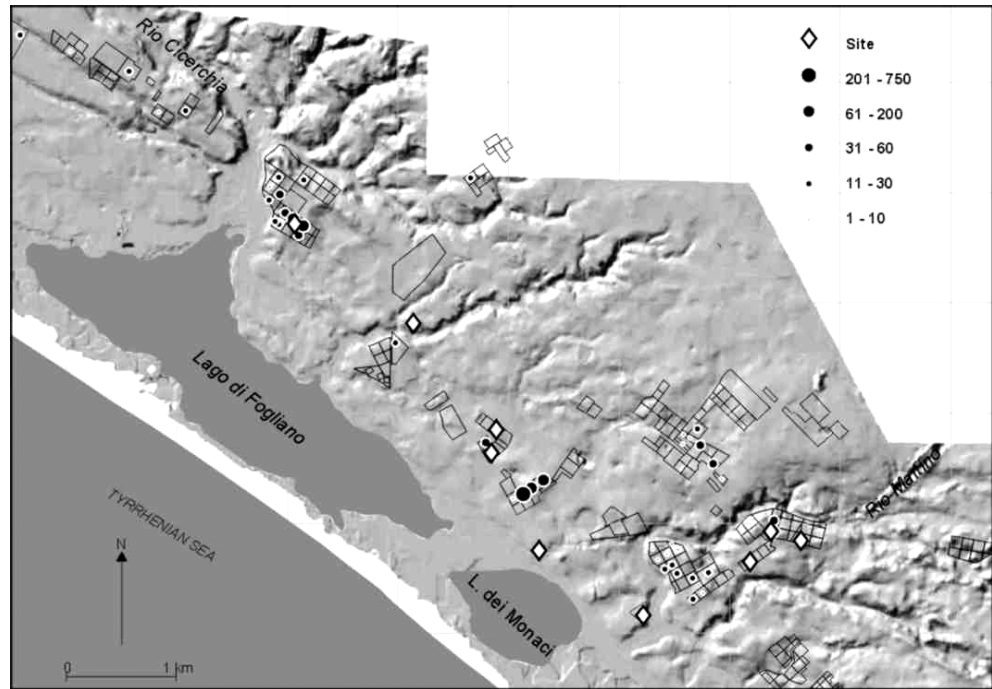


Figure 2 – Results of the 1998/9 RPC survey in the Fogliano area, protohistoric period. Find densities per hectare corrected for surface visibility. Background: 1927 shaded relief map and km grid.

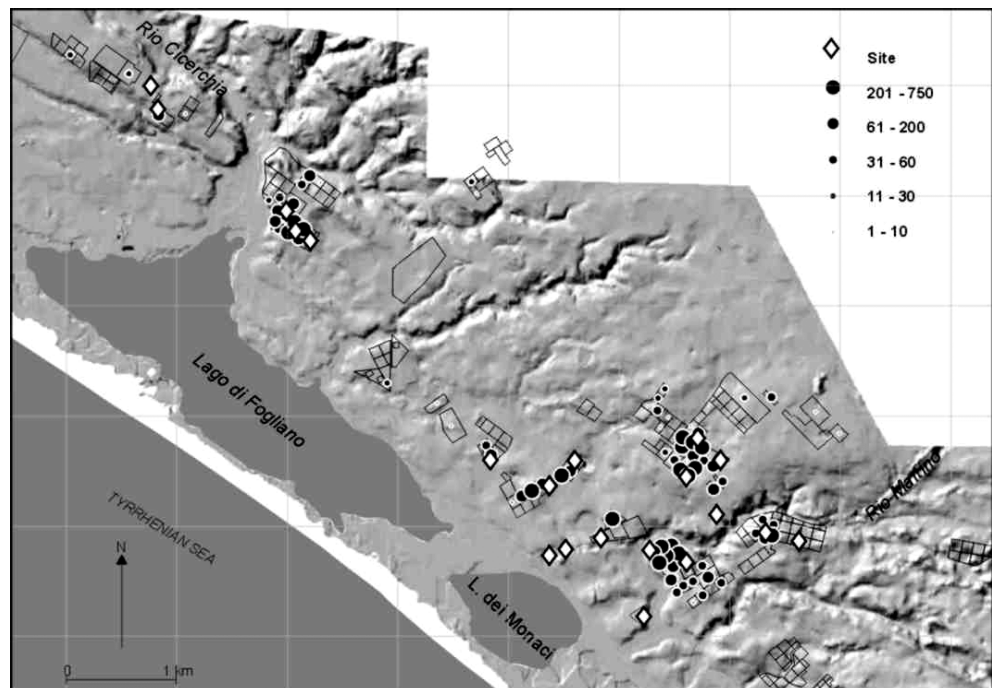


Figure 3 – Results of the 1998/9 RPC survey in the Fogliano area, Roman period. Find densities per hectare corrected for surface visibility. Background: 1927 shaded relief map and km grid.

usable area to the east of the Lago di Fogliano, where a late Republican village seems to have sprung up. We can tentatively relate this development to the inclusion of the area in the wider economy of Roman society. Roman agricultural technology (drainage of lower-lying areas, heavy ploughs) enables more land to be farmed; Roman hydrocultural technology (regulation of lake levels) enables commercial fisheries to be established in the lagoons; Roman roads and markets enable the commercial exploitation of the clay beds along the nearby Astura river; from the 1<sup>st</sup> century BC rich Romans even built their summer palaces along the banks of the coastal lagoons of south Lazio. All this activity makes it likely that the growing number of small farms became dependent on a few large specialised rural villae. However, this system collapses from the 2<sup>nd</sup> century AD onwards, as a wetter climate<sup>3</sup> led to the return of marshy conditions and the expanding Roman empire found its supplies elsewhere.

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## 2 TRACKING HISTORIC RELIEF CHANGE

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For the purposes of studying historic relief change in the Fogliano area, we have used historic maps of land use and land form. We know from historical research that the landscape was little changed since the Middle Ages, and historic maps dating to the 17<sup>th</sup> century show us an approximation of the landscape as it was in the late Roman period. Such maps may even be a better guide to interpreting the proto- and early historic archaeological record than the modern ones, which were made after major restructuring of the region during the Bonificá.

When we digitised and compared a very detailed digital elevation model (DEM) from the 1:5,000 scale maps prepared during the Bonificá (figure 4; IGM 1927) with a commercially available DEM of 1 arc second (~25 m) resolution (figure 5)<sup>4</sup>, some major differences became immediately apparent. Whilst obtaining a map of the differences between the two mappings was easy - all we needed to do was to subtract the two DEMs from each other - most of our study was concerned with the identification and removal of various mapping errors obscuring the ‘real’ relief changes that might have taken place during and following the Bonificá. Since it is usually one of the most important layers in a regional archaeological GIS, deficiencies in the DEM can cripple much analysis. These sources of error, and our attempts at removing them, are discussed in section 3; our interpretation of the archaeological evidence in the light of the ‘cleaned’ elevation data follows in section 4.

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## 3 EXTRANEOUS SOURCES OF DIFFERENCES BETWEEN THE TWO DEMS

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The first point we need to make is that any DEM is a *model*, that is, a simplified version of reality. The type and amount of simplification that can be supported in any analysis depends on the questions asked, and any analysis relying on DEMs should be explicit about its limitations. Secondly, the *comparison* of two DEMs forces us to be even more precise in our description of the data. Differences between two DEMs may be due to real changes in the morphology of the terrain they represent, or to errors committed in the process of producing the digital elevation data, or to the precision with which the data were recorded, or to the use of different projection parameters and coordinate systems. The following list summarises seven distinct sources of differences we discovered between the two DEMs, which are *not* due to an actual (real) change in the land form.

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<sup>3</sup> As deduced from pollen cores analysed by Haagsma (cited by Attema 1993:253) and Veenman (1996:59).

<sup>4</sup> A matrix of numeric data, containing one value for each square arc-second, and based on the digitised contour lines and elevation points of the 25 and 25V map series produced in the 1940s and 1950s at a scale of 1:25,000 (IGM 1996:13 and Table 42).

**Scale:** The scales of the topographic map sheets, from which our two DEMs are derived, differ. The 1927 DEM derives from a 1:5,000 scale map; the more recent DEM derives from a 1:25,000 scale map. The reduced mapping scale implies that features are simplified and smaller features may even be lost. When comparing DEMs of different scales, such features will stand out as differences.

**Resolution:** Both the horizontal (X and Y) and the vertical (Z) resolution of our two DEMs differ. The horizontal resolution of the 1927 DEM is approximately 5 by 5 m; that of the more recent DEM is 1 arc second (approximately 25 by 31 m at the latitude of Italy). This means that an area represented in the latter by a single elevation value, is represented by approximately 30 (5 by 6) values in the former. Unless that area happens to be level, most of those values will be different from the single elevation value provided by the low resolution DEM—they will lower downslope, and higher upslope (see figure 6a), giving rise to the ‘banded’ appearance in some areas of the raw differences map (figure 7a). The amplitude of the differences is related to the terrain slope and the difference in resolution of the DEMs: at any given percent of slope, the error is directly proportional to that difference. Because the error is systematic, we can devise a formula for deducing it:  $E = dR * S / 2$ , where E = Error; dR = resolution difference; S = percent slope. The vertical resolution of the 1927 DEM is 0.1 m; that of the more recent DEM is 1 m. Since the latter must round any values to the nearest whole meter this may lead to differences of up to 0.5 meters compared to the former.

**Mapping errors:** Mapping errors may (and will) occur both during the original recording of elevation measurements, and during the subsequent cartographic process. Proper control procedures are needed to minimise the occurrence and effects of such errors. While we could not check the quality of the primary cartographic data, we were able to compare both DEMs with the elevation data in the original map sheets, and found some major mapping errors. One of these can be seen in figures 4 and 5 (area marked ‘A’) where a small valley that existed in the 1928 DEM had mysteriously changed into a hill by the 1950s. Whilst such obvious errors can be found and corrected fairly easily, there certainly remain many less obvious mapping errors in our DEMs - a very worrying situation...

**Interpolation:** Our two DEMs were created by interpolation from digitised contour lines and elevation points, and this has led to the introduction of three different kinds of errors in the data. Since many properties of the resulting DEM are determined by the interpolation method (e.g., inverse distance weighting or thin plate splining; see Hageman & Bennett 2000), it is important to study its effects:

While the interpolation method used in creating the 1927 DEM is known (a ‘flood fill’ algorithm provided by GRASS GIS), no such information was available for the more recent DEM. However, it appears from the data that some sort of inverse distance weighting using a low number of data points was used, and this has led to a large number of visible artefacts in the latter. Since the two DEMs were created using different interpolation algorithms, the interpolated values will also differ.

Some softwares are unable to handle ‘0’ (zero) as a real elevation value, in which case such values are ignored during interpolation. The method used to create the more recent DEM apparently suffers from this error which, for example, has caused the present dunes to ‘smear out’ across the lagoons because the water’s edge was digitised as a zero contour (see figures 4 and 5, area marked ‘B’). The elevations here are clearly in error, and the area cannot be used in any further analysis;

Many interpolation algorithms that start from an input of digitised contour lines (including the ones used to create both our DEMs) do not resample the input values. Since contour lines always represent cardinal elevations, these end up being overrepresented in the resulting DEMs - the map histogram has a ‘saw tooth’ appearance, with the distance between ‘teeth’ depending on the vertical resolution of the original map. While the 1927 DEM used contour lines every 0.5 m, the more recent DEM used contour lines every 5 m. In terms of accuracy, this means that values are only accurate to half the distance between contours, i.e. to 2.5 m in the case of the more recent DEM (see figure 6b).

**Datum shift:** One of the parameters of the coordinate system used by both DEMs is its datum (origin). The horizontal datum of Italian topographic maps was moved by 2.53” (about 70 m) on one occasion; we could not obtain any information regarding changes in the vertical datum used in either DEM<sup>5</sup>. Left uncorrected, comparison of the two DEMs using different datums would have led to measurement errors especially in areas of steep slope; in this case, we were able to correct the horizontal datum shift.

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<sup>5</sup> We attempted to compensate for this by comparing the recorded elevations of relatively stable landscape features (e.g., buildings) in both DEMs. No vertical datum shift could be deduced from these.

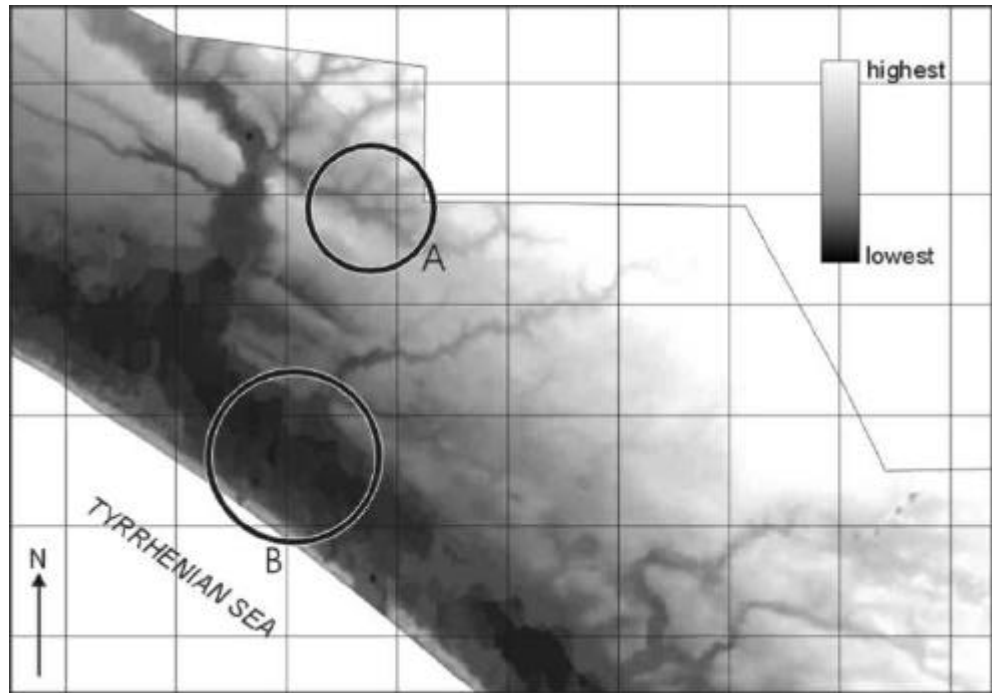


Figure 4: Digital Elevation Model of the Fogliano area, derived by interpolation from digitised 0.1m contour lines and elevation points of the 1927 1:5000 IGM maps.

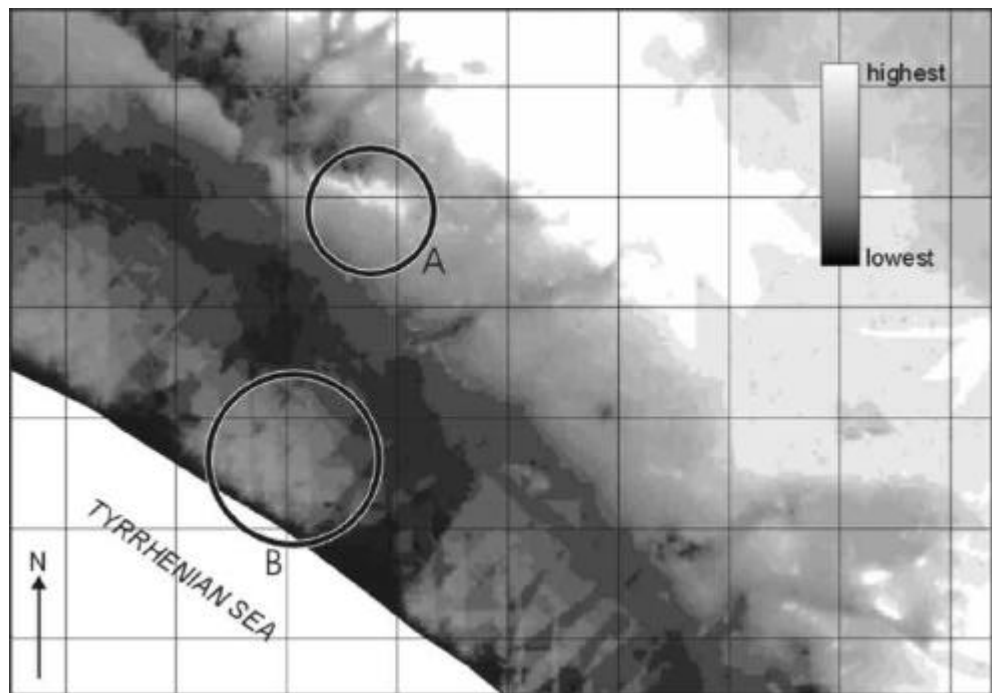


Figure 5: Digital Elevation Models of the Fogliano area, from 1arc-second numeric cartography derived from the 1:25000 IGM topographic map series (permission IGM 26/05/98, no. 4805). A: digitising error; B: interpolation error.

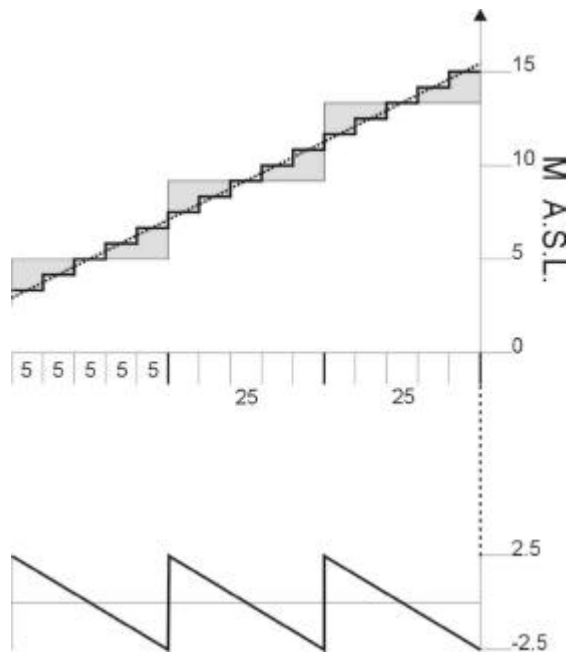


Figure 6a - On a slope represented by the thin continuous line, the differences between two DEMs of differing horizontal resolution (here, 5 and 25 m) alternate between positive and negative (shaded areas). The maximum difference depends on the terrain slope and the difference between the resolutions of the two DEMs. All units in m.

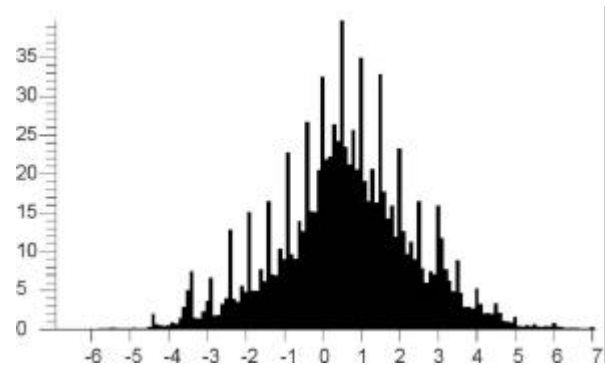


Figure 6b - The histogram of a typical DEM shows the systematic 'saw tooth' shape caused by overrepresentation of cardinal values. Horizontal axis: elevation in m; vertical axis: number of cells  $\times$  1000.

Our aim in identifying all these errors is, of course, to be able to correct them. Mapping errors (at least those that were discovered by us) were corrected by re-digitising and interpolating from contour lines on the original map sheets, and replacing the incorrect sections with these new data. Other areas of faulty data could only be 'corrected' by removing them entirely from the analysis (using 'masking' functions in the GIS). But the most interesting type of error was the one that could be estimated or calculated, because these errors could be corrected by first mapping them and then using them as 'noise filters' when interpreting the differences between the two DEMs. Thus, the error formula referred to under 'Resolution' in the list given above was used to calculate a map layer of the estimated amplitude and sign of the error, given the known slope and resolution of the more recent DEM. We then applied the correction by subtracting this calculated error from the observed difference between the two DEMs.

Figure 7 shows the differences between the 1928 and 1950s DEMs, both (a) before and (b) after the corrections were applied. The general effect is one of producing a much less extravagant map, whose values do not exceed 5 meters. We were now ready to evaluate these differences in terms of natural and human processes that occurred in the area, rather than in terms of data error.



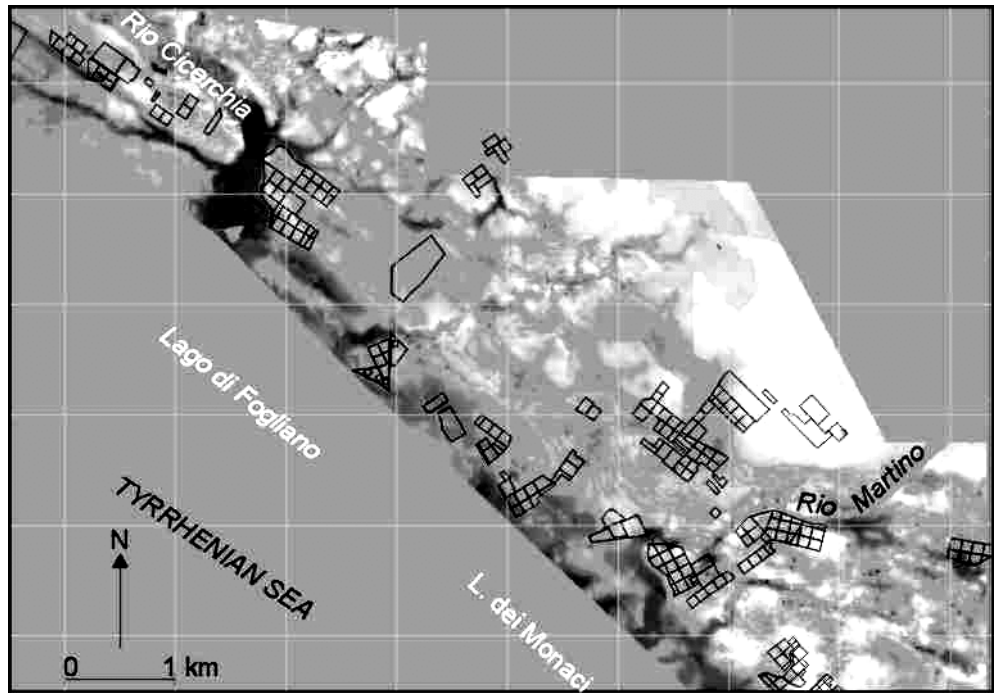
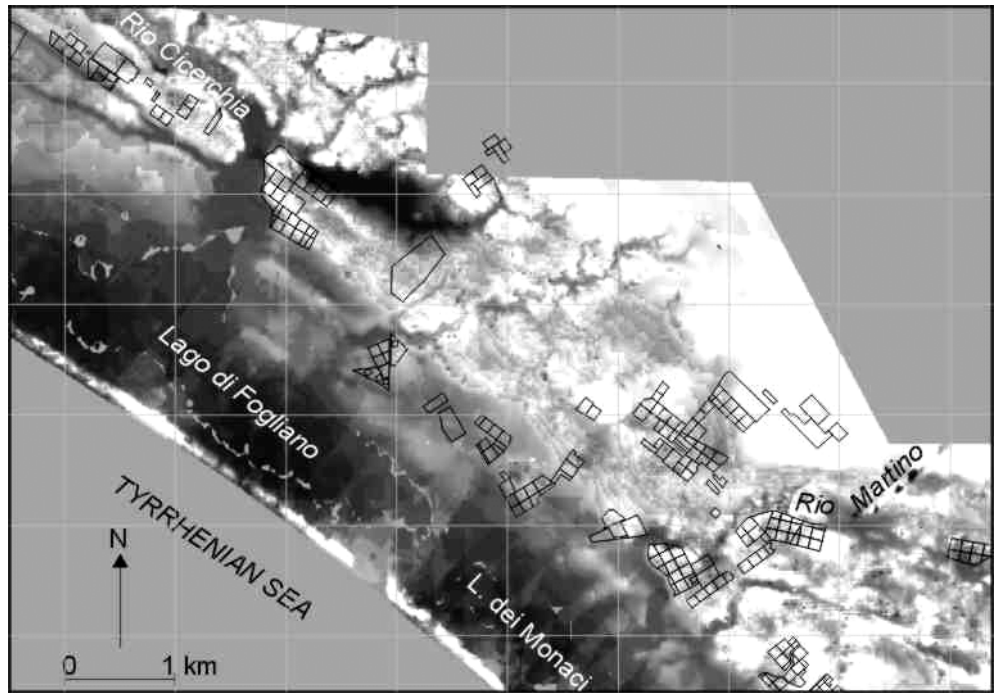


Figure 7 – Interpreting the differences between the two DEMs. A (top): uncorrected; B (bottom): corrected.

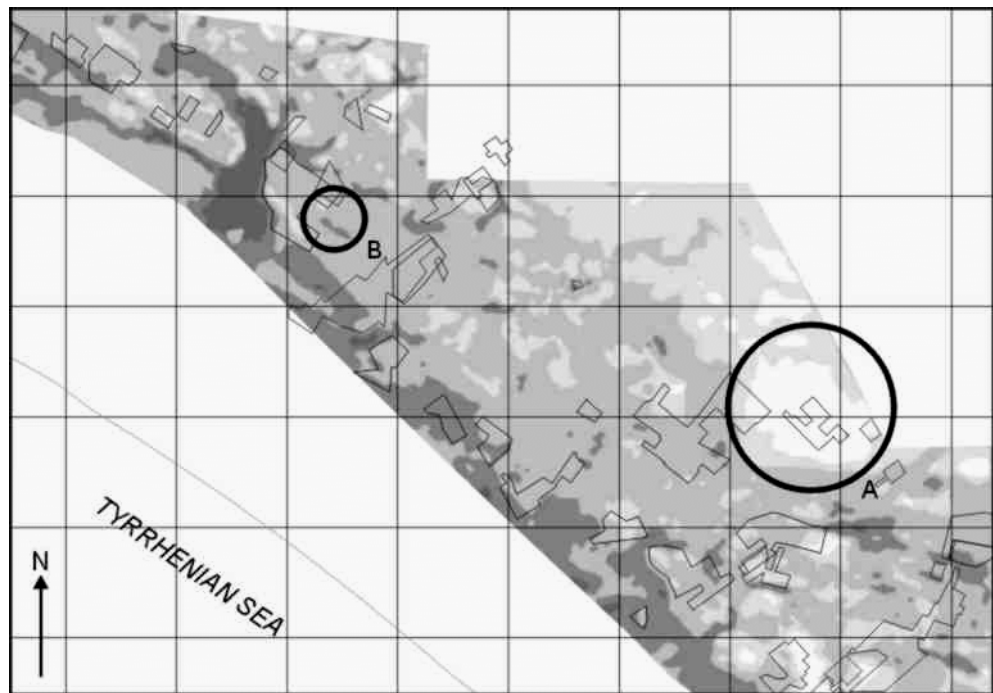


Figure 7 C – Simplified corrected differences between the two DEMs, with the RPC (continuous lines) and APP fieldwork areas (dashed lines) overlaid. A: area where large-scale sand removal may have taken place; B: area where farmer has levelled his field.

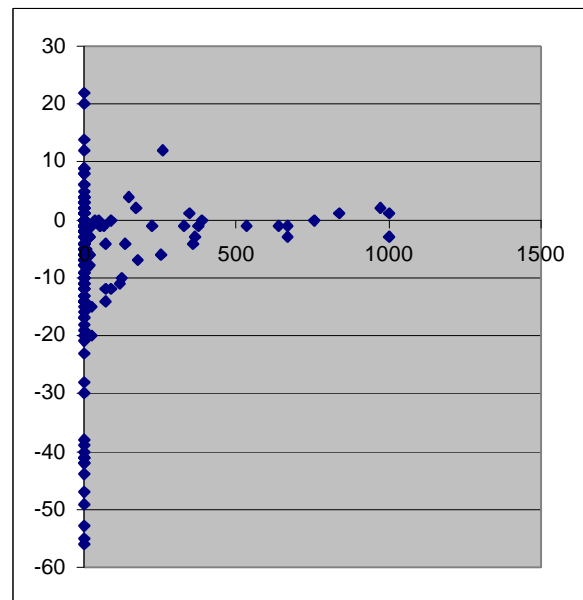


Figure 8 – Scatterplot of average deflation/inflation (in dm) versus average find density per surveyed unit of the Fogliano survey (Attema et al. 2001).

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 4 INTERPRETING THE EVIDENCE
 

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Any real differences between the two DEMs might be the result of either natural or human causes, or to a combination of both. In the simplified corrected map of differences between the two DEMs (figure 7c), light zones have become up to 7 meters lower, dark zones up to 6 meters higher since 1927, and these zones may therefore betray works carried out during the Bonificá. However, we must also consider other processes such as plough-induced erosion and settling of zones with a clayey subsoil.

With the help of a soil scientist familiar with the region we began by evaluating the potential size of the effects of natural causes. We could see that the lower-lying areas (especially the small valleys) had all gotten considerably higher since the late 1920's, whereas some areas to the north-east had been reduced by 3 meters or more. The former is probably due both to intentional dumping of material into marshy places and to the effects of ploughing the slopes of the adjacent ancient beach ridges. The latter may well be partly caused by soil settling after the construction of the canal system during the Bonificá<sup>6</sup>, but it is unlikely that a difference of more than one meter could be explained that way. We have some historic evidence that a top layer of aeolian sands may have been removed from some terrains in order to provide material for the founding of the new capital of the area, at Latina, and sand and gravel pits were still in use in the northwestern part of the study area in the early 1980s and recently (Sevink et al. 1984:28); archive research may reveal further evidence as to which terrains were historically involved in such activities.

Certainly many parts of the study area were levelled in order to facilitate access and workability for modern farming equipment, but such works were not often recorded<sup>7</sup>, so we have to rely on the recollections of the local farmers and on the occasional evidence from soil cores. Raised terrains also occur along the banks of the coastal lagoons, and we know from historical sources that these were deepened and the material used to raise the surrounding land enough to prevent the formation of marshes<sup>8</sup>.

Figure 7c shows that some of the fields surveyed in 1998/1999 by the RPC project (and in the 1980s by the Agro Pontino Project) lie in zones affected by serious deflation or inflation. For the fields surveyed by the RPC project, the relation between the average amount of change in the elevation and the average density of ceramics found (see figure 8) gives rise to the suspicion that limited deflation (of ca. 0.5 m) is helpful in bringing archaeological material to the surface, while strong deflation (more than 0.8 m) destroys the record altogether. Conversely, even weak inflation tends to hide any archaeological material that might be present on the surface. A closer look at the observations made in the field confirms the general picture, and suggests ways in which our archaeological interpretations may be improved:

- Areas with strong deflation (over 1.5 m) were observed during the survey to have no soil profile at all and to be archaeologically sterile (area marked 'A'); Sevink et al., in their account of the soils of the area (1984:30), suggest that subsoil was brought from elsewhere, but this is flatly contradicted by the evidence for deflation from our study. It is therefore quite possible that the top layer of soil, including any archaeological remains, was removed from this area and used elsewhere in construction work<sup>9</sup>.

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<sup>6</sup> Evidence of such soil settling is plentiful in the Pontine region. The approaches to many of the small bridges built in the late 1920s have had to be lengthened, and the concrete bottom of the channel below them broken through, because the surrounding land had sunk 70 cms or more.

<sup>7</sup> With the exception of the local, often marshy, hollows which were mapped on the 1920s land cover maps.

<sup>8</sup> In fact, this was one of the major aims of the Bonificá – to reclaim the Pontine marshes for agriculture by destroying the habitat of the malaria mosquito.

<sup>9</sup> It is known from historical records that large amounts of soil were brought in to found the new capital of the Agro Pontino at Latina.

The late Republican village mentioned in the introduction may therefore have extended further to the northwest than the results of our survey suggested.

- The reduction of local relief through ploughing or levelling can be traced in many fields:
  1. Areas that were observed during the survey to have an unusual soil colour or material often correlate with small hollows and valleys mapped in 1927/8 and afterwards levelled;
  2. The raised banks of canals dug during the Bonificá on occasion also contain archaeological material, which must presumably have come from the immediately adjoining stretch of the canal;
  3. We have several examples where our study confirms that sites located on hillocks were, along with the soil, 'smeared out' across the surrounding fields by tillage;
  4. One hollow, which the owner informed us he had filled in using soil (containing Roman ceramics and building materials) from elsewhere in the same field, coincides exactly with a patch of inflated soil (area marked 'B').

These observations confirm the importance of landscape history as a factor biasing the results of field surveys, and the need for a structured 'source criticism' so that we can trace and correct such biases.

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## 5 CONCLUSION

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This case study has demonstrated the feasibility of employing GIS to extract and interpret land form changes from historic elevation and land cover data. Although it is generally recognised that the interpretation of survey results requires knowledge of local geopedology and landscape history, workers have not yet gone very far with this approach. The present case study shows that, provided certain requirements regarding data quality are met, historic elevation data can be used to track one of the most important factors biasing the results of field surveys today – changes in land form caused by human agricultural and construction activity. By comparing historic to recent elevation data, using GIS, maps can be made of the location and approximate amount of deflation/inflation influencing the presence and visibility of the archaeological record. Such maps can be used both to target future surveys to areas that are likely to have survived undisturbed, and to re-interpret the results of older surveys.

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# SUMMARY AND CONCLUSIONS

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## 1 AIMS AND APPROACHES

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This thesis is the result of studies performed in the context of two separate multi-annual research projects conducted in widely separated parts of Europe. Between 1994 and 1997 I was part of the Wroxeter Hinterland Project (WHP) directed by Dr Vincent Gaffney at the Birmingham University Field Archaeology Unit (BUFAU). The aim of this project was to relate the growth, flowering, and decline of the Roman *civitas* capital Viroconium (modern-day Wroxeter, Shropshire) to its largely indigenous hinterland, which in the late pre-Roman Iron Age was settled by the tribe of the Cornovii. From 1997 to 2001 I conducted my dissertation research at the University of Groningen within the Regional Pathways to Complexity (RPC) project. Within this umbrella project directed by Dr Peter Attema (RUG) and Dr Gert-Jan Burgers (VU), I studied methods of comparison of settlement dynamics and land use from late protohistory until the Roman Imperial period in three Italian regions – the Pontine region in southern Lazio, the Salento Isthmus in Puglia, and the Sibaritide on the Ionian gulf in northern Calabria. Both projects are similar in that they focus on the combined ‘classical’ issues of Romanization and urbanization, apply a regional scale of analysis, and attempt to restore indigenous populations and elites to their ‘rightful’ place in history.

### PROBLEM ORIENTATION (CHAPTERS 1 & 2)

The archaeological problem definition in both projects revolves around the relationship between the internally driven dynamics of the indigenous societies and the role of external colonizers. Whilst the latter was widely perceived until recently to be the driving force behind supra-regional processes such as centralization and urbanization, perspectives have changed since the 1980s and indigenous roles are now seen to be as important as that of the colonizing powers, if not more so. Because such a perspective can receive little or no support from historical sources, archaeologists must employ other tools such as ethnographic comparison; they must also compensate their lack of knowledge of the indigenous non-urban landscape with new targeted fieldwork and the study of indigenous patterns of land use and settlement.

The methodological problem consists in the combination of two facts. Firstly, the available archaeological data was for the most part not collected with modern landscape archaeological aims in mind; rather, for the past century or more, archaeologists have worked within a classical culture-historical paradigm which has defined the goals and scope of archaeological research. More-over, it has become evident that patterns in archaeological data *at any spatial scale* can be caused by systematic biases in the these data have been collected and turned into archaeological records. When, as in landscape archaeology, it is intended to study archaeological remains in conjunction with the landscape, ways must be found to address this problem. Secondly, there is no accepted methodology for deriving regional and supra-regional interpretations of settlement dynamics *on the basis of the archaeological remains alone*. That is, we do not know how to do landscape archaeology without the culture-historical prejudice. In the terminology of New Archaeology, there is a general lack of middle range theory, needed to link the archaeological evidence to the culture-historical interpretation in a substantive manner. Much of this thesis consists of explorations into this gray area. The comparison of regional patterns and long-term trends in settlement and land use is approached here from a geographical point of view, which has mainly been implemented through the (study of the) application of geographical information systems (GIS) software. A large part of this thesis

therefore consists of articles presenting and illustrating aspects of GIS methodology that were found to be directly relevant to the analysis and interpretation of regional archaeological data.

Chapter 2 presents these archaeological and methodological problems in detail, using examples taken from the three Italian RPC project study regions, and beginning with a brief review of regional settlement dynamics as these are presented in recent literature. The societal processes considered most important for the 1st millennium BC, and the most important archaeological concepts, theories, and methods that are used in this thesis, are isolated and discussed.

Centralization, urbanization, and colonization are introduced as the most important, but at the same time problematic, concepts. Centralization is a process affecting all of society: power (whether religious, economic, political, military or administrative) becomes progressively concentrated in the hands of fewer families or persons, settlement structure is tending toward nucleation, and economic life (production, storage, trade, and exchange), cult, and construction is progressively mobilized and concentrated in a fewer number of locations. The process, occurring generally in the Mediterranean between the Bronze Age and the Archaic, is thought to have ultimately been driven by demographic expansion, through the gradual increase in supra-regional contacts and the successful introduction of Aegean technology (olive culture, storage of oil in pithoi). Urbanization (and, in its early stages, proto-urbanization) in its indigenous form is a direct consequence of the process of centralization, but has in all four study areas been deeply affected by the external imposition of urban forms – the Greek colonies in the Italian south, and the Roman colonies in south Lazio and central Shropshire. This colonization by Greeks and Romans was not a unitary phenomenon but took place for many different reasons and across several centuries. In its early phase, lasting perhaps a century, it was characterized by relatively small populations planted for economic or strategic reasons (late 8<sup>th</sup> – 7<sup>th</sup> century Greek colonies in the Tarantide and the Sibaritide, 5<sup>th</sup> century Roman colonies in south Lazio). Population and settlement expansion, and its attendant encroachment on and eventual domination of indigenous societies, occurred only later (6<sup>th</sup> century expansion of the Greek colonies, 4<sup>th</sup> century expansion of the Roman colonies). The geographical progression of this latter phase can to some extent be attested archaeologically in the material evidence associated with Hellenization and Romanization: this occurs in the 5<sup>th</sup>/4<sup>th</sup> century on the Lepine side of the Pontine plain, in the late 4<sup>th</sup>/3<sup>rd</sup> century in the Salento Murge and the foothills and uplands of the Sibaritide, with the late 3<sup>rd</sup>/2<sup>nd</sup> century Roman conquest of the Greek south, in the late 2<sup>nd</sup>/1<sup>st</sup> century in the coastal side of the Pontine plain, and in the 1<sup>st</sup> century AD in outlying provinces of the Roman empire, such as Shropshire.

This review of concepts is followed by an analysis of the theoretical basis for interregional comparison, presenting the advantages and disadvantages of the various approaches and opting for a quantitative approach that stays closer to the archaeological data than the hitherto usually applied qualitative, socio-political explanatory models. Finally, a brief preliminary exploration of qualitative and quantitative comparison between the three study regions is presented.

The introductory section of the thesis ends with a chapter (3) introducing in more detail the problematic of Romanization in the Wroxeter Hinterland and the aims and approaches of the WHP, using two articles published in 1996-7 in conference proceedings. The first article defines the aim of the project – explaining the anomalous existence of Wroxeter itself, which was the fourth largest town in Roman Britain but seemingly lacked the developed rural hinterland needed to support it. The project's goal is defined as an attempt to establish Wroxeter's place in Millett's (1990) models for urbanization and Romanization in outlying provinces of the Roman Empire, both through the study of the available archaeological records and through an extensive program of systematic field survey. The second article uses both direct evidence and theoretical arguments to reject three current explanations for the existence of a flourishing provincial Roman town in a barely Romanized hinterland; namely 1) that Wroxeter had been an overly ambitious foundation and never reached high population levels, 2) that the rural population remained hostile to the colonizer and resisted acculturation, and 3) that Wroxeter never developed a strong economic base. The first of these explanations was refuted directly by the project's full geophysical and aerial photographic study of the town itself, and the two remaining explanations are rejected as well on the basis of the argument that the obvious economic and demographic health of the town *implies* that a wealthy pre-

Roman hinterland existed and that the native Cornovian elite was happy to invest this wealth in the town. An alternative explanation for the apparent economic and cultural contrast between town and hinterland is then presented, based on two arguments: firstly, that the wealth of the native pre-Roman Cornovians took on archaeologically invisible forms (cattle, salt) probably as a consequence of poor access to foreign trade routes (hence a lack of means to generate prestige through the acquisition and redistribution of foreign goods), and secondly, that our current knowledge of late Iron Age and Roman settlement and land use in the region is biased by a lack of systematic research.

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## 2 FIELD WORK IN ITALY (1998 – 2000)

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Our knowledge of the archaeology of all three RPC regions was, at the start of the project, composed mainly of Italian studies that took place from the 1960's onwards, and Dutch research projects combining excavation and survey from about 1980 onwards. Gaps in this knowledge can, for most of this period, be traced in a fairly straightforward manner to the archaeologists' preponderant interest in 'high' classical culture to the detriment of earlier and later periods, linked to a disregard of 'low' culture and the rural landscape in favor of cult places and urban settlements with their architectural remains and their cemeteries. It is unfortunate that the lack of information about the spatial coverage of these studies means we cannot even take the relatively robust classical patterns for granted. Likewise, the large-scale Agro Pontino survey conducted by the University of Amsterdam, which applied a random transect sampling strategy from which to extrapolate over all of the Pontine plain, remains unfortunately unpublished, and their methods of collecting and recording ceramic data do not seem to allow detailed pattern analysis. Regarding the later more intensive and systematic Dutch surveys of the 1990's, their location within the study regions was evidently biased toward urban settlements and their immediate hinterlands and ignored rural and 'marginal' parts of the landscape. In short, the available data displayed significant geographical, chronological, and typological biases. During the period 1998-2000 the RPC project team, through its program of intensive and systematic archaeological field surveys in all three study regions, has contributed towards the filling of these various gaps in the existing archaeological record. Four preliminary reports on this fieldwork, published with other members of the RPC project team, were presented in chapters 9-12, preceded by a summary of the overarching goals and results of the RPC fieldwork program in chapter 8. At the same time attention was also turned to the development of a suitable methodology for conducting the field surveys themselves and for the analysis of the resulting data. These two topics are summarized in the following sections.

### 2.1 FIELD WORK

#### PONTINE REGION

The 1998-1999 RPC surveys at the foot of the Lepine mountains near the deserted Medieval village of Ninfa, and around the Lago di Fogliano on the Pontine coast, were reported in chapters 9 and 10. Although the original aim of the Ninfa fieldwork was the continuation of a mapping program of so-called 'platform' villas, the study area also fell just inside one of the map sheets of the *Forma Italiae* series of archaeological maps (Cora, Vittucci Brandizzi 1968) and could therefore be used to examine the degree to which this older Italian data set had succeeded in capturing the diachronic archaeological landscape. It was demonstrated that the study area contained, in addition to the almost exclusively Roman monumental remains mapped by Vittucci, many smaller and less obtrusive Roman sites. Moreover, the area contained ample remains of an intensively used pre-Roman (Archaic and post-Archaic) landscape which had not been registered by her at all. In view of these results, the settlement history of this landscape unit (the 'northern colluvium', which also includes the proto-urban settlement at Caracupa/Valvisciolo) now appears to have more in common with that of the core area of Latial society in the Alban hills than with that of the Pontine plain proper, for which intensive settlement and land use has not been demonstrated until the middle Republican period. Following the recognition of variations in size, situation, and status of



the Roman rural villa sites in the Ninfa area, we have now begun to delineate the contours of a more detailed rural Roman settlement hierarchy. The following conclusions regarding urbanization and colonization were drawn:

- Archaic settlement in the Ninfa area, while dispersed, appears to have been quite dense – an indication that the population certainly was not ‘urbanized’ (in the sense of ‘nucleated’) to a very high degree. It may be that incipient Latin urbanization was halted in the northern colluvium by the end of the Archaic as circumstances became less favorable through sporadic warfare, and the inhabitants were forced to resettle into smaller and more easily defended sites on the Lepine scarp during the late and post-Archaic (550 – 350 BC). Some of the latter would then have been targeted for the early (i.e., early 5<sup>th</sup> century) strategic Roman colonization.
- The fact and nature of Roman colonization in the Lepine slopes is to a large extent predicated on the presence or absence, between the Archaic and Roman periods, of a post-Archaic hiatus in the settlement history of the area. Dispersed post-Archaic settlement existed in the Cisterna area only a few kilometers to the west (Attema 1993:181ff) and we may therefore assume that there was settlement continuity throughout the post-Archaic. The nature of the change from slight buildings and thick augite tempered pottery in the Archaic, to tile-roofed buildings with cisterns and depurated amphora and fine wares in the Republic remains to be explained. Are we looking at the transformation of temporary shelters into permanent habitations? Was the indigenous population moved to make way for new Roman settlers whose farmsteads were constructed according to some colonial base plan, or do the changes visible in the archaeological record reflect the gradual integration of the local Latial rural economy into the same regional economic and cultural networks that also include their Roman allies?

The Fogliano fieldwork area was selected because it represents the coastal landscape of the Pontine region, regarded as economically, politically, and demographically ‘marginal’ on the basis of both classical and more recent historical sources. The results of the survey support this hypothesis for the time up to and including the middle Republican period, establishing a basic settlement history that can probably be extrapolated to the whole Pontine coastal landscape. Sporadic ceramic evidence was encountered for what was probably non-intensive land use and impermanent settlement in this landscape of ancient beach ridges, valleys, and coastal lagoons from the Bronze Age onwards, and the number and ceramic density of sites only begins to increase in the Archaic period. In the absence of sufficiently diagnostic ceramic types, the intensity of land use during the post-Archaic and middle Republican periods must remain unclear for the present, but a clear departure from the *status quo ante* occurs with the remarkable growth in the number of rural villas during the late Republican period (200 – 50 BC). As this growth takes place mostly in the single largest available continuous and flat area of suitable sandy (eolian) soils, we interpret it as the development of a rural village. This rural socio-economic development was tentatively connected to the production and supra-regional trade in fish and fish products that emerged in this period along the Pontine coast, but apparently lasted not more than two centuries since none of the sites appears to have been in use after the early Imperial period; a decline that is in line with general economic trends in the expanding Roman empire.

The results of these surveys were put in the context of diachronic developments in the wider region: the development during the Bronze Age, Iron Age and Archaic period (i.e. to the 6<sup>th</sup> century BC) in the core areas around the Alban massif and Rome of, first, centralized settlements and, later, peer polity city states is reflected by a similar, but late and stunted, development of more marginally located polities such as Caracupa / Valvisciolo on the Lepine footslopes and Cisterna di Latina on the south-eastern margin of the Alban massif. During the post-Archaic and Republican period the growing political, military and economic influence of Rome expressed itself archaeologically first in the establishment of colonies on the Lepine margin and mixed farming on the colluvial slopes and (though much less so) along the Via Appia. Only much later did it result in the exploitation of the coastal landscape for fish farming, pottery production and leisure industry. The apparent dismantling of the Lepine olive culture and the near abandonment of settlement there and in the coastal area following the early Empire indicates that the

Pontine region generally became economically marginalized as the Roman Empire moved its large-scale agriculture and service industries elsewhere.

#### SALENTO ISTHMUS

Just as at Fogliano, the aim of the field survey conducted in 1999 near the town of Ostuni in the Salentine Murge (chapter 11) was to map in detail some previously barely studied ‘marginal’ landscape units. The limestone plateau of the Murge had long been seen as constituting one of the social, economic, and geographical margins of the lowland urban society developing in the early Hellenistic period in the Salento. Whereas research by the University of Lecce and the Free University of Amsterdam had been concentrated on these lowland central places and their immediate hinterlands, the Ostuni survey for the first time offered a chance to chart in detail the long-term history of sections of both the high Murge and the transitional zone toward the coastal plain of the Adriatic. On the micro-regional scale of interpretation, one of the major conclusions that were drawn on the basis of the survey is that, in broad outline, both landscape units demonstrate parallel shifts in artefact densities and distributions from the Bronze Age to within the early Imperial period:

- With regard to the landscape history of the protohistoric, classical, and archaic periods, the almost complete absence of finds dating from the Late Bronze Age until the 4<sup>th</sup> century BC confirmed that society during that period probably had a strongly nucleated structure, centering on strategically located cliff and hilltop settlements. Archaeological material dating to these centuries is restricted to the cave site of S. Maria d’Agnano, where the Archaic formalization of cult activities can be argued to have supported territorial claims on the surrounding land. The fluidity of protohistoric land use strategies was illustrated when the survey unexpectedly found widespread and often dense scatters of a very homogeneous *impasto* dating to the Middle Bronze Age. These scatters, occurring in large numbers in both upland and lowland settings, must be interpreted as the remains of a system of shifting cultivation that was in use for a relatively brief period, and in which family groups periodically relocated to exploit fresh or regenerated parts of the landscape. During this time no large and permanently inhabited settlements would have existed in the area.
- For the Hellenistic and Roman periods the survey confirmed the expected low intensity of land use, in that individual farmstead sites were found to be located approximately 1 km apart in both landscape units. On the other hand the survey provided surprising evidence that ‘colonial’ ceramics, building materials, and building styles had already penetrated far into the Murge during the early Hellenistic period. The development of an indigenous-Hellenistic urbanized society on the Salento Isthmus was therefore complemented by a contemporaneous Hellenization, possibly even colonization, of even the most remote areas. This suggests that essentially all of the population was involved in and affected by this process. For both survey areas, a basic continuity of occupation throughout the Roman Republican and Imperial periods can be deduced, with the possible exception of the late Imperial period in the upland area.

#### SIBARITIDE

For the survey in the Sibaritide (2000; chapter 12), field work was aimed at testing several hypotheses generated on the basis of Lorenzo Quilici’s large-scale topographic survey of the late 1960’s, while at the same time charting in more detail part of the archaeological hinterland of the protohistorical settlement and cult place on the Timpone della Motta near Francavilla Marittima, excavated in the 1990s by M. Kleibrink. From Quilici’s survey, as from other similar surveys conducted for the *Forma Italiae* series, had emerged an intensively settled but almost exclusively classical (Hellenistic-Roman) landscape. Within the survey zone, these farmstead sites appeared to cluster into loose-knit villages linked by Quilici to a (hypothetical) regional and supraregional infrastructure. The RPC survey tested these ideas by means of a field work transect through the foothill zone, designed to reveal the existence of any systematic chronological and geographical biases or lacunae.

The results of the survey confirmed most of Quilici's ideas. In view of the very sporadic presence of protohistoric surface ceramics the foothill zone appears not to have been intensively used before the archaic expansion of the sphere of influence of the Greek colony at Sybaris. The adverse conditions for retrieval of protohistoric ceramics on the intensively worked terraces must be taken into account when interpreting the archaeological record of relatively well-preserved upland protohistoric sites. Despite the historical date for the establishment of Sybaris around 720 BC and the archaeological evidence for continued use of the sanctuary and necropolis at neighboring Timpone Motta into the late 6<sup>th</sup> century BC (Attema et al. 2000), no securely datable materials from this period were found. Given our experience with the very low visibility of coarse Iron Age impasto wares among the naturally occurring stones in the survey area, we concluded that neither ourselves nor the Quilici team were able to identify such material with any degree of reliability; we cannot therefore infer much from its absence. For the Archaic, much will depend on a closer dating of the coarse wares, which make up more than half of the finds by weight, through association with datable fine wares or through typological comparison with excavated material within the region. The large numbers of classical sites do indeed originate, for the most part, in the early Hellenistic period; and they do indeed cluster along the edges of specific landscape units (gently sloping plateaus of marine origin). Among the 'new' small classical sites identified by the intensive survey several are located within clusters identified by Quilici, while others are scattered all over; the material recovered from these mostly small Hellenistic farmsteads is remarkable for its uniform poverty.

In other respects, however, Quilici's thoughts on site distributions and settlement history have had to be modified as a result of our survey. Despite the deterioration of the soil archive in the intervening decades about twice the number of sites mapped by Quilici were recorded in the same area by our more detailed and complete coverage. Large and small Hellenistic sites were found to occur in other landscape settings (among them secondary plateau edges of fluvial origin) besides the ones identified by Quilici as well, and most appeared to be discontinued in the Roman period. The survey also established that just over half of the undiagnostic surface ceramics in the transect displays fabric characteristics *potentially* placing them in the Classical/Archaic rather than the Hellenistic period. If this dating can be confirmed it has obvious consequences for the settlement history of the Sibaritide as a whole, substantiating historic accounts of the *imperium* of Sybaris.

## 2.2 FIELD METHODS

Topographical and field surveys can cover relatively large areas, but the diversity of approaches, the potential for significant bias, and the lack of an accepted approach to statistical analysis of the resulting data mean that their interpretation is a matter often left exclusively to the judgement of the survey director. The promise of the large field survey projects based on regional sampling designs of the 1970's and 1980's, of providing a firm basis for regional extrapolation and statistical inference, has not been fulfilled, and more recent survey projects (including those of the RPC) have elected to map the surface record at a certain resolution, rather than sampling it at a certain fraction. Accordingly, the RPC surveys were used to experiment with methods for more objective recording of archaeological landscapes (summarized in chapter 8). In order to alleviate the resulting substantial load of administrative procedures, experiments were also conducted with automated and digital field recording (chapter 7).

### FIELD PROCEDURES

With regard to methodology, the 1998 Ninfa survey provided a valuable first insight in and confirmation of the limitations of the old topographical style of regional survey, confirming the need to develop methods for the registration of *continuous* spreads of ceramics across the landscape (as opposed to *discrete* spreads in the form of 'sites') in later field surveys - a lesson taken to heart in experiments during the 1998 survey campaign at Fogliano. The conduct and recording of the fieldwork there and in all later surveys was based on geographical collection units (land parcels of circa 1 hectare) instead of archaeological units (sites) or agricultural units (fields), and the problem of selective recording was fought by adopting a policy of collecting and bagging all surface material per unit, leaving the classification of finds by an expert to a later stage.

In addition to the realization that the history of settlement and land use in the Pontine region can be more easily understood if we analyze it in terms of relatively small physical landscape units than if we attempt to do so for the region as a whole, the Fogliano survey also highlighted a problematic recognized earlier by British archaeologists during the analysis of surveys in the Aegean. This problematic regards the interpretation of the often very low 'off-site' finds density of ceramic from various periods carpeting the Mediterranean landscape. Efforts to obtain a better understanding of the factors that influence the probability of retrieving surface finds by revisiting find spots from the 1998 campaign in 1999 and 2001 led me to believe (with others) that even a single ceramic find should, under certain circumstances, be interpreted as indicative of the existence of a local subsurface reservoir (site). The importance of factors influencing the survival and visibility of ceramics in the plough-soil was shown to vary greatly, more-over, depending on the manner of production and age of the material. This causes protohistorical ceramics, for example, to have a much lower probability of retrieval in a field survey than is the case for classical Roman and Hellenistic ceramics, and is an obvious cause of bias.

The experience gained in these earlier survey campaigns in the Pontine region was employed to improve aspects of methodology, and later surveys in the Salento and Sibaritide were conducted with a higher spatial resolution (units of 0.25 ha) and a more rigorous registration of factors affecting visibility. An appendix to chapter 8 presents the annotated field forms developed in the course of these surveys; they represent the current stage in an ongoing process of developing field administration procedures that satisfy internationally accepted standards of good practice in the conduct of field surveys.

- By applying a detailed survey method, focusing on the documentation of the density distribution of artefacts rather than of sites, it has become possible to assess accurately the variability in quality and quantity of this surface material in the light of both cultural and natural formation processes.
- The goal of formal comparison of survey results can only be reached if procedural standardization and rigor are applied in the recording and processing of field data. This will involve greater use of digital recording and wireless transmission methods to increase the precision and efficiency of field surveys; the more detailed recording of landscape parameters that may affect not only site location, but also site visibility; the realization that survey biases may differ, and must therefore be assessed separately, for each landscape unit and category of archaeological material; and the development of widely accepted definitions of such crucial concepts as 'site', 'off-site', and 'scatter'.

#### DIGITAL RECORDING METHODS

Chapter 7 is dedicated to a description of experiments conducted in collaboration with Dr Nick Ryan of the University of Kent at Canterbury during the October, 2000, fieldwork in the Sibaritide. The aim of these experiments was to increase the accuracy and efficiency of the recording and processing of information during and after archaeological field surveys by using programmable, lightweight, and semi-automated digital registration tools (digital field assistants or dFA's). By conducting instant digital recording of landscape parameters and collected materials in the field (that is, without first passing through a 'hardcopy' stage) the efficiency of the work is increased and the danger of transcription error removed. By pairing such digital field recording with automatic and accurate GPS location methods, the mapping of collection units and archaeological entities is no longer dependent on less precise manual methods often involving outdated topographical maps. This apparatus was used successfully to record the surveyors' routes and observations, agricultural field boundaries, and the center and circumference of archaeological sites. The experiments confirmed the potential of the dFA system for both speeding up field recording procedures and reducing the number and size of errors made during the recording process. The system's potential for easing navigation and the sharing of information during surveys was not fully explored, but our experience in (re-)locating archaeological sites mapped in the 1960's indicates that it will also prove useful in that area. With limited enhancements to functionality, and further improvements to the standard spatial accuracy, it was demonstrated that the system can profitably be used in any type of archaeological field survey. With the full technical and procedural integration of a professional version of the kit into fieldwork methodology dFAs may transform fieldwork practice, but

this will require further extensive testing of system components, software, and field procedures.

In recent years, the use of professional GPS surveying equipment in archaeological fieldwork has become much more popular, and some teams are adopting commercially available products in order to obtain GIS-like capabilities in combination with GPS. These high-powered approaches, while providing very high accuracy and versatility, require considerable expense and highly skilled personnel, and cannot yet provide a true field information system. The digital Field Assistant system was argued to be preferable over such alternative approaches, because it is relatively inexpensive, can provide immediate feedback in the field, is portable and unobtrusive, and is designed to perform typical and frequent archaeological fieldwork tasks. With respect to the GPS component of the dFA system, the availability of a good location device is a crucial feature in the recent shift in emphasis of archaeological survey work away from the well-mapped and well-controlled coastal zones of Italy, to the more rugged and less well-mapped inland zones. For archaeological applications where the accuracy requirements are higher than what can be achieved with a single receiver, the addition of a GPS base station for differential correction would give the most satisfactory results. Post-processing, of course, would not offer any improvement in real-time positioning in the field but so far we have not identified any reason why this should be a high priority. Should it become necessary, corrections could be broadcast from the base station and received at the rovers by using conventional wireless-modems.

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### 3 THE METHODOLOGY OF REGIONAL COMPARISON

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The process of compilation, comparison, and interpretation of regional data sets from a quantitative point of view was illustrated in chapter 13, using the Pontine region as an example. Included is a discussion of the desired structure of regional relational archaeological databases, of the need for unambiguous and standardized definitions of archaeological entities such as the 'permanent habitation site', and of the remarkable lack of standardization in fieldwork methods and publication which hampers even the most basic comparison between two or more archaeological data sets. It is shown that traditional regional site databases do not provide a good basis for storing the new data types and emphasis on uncertainty and fuzziness inherent in modern landscape archaeological data. In future, archaeological databases such as that of the RPC project should contain the new types of entities and relations needed to describe accurately all types of archaeological field observations; they should fully document the process of interpretation of these observations along with the interpretations themselves; they should contain mechanisms for keeping track of data quality and for improving data quality through bias modeling if necessary; and they should use formal authorities for the chronological and typological classification of source data and interpretative constructs. To ensure that such databases can be used by others, the need for metadata describing the database itself, and for the development and implementation of explicit and formal classifications was argued.

From the quantitative comparison of the results of all the available surveys in the Pontine region, it emerges very clearly that less intensive survey (such as practiced until the early 1990s) has tended to result in the discovery of a predominantly classical landscape, because sites from this period are the most obtrusive (large and dense scatters containing both tile and ceramics, standing architecture, many diagnostic wares). More intensive survey results in an explosive growth in the number of small and/or diffuse ceramic scatters identified, for which chronological and functional typology tends to be much less clear-cut. A further hurdle to the comparison of survey data sets across projects is presented by the lack of a standardized approach in almost every aspect of their collection, description, interpretation, and publication. This is demonstrated by the example of several incongruent chronological and typological site classifications in recent use in survey projects in central Italy.

It is concluded that priorities for future work in the regional or interregional comparison of survey data must lie with the removal of weaknesses in the core classifications employed. Local ceramic chronotypology must be further developed through fabric classification and seriation of survey assemblages, especially for the post-Archaic period. Site type classifications, particularly for the pre-

Roman periods, should be improved through a program of field tests involving surveys, trial trenches, and excavations at a representative sample of site types. Surveys should address the current lack of data for what has traditionally been considered the marginal parts of the ancient landscape; especially the up- and highlands. Furthermore, the intensive surveys conducted in the various landscape units of the Pontine region since the early 1990s now provide a solid basis to revive the idea of a regional stratified sampling design. The conduct of future survey campaigns within such an overarching strategy can result in a more efficient use of limited resources and should generate more easily comparable data for the region as a whole.

### 3.1 MODELING DATA FORMATION PROCESSES

The interpretation of large-scale (wide-area) patterns in archaeological landscapes has in the past always taken place within the context and limits created by the available written sources from classical antiquity. In order to escape from these limitations and base one's interpretations directly on patterns in the available archaeological data, suitable methods must first be developed. Two types of methodological studies were accordingly undertaken. Firstly, studies that aimed at obtaining an understanding of, and control over, the quality of the archaeological data that lies at the heart of regional settlement histories and the comparisons based on them (chapter 4). Secondly, studies that aimed to assess the utility of the GIS toolkit for the analysis and interpretation of patterns in those same archaeological data (chapters 14 and 17).

#### DATA QUALITY

On the regional scale, geographical, typological and chronological biases abound. There is, for example, a great lack of survey data for what has traditionally been considered the marginal parts of the ancient landscape - especially the up- and highlands in the case of Italy; and if theoretical arguments for the 'invisibility' of the majority of small protohistoric settlements are correct, then what appears to be a clear-cut process of proto-urbanization taking place in Italy, may in fact be the preferential discovery of the highest-ranked settlements within a much more widely settled landscape. Chronological biases are especially insidious, as they are built in to typo-chronological classifications which are often imported from outside the region being studied. For example, the early settlement histories of the Pontine region and the Sibaritide are greatly influenced by our (in-)ability to recognize post-Archaic, respectively Archaic ceramics. Rather than continuing to rely for dating on fine wares originating in other regions and often itself dated only by typological association with wares from even further afield, it is therefore of singular importance to study the local fabrics and wares in excavated contexts. Local ceramic chronotypologies must be further developed through fabric classification (cf. Attema 2000) and seriation of survey assemblages.

The problems that currently haunt the interpretation of the results of surveys by one and the same group operating in the same area, are shared to an even greater extent by those intending to assess the archaeological record at a wider regional, or even supra-regional, scale. Currently, students are forced to choose between two equally unattractive approaches to regional and interregional comparison: either to compare the broad characteristics of the data sets while ignoring most of the associated problems, or to spend a huge effort on devising a multitude of correction methods for low quality data sets. Qualitative comparison of high-level interpretative constructs is doable because these are provided ready-made by period and area experts, but unsatisfactory because the interpretations 1) rely on a shared and limited set of theoretical constructs, and 2) are heavily biased by past research trends and results. Rather than continuing to collect data that suffer from these biases, research should be targeted at the development of more reliable methods of collecting data that are truly representative of the extant archaeological landscape, and of standardized ways of describing, archiving, and publishing results. Clearly there is an urgent need to begin to develop landscape archaeological data sets of a sufficiently high quality to allow (inter-)regional comparison – guidelines for which should become embodied in an international standard defining 'best practice in landscape archaeology'.

## BIAS MODELING

The strength of our interpretations of regional archaeological databases, such as are compiled by desktop study and occasional fieldwork, rests entirely on the quality of the data within it. With the exception of a few survey projects designed in the late 1970's under the influence of the New Archaeology, and implemented mostly in the 1980's, none of those data were produced with the express aim of obtaining a representative picture of the regional archaeological landscape. Regional interpretations must therefore explicitly take into account the possibility that the data on which they are based are *not* representative for that landscape. A similar problem has plagued the interpretation of the results of archaeological field walking surveys, which had become increasingly popular during that same period as well. Ever more intensive and systematic field work has brought to light the significant role of numbers of factors biasing the objective retrieval of archaeological surface data. Chapter 4 deals with methods that can be used to detect and counter such biases, both proactively by introducing procedural improvements in the design and execution of contemporary fieldwork, and retroactively by applying extensive source criticism on data sets formed in the past:

- Our ability to record surface archaeological material is not perfect; it is biased by visibility and research biases. Causing the former are factors such as current and historical land use / land cover (LULC); causes of the latter include the recording and classification methods used by the field archaeologist. The amount and type of bias varies strongly depending on the type of data and scale of analysis; no hard and fast rules can therefore be given, other than that a bias study should be a requisite part of any regional data collection exercise or analysis.
- Neither the intensive interest and study conducted in the early 1980s, nor the growing popularity of surveying and use of GIS since then, have so far led to anything resembling a successful approach to the recording and correction of biases which is valid across projects. We must follow up on Terrenato's (1996) urgent call to record bias factors if we are to attempt 'the correction, at least partially, of incomplete distributions', and conduct the 'series of methodological experiments dealing with the various aspects of how to document surface scatters', advocated by him.

The case studies presented here were conducted to demonstrate a) the relevance of bias factors to the interpretation of survey data and of landscape archaeological data in general; and b) methods by which bias factors can be included in geographic models of archaeological landscapes. At the regional scale, studies of the data collected by the Wroxeter Hinterland Project and the Agro Pontino Project (Voorrips *et al.* 1991) demonstrate this for systematically surveyed data and general archaeological records; at the scale of a 'local' survey such as the Ninfa and Fogliano surveys conducted 1998-9, case studies demonstrate this for specific visibility and research biases.

## CHANGES IN LAND USE AND LAND FORM

The geological history and the history of land use of the landscape have a great influence on the design and results of archaeological fieldwork. In the WHP surveys conducted in 1994-6, the choice of fields was limited by modern land use and land cover (LULC), in particular the availability of recently ploughed agricultural fields. Since such fields are not randomly distributed over the landscape – relief, distance to the river Severn, soil type, modern infrastructure and hydrology all play a role – the surveys result in the taking of a potentially biased sample which cannot be used to make straightforward extrapolations about the study area as a whole. In the surveys conducted by the Agro Pontino project during the 1980s, paleosurfaces dating to the Paleolithic period had been covered in most parts of the Pontine plain by more recent alluvial and colluvial deposits (Kamermans 1993), and similar though less clearly evident biases must have been present for material dating to later periods. In chapters 14 and 17 of my thesis I presented examples of bias modeling applications focusing on the recent and subrecent land use history of the Wroxeter hinterland and the Pontine plain. It was demonstrated that 20<sup>th</sup> century land use in the former region is correlated with the large-scale distribution patterns of several of the most numerous site types in the former area. Land form changes as a result of the fascist and later land improvement schemes

in the latter region were likewise shown to have a significant influence on the results of the RPC field surveys near Fogliano (chapter 10).

The study of LULC for regional archaeological research can be said to have both a methodological and a historical purpose. The former is perhaps best approached by the use of GIS to store and compare historical cartographic data about land use. Such data may be derived from archival records made for military, legal or taxation reasons; from studies of agricultural productivity; and, more recently, from historic aerial photography and satellite imagery. The resulting LULC maps can then be compared and correlated to the visibility and discovery mode aspects recorded in the archaeological archives. The case study presented in chapter 14 found that recorded discovery mode in the Shropshire SMR does indeed correlate with historic LULC. Examples are given of the positive correlation of aerial photographic data to arable land use, of chance finds to areas more likely to be frequented in recent times, and of earthworks to uncultivated land. Using the example of barrows and ring ditches, it was demonstrated that analysis of the archaeological record *within* a particular discovery mode can also flag up significant deviations. Whilst both feature groups represent a single underlying class of sites (ring ditches being the ploughed-out remains of burial mounds), barrows discovered by air are located mainly on poor soils while ring ditches discovered by air occur mainly on rich soils. When the two data sets are recombined the latter correlation becomes insignificant. The second, historical, use of LULC studies is demonstrated by reconstructing a regional pattern of arable vs. woodland for the late Roman period supported by archival studies of diocesan boundaries and literary topographic references. It is argued that such studies are needed if we are to distinguish between archaeological patterns relating to ancient LULC, and those relating to modern LULC.

Whilst the scope of this case study was limited both by the available time and by the relatively low quality of the data available from the Shropshire SMR, there is no reason to assume that other regions will have been much better documented. Our archaeological understanding of the Wroxeter hinterland should not be conditioned by the ‘accidental’ but systematic absence from the landscape of certain kinds of evidence as recorded under certain kinds of conditions. Such hiatuses can be managed efficiently in a GIS by mapping the type, coverage, and intensity of archaeological research events<sup>1</sup> across the landscape. With regard to the potential of land use mapping in Mediterranean studies, one may point to the many and sometimes very detailed topographic maps of the Pontine region, which contain land use data dating back as far as the 16<sup>th</sup> century. Attema (1993), for example, used military topographic maps of 1851 to derive a map of the typical transhumant settlement and land use practiced until the early part of the 20<sup>th</sup> century in the Pontine plain.

The case study presented in chapter 17 demonstrates the feasibility of employing GIS to extract and interpret recent and subrecent land form changes from historic elevation and land cover data. Although it is generally recognized that the interpretation of survey results requires knowledge of local geopedology and landscape history, workers have not yet gone very far with this approach. The case study shows that, provided certain requirements regarding data quality are met, historic elevation data can be used to track one of the most important factors biasing the results of field surveys in Europe today – changes in land form caused by agricultural and construction activity. By detailed comparison of historic and recent elevation data in the GIS environment, maps can be made of the location and approximate amount of soil deflation/inflation affecting the presence and visibility of the archaeological record. Such maps can be used both to target future surveys to areas that are likely to have survived undisturbed, and to re-interpret the results of older surveys.

Taken together, chapters 14 and 17 provide an especially clear demonstration of the strength of the correlation between most small-scale (wide area) patterns in regional archaeological data sets, and the combined factors of recent and subrecent land use and local research methods and interests. A more

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<sup>1</sup> The term ‘event’ is here used in accordance with accepted archaeological recording practise, where it indicates a single episode of relevant actions/observations affecting a monument.



extensive and detailed meta-analysis of Italian surveys is now needed in order to map in detail their correlation with contemporary land use.

### 3.2 MODELING SETTLEMENT PATTERNS

#### SITE LOCATION MODELS

In order to arrive at an assessment of the two main schools current in archaeological GIS studies of the last decade, chapters 5 and 6 presented a full analysis of the theory, methodology, and methods underlying ‘predictive’ models (location models mostly based on the extrapolation of correlations between the locations of archaeological remains and characteristics of the physical landscape) and ‘cognitive’ models (mostly models that relate the location of archaeological remains to the degree of visibility and accessibility of the surrounding landscape). Predictive models were developed internationally mainly in the context of heritage management and preservation, but in the form of location models have long been the object of academic research as well. In the latter case the aim is usually to explain existing settlement and land use patterns by relating them to landscape parameters. The potential of GIS software as a tool for this kind of study was quickly recognized and in Europe led to a steadily increasing flow of publications since the early 1990’s. During that same period, however, post-modern theory also gained an increasing number of proponents within European archaeology, giving rise to heavy criticism of the ‘ecological determinism’ inherent in predictive models, and proposals to replace it by ‘cognitive’ alternatives. This led to a lively but chaotic debate regarding both the theoretical underpinnings and the aims and methods of this type of geographical model. Based on an overview of the international literature on the subject, chapter 5 lists and evaluates all of the arguments employed in this debate, in which a series of dichotomies stemming from the polarized theoretical stances appear to predominate.

The main conclusion arising from this review is that procedural transparency rather than theoretical purity should be the main characteristic of predictive models, a goal that can be reached only by formalizing all the stages in the modeling process as presented in the chapter, increasing the quality of the data and methods employed, and adequately testing the resulting models in the real world. Wide-area predictive modeling using GIS is poised to play a very important role in archaeological heritage management at the national level in the European Union because of the imminent implementation of the Valletta Treaty on the protection of the cultural heritage, but at the same time has remained an important tool for archaeological research as well. The ability to generate formal, rule-based, and testable hypotheses in the form of predictive maps is fundamental to both types of use, and requires a better understanding of the underlying theory, data and methods. Specific recommendations include the need to improve the spatial, functional, and temporal resolution of the models, to arrange for the *formal* inclusion of archaeological theory and expertise through the use of expert systems, and to incorporate *formal* stages of source criticism (bias correction) and quality testing. In both CRM-type and academic models there is sufficient scope for procedural improvement, including the proper and transparent use of statistical techniques and inclusion of bias models. It should be clear to students and end users alike to what extent models are supported by statistical inference, and what can and cannot be inferred from them. ‘Source criticism’ of both archaeological and environmental input data, including especially the absence of such data, should be an integral part of the modeling methodology. This can perhaps be implemented through the use of “taphonomical map layers” that assess the nature and extent of the distortions of the known material heritage, and suggests a link with the area of error propagation modeling in Geography.

#### COGNITIVE MODELS

A heightened attention to the landscape as perceived and conceived by humans both in the past and today is one of the more significant contributions of post-modern archaeology to the debate regarding the nature and goals of GIS applications (chapter 6). In contrast to the external and physical characteristics of the landscape, this approach targets its internal, cognitive, aspects. In everyday research practice it translates into archaeological applications and development of two GIS tools in particular: line-of-sight analysis (LOSA) and cost surface analysis (CSA). Leaving aside the fruitless theoretical debate accompanying this development, research efforts in this direction have allowed a more realistic

approach to predictive modeling that takes into account the human experience of being in the landscape. In chapter 6 I reviewed the international archaeological literature on these two techniques. It is concluded that, a decade after the first LOSA / CSA studies were conducted, an initial phase characterized by naïve applications and constrained by the capabilities of generic GIS has drawn to an end, and is being replaced by a phase in which specific procedures are being proposed in order to implement more realistic models of human perception of the landscape. Although research in this area is still characterized by the existence of ‘schools’ - the ‘environmental’ school continues to explore refinements to approaches current throughout the past decade while proponents of the ‘enrichment’ school advocate a landscape architectural approach – it is becoming increasingly clear that deterministic analysis in GIS can become more accurate by adopting a flexible approach to cognitive criteria. Early explorations of such a ‘cognitive processualist’ approach include Wheatley and Gillings’ (2000) investigations in the framework of Higuchi viewshed properties, Llobera’s (2000) implementation of ‘attractive’ and ‘repellent’ features in the landscape, and several of the case studies presented elsewhere in this thesis.

The apparent, and vocal, conflict between adherents of processualist and post-processualist approaches to archaeology was shown to be beside the point from a pragmatic point of view. A much more significant watershed exists between studies that fail to adduce proper supporting evidence to their interpretations, and those that do. A case in point is the general lack of supporting evidence given for claims of unusual (non-random) cost or viewshed properties for particular locations within a region. Yet the techniques to provide such evidence exist:

- To substantiate the significance of visibility and accessibility properties obtained for a sample of archaeologically meaningful locations, they can be compared with similar properties of either one large sample, or many similar-sized samples of randomly chosen locations. The former is typically done by first generating a cumulative visibility or accessibility index for all, or a representative subset of, locations within the study region. The result obtained for the sample of interest can then be formally compared to the population (one-sample tests) or to a representative sample of it (two-sample tests). As is shown by Fisher and others (1997) and Kvamme (1999), Monte Carlo tests can be employed in the latter approach to demonstrate that the results obtained are unlikely to have arisen by chance, now that computing power is no longer an issue.
- A different method by which LOSA- or CSA-based models may be supported is by comparison with independent archaeological evidence. For example, networks of least-cost paths may be compared to historically known networks such as the mule-paths that criss-crossed the Italian uplands until recently.
- Finally, two potential approaches have been suggested to make cognitive models more robust: firstly, since there are a large number of potential sources of error in the input parameters and algorithms involved in these models, Wheatley and Gillings (2000) suggest that we should instead study the trends emerging from an accumulation of models with a wide variety of such input parameters and algorithms. Secondly, rather than attempting to interpret the viewshed or accessibility properties of sites directly, we could study the *differences* among sites and between sites and ‘background’. Both methods avoid a lot of the uncertainty and errors usually associated with this type of analysis.

Case studies from the Wroxeter hinterland, illustrating the application of line-of-sight and cost surface analysis techniques in models of the Late Iron Age and Roman cognitive landscape, were presented in chapter 16. Developed originally in 1996-7, these case studies no longer represent the ‘state of the art’ in GIS modeling of visibility and accessibility, as the modeling of ‘energy and resource landscapes’ with the help of cost surface techniques has become increasingly sophisticated in the last few years. Cost is now measured in real terms as energy expenditure in Watt or kcal; cost surfaces have become anisotropic to reflect the importance of the effect of direction of movement on costs; the interpretation of visibility and accessibility models is now informed by a better understanding of statistical complexities; and, last but not least, the limitations of the underlying theory are now beginning to be understood. Keeping these limitations in mind, line-of-sight analysis is used to model and visualize the potential degree of control exercised from Iron Age hillforts and the later Roman legionary fortress at Wroxeter over parts of

the central Severn valley. Cost surface analysis is used to model, first, the accessibility of the region in the Roman period, and then, on the basis of that accessibility, the locations of potential routes and nodes in the local infrastructure.

An exploration of the properties of ‘background’ visibility and accessibility indices is also included in chapter 16. Although the simulations presented there do not constitute definite proof, it would appear that simply by increasing the viewshed range used, the higher visibility values will concentrate on areas of higher ground, ridges and peaks. Any sufficiently large sample of archaeological viewpoints will tend to generate a cumulative viewshed similar to these simulated ones, depending on the viewshed radius used. Furthermore, any such viewshed based on points located on or near ridges and peaks will further emphasize the visibility of other ridges and peaks. It is argued that the properties of cumulative ‘background’ indices should become more widely known and used by practitioners. Of equal importance is the testing of GIS-generated visibility and accessibility models, firstly by a comparison with extant historic, archaeological, and cartographic data, and thereafter by targeted fieldwork.

#### CENTRAL PLACES AND TERRITORIAL DIVISIONS

In chapter 15, spatial models deriving from the theoretical models of centralization, urbanization, and colonization presented in chapter 2 were investigated, using examples from the Pontine region and the Sibaritide. These examples concerned centralization, urbanization, and the formation of territories during protohistory, and early and middle Republican colonization of the Lepine margin.

Protohistoric settlement dynamics in widely separated regions of central and southern Italy, as presented in the literature, demonstrate a remarkable similarity, so that it is quite possible to draw comparisons between the regions on this basis. The development of indigenous central places and territories in the late Bronze Age and early Iron Age is one such dynamic. The process by which archaeological sites of that period are identified, the criteria by which they are classified, and the arguments and methods used to segment the surrounding landscape into territories, are investigated and weaknesses in the process are exposed. In general it emerges that current economic and cognitive models of the ordering of settlements and the landscape in protohistory (and, for indigenous societies, even for many centuries afterwards) are of a very non-specific and intuitive nature. Bias modeling (chapter 6) and corrective fieldwork (chapter 8) will be needed to test the many assumptions on which these models are based. For the early (4<sup>th</sup> century BC) Roman colonization of the Lepine margin, a viewshed study is conducted to test the hypothesis that these colonies were established as strategic strongpoints, as much for the purpose of controlling the Lepine uplands from which direction attacks by mountain tribes could be expected as for protecting the agricultural resources and infrastructure of the Pontine plain. A brief review of literary historical sources regarding Rome's early colonies in south Lazio is given to substantiate the need for such strategic decision making in a landscape which remained contested between Latins, Volscans, and Romans for a century and a half. The results of the study show that the colonial viewsheds cover the whole of the western Lepine mountains in a complementary fashion, and support the hypothesis.

Specific conclusions regarding settlement patterns in the three study regions, drawn in chapter 13, include:

- The developed Iron Age settlement pattern in the Sibaritide and Salento Murge displays remarkable similarities in the geomorphological location and spacing of the settlements, located some 10-12 km apart in defensible hilltop positions. It must be doubted that regular access to sea-born trade had a major role to play in this, because the pattern continues into the Murge upland, and may in fact be more strictly related to control over high quality agricultural and pastoral resources. This hypothesis can be tested by targeted fieldwork in the Lepine uplands and the inland reaches of the Sibaritide.
- The ‘colonial’ settlement pattern in southern Italy was centered on the coast rather than on the hill country, and combined accessibility by sea with the presence of a substantial agricultural hinterland. In contrast, Rome’s early colonies were as much or more intended to fulfill strategic functions, so their locations meet other criteria of dominance – namely that of control over routes of attack

and advance. The fact that the viewsheds of the Roman colonies on the Lepine margin are both complementary and fall within the Higuchi 'middle range' distance creates support for the idea that these towns were located as much to control movement across the Lepine up- and highlands, as to control and protect communications and agricultural resources in the Pontine plain.

- As a tool for archaeological spatial analysis of territories, Thiessen polygons have been used extensively. The case study presented in section 2 of chapter 13 demonstrates the weaknesses of the technique in specific archaeological situations. The use of GIS and cost surface analysis allows the technique to be refined by replacing the simple gravity model of space with one in which each center can have its own 'weight' determining the relative size of its polygon, and in which characteristics influencing the accessibility of the terrain are used to determine the location of territorial boundaries instead of horizontal distance. Rank-size studies such as the one by Guidi (1985), although based on unreliable settlement sizes, when combined with X-Tent modeling techniques provide a more credible alternative to Thiessen polygons; another advantage is that they can be used to implement central place models as well as peer polity models of society.

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#### 4 CONCLUSION: REGIONAL ARCHAEOLOGICAL DATA ANALYSIS

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My research has shown that the type of regional archaeological data analysis required by landscape archaeological approaches is an area where both theory and method are still in their infancy. High-level theories about the occurrence, scope, and effects of processes such as centralization, urbanization, and Hellenization/Romanization cannot yet be supported by middle range theory, which itself cannot be developed until the basic business of generating information of sufficient quality about the archaeological record has been tackled. Currently, archaeological data can be made to fit almost any interpretation generated, ultimately, on the basis of the ancient written sources. If we are to escape from this self-reinforcing cycle, research should perhaps no longer be focused on the classical themes generated by culture-historical approaches, but should seek its own proper field of operation.

In the area of methods and methodology, I have demonstrated the pervasive influence of systematic research and visibility biases on the patterns that are present in the archaeological data generated over the past 50 years or so. There are mechanisms at work, both in the traditional archaeological interpretation of limited numbers of excavated sites and historical sources, and in the landscape archaeological approach, that cause the systematic undervaluation of unobtrusive remains. The significance of systematic biases in both the coarse site-based data sets resulting from desktop and 'topographic' studies and the more detailed site-based or 'continuous' data resulting from intensive field surveys has become much clearer as a result of the studies reported here. This should have practical consequences for the ways in which we study the existing archaeological record, plan future landscape archaeological research, and conduct field surveys. Site databases, the traditional starting point for regional archaeological studies, can no longer be taken at face value; rather, they require careful source criticism before being used to support specific arguments and hypotheses about settlement and land use dynamics. My studies have also shown that future data collection, whether through field survey, excavation or other methods, has to take place in a much more methodical manner if we are to produce data that are sufficiently standardized to be successfully exchanged, compared, and interpreted by others – guidelines for which should become embodied in an international standard defining 'best practice in landscape archaeology'.