

16 The Costs of Our Coasts: Examples of Dynamic Dune Management from Western Europe

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16.1 Introduction

Coastal dunes are highly diverse and valuable, but vulnerable ecosystems. In certain regions of the densely populated western part of Europe, coastal dunes are multifunctional, serving several, often conflicting functions at the same time, such as nature conservation, recreation, drinking water catchment and coastal defence. Yet nature management has been accepted politically and socially. Who are the managers, what are the costs of this management and what does society gain from it? An example is given from the Sefton Coast in north-west England near Liverpool and from Meijendel, near The Hague, The Netherlands.

16.2 Coastal Dunes: Dynamic Systems and Management

Coastal dunes are extensively described elsewhere in this book. For a recent overview of dunes as a dynamic system in management and conservation, the reader is referred to Arens et al. (2001). For this chapter, some essential concepts are summarised.

A useful model of a dune system is given by Bakker et al. (1979; Fig. 16.1). This is a hierarchical model, showing, from top to bottom, the landscape-forming factors (climate, coastline processes, geological substratum, relief, groundwater, soil and vegetation) and their associated processes (respectively: changes in temperature, precipitation, etc.; coastal erosion and accretion, etc.). Two kinds of process are distinguished: natural (left) and human induced (right). In the latter, the role of man as a landscape-forming factor is given. The hierarchical arrangement indicates that factors (and processes) towards the top of the model dominate more over those at lower levels than

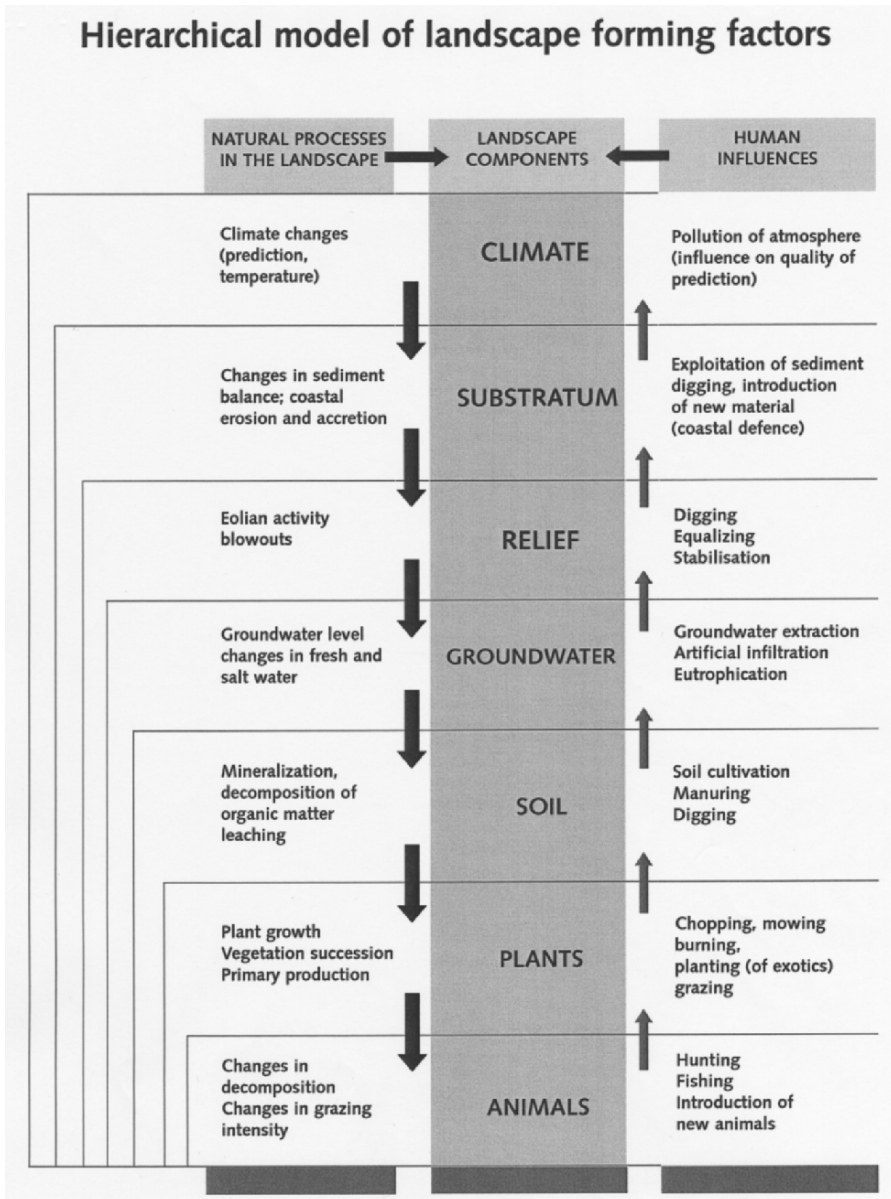


Fig. 16.1. Hierarchical model of landscape forming factors. (Bakker et al. 1979)

the other way around. For example, relief dominates over vegetation and soil (compare north-facing and south-facing slopes and their different soil and vegetation as a result of microclimate differences); in final instance, climate dominates over all factors. Not to be seen in the model is the importance of scale (temporal as well as spatial): processes on top of the model take more time and space than those near the bottom (coastal erosion acts over kilometres, while soil leaching acts over centimetres or decimetres). It is clear that changing of climate will ultimately affect all processes and may change a dune completely. Some signs of this can already been seen in the effects of (acid and eutrophic) atmospheric deposition (Harkel 1998).

What is the use of this model for the manager? At first, it presents the dune landscape in an orderly way, a frame for thinking and managing. Every management plan eventually results in a measure, in a physical intervention in the landscape. Mowing, grazing, cutting of sods, the reintroduction or stabilisation of mobile dunes, all these measures influence the existing processes and introduce new processes. Looking at the model, the manager can assess at which level to intervene in the dune system and how this intervention might influence processes at other levels. Dynamic management primarily is working with natural processes. The more managers are in line with the natural processes at higher hierarchical levels, the more they are managing towards a “natural” system. This is what is the objective in a so-called natural core area (see later this chapter).

16.3 Examples from Western Europe: England and The Netherlands

Dunes, because of their very position at the border between land and sea, are attractive for many other functions than nature conservation alone. This is especially the case in intensively used dunes of western Europe, but it holds for many places over the world, where dunes border densely populated areas. Dunes become multifunctional landscapes, and the manager has to deal with several, often conflicting, uses. How does this work and what are the costs of these coasts?

We give two examples of managers taking care of important dune systems adjacent to large industrial and populated areas: Sefton Coast dunes, near the city of Liverpool, north-west England and Meijndel dunes, near the city of The Hague, The Netherlands. These dunes are under great pressure, but nature management has been accepted politically and socially. Despite great pressure, it was decided to maintain nature conservation areas in the middle of densely populated land, both for the benefit of nature itself and for other uses, such as recreation, production of drinking water and coastal defence. Who are the managers, how is the management organised and what does it

cost? What does society have to pay to maintain these dune areas and what does it gain from it?

The management of the Sefton Coast Dunes and the Meijendel Dunes will give more insight into these questions. To understand management in its social-cultural context, it is interesting to see how the attitude towards nature management has changed in the past 50 years in The Netherlands.

Towards the middle of the 20th century, nature conservation concentrated on (rare) species, species habitats and inventories of nature areas. This was followed by more attention for the physical and biological processes, which, in fact, “produced” these habitats, and for whole landscape ecosystems, consisting of aggregates of different habitats. As a consequence, more attention focused on process management. At the onset of the 21st century, more and more managers became members of society, offering a “product” to be used by that society. The general public commented on the management and the managers were explaining to the public why certain measures were necessary. Managers and politicians asked for the quality of the “product”, the appreciation by the general public and the costs and benefits of all this work.

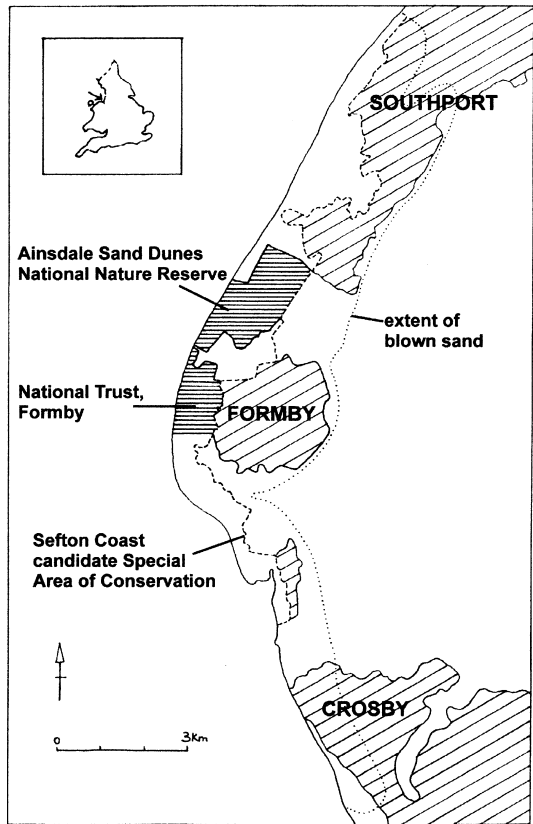
16.4 The Sefton Coast (England)

16.4.1 Area

The Sefton Coast in north-west England is a 14-km arc of dunes lying between the city of Liverpool and the resort town of Southport (Fig. 16.2). The coastal landscape is formed by a wide foreshore, a dune system of high (20–30 m) dunes and a dune backland of older low dunes. In the early 18th century, the dune system had a wilderness character and was used mainly agriculturally with extensive areas of rabbit warren. In the late 19th century, rapid changes took place with the construction of railways, urbanisation, the laying out of golf courses, military use, the planting of pinewoods and growth in tourism and recreation. In the 20th century, increasing development pressures and increased tourism led to the loss of many dune areas and severe damage to others.

The three primary functions of the area are coastal defence (the dune system helps to protect over 150 km² of low-lying land from flooding), nature conservation and recreation. Other issues include military training, golf and agriculture. It is estimated that the dunes and beaches (excluding the resort town of Southport) are visited by 1.3 million people a year (Atkins 2001).

Fig. 16.2. The Sefton Coast in north-west England showing the extent of blown sand, the main urban areas, the boundary of the Sefton Coast candidate Special Area of Conservation (covering most of the remaining area of open dunes) and the location of the sites referred to in the text



16.4.2 Management

The breakup of private estates in the early 20th century led to piecemeal land acquisition with currently 12 managers within an area of 2000 ha. Despite attempts to establish a co-ordinated management framework in the 1960s, it was not until 1978 that a proposal by the County Council, the District Council and the Government's countryside advisory agency led to the establishment of the Sefton Coast Management Scheme (see Houston and Jones 1987).

The management scheme brought together statutory agencies, principal land managers and conservation and recreation interests in a collaborative partnership to restore and enhance the dune coast. The three principal managers are Sefton Council (the local authority), English Nature (a government body) and the National Trust (a land-owning charity). At first, coast defence issues took priority over conservation and recreation interests and a programme of dune building and dune repair was initiated. Even looking back

today from the perspective of a dynamic approach to dune management, the dunes of the Sefton Coast had suffered unacceptable damage from uncontrolled recreation pressure, vehicular damage and loss of natural foredunes.

The restoration works took a decade and were only possible through central government funding through unemployment relief programmes. The focus of the work was to control recreation pressures whilst repairing the extensive damage to the dune landscape and planning for the future with the designation of nature reserves, employment of a ranger service and encouragement of volunteer and community support. By the end of the 1980s, the Sefton Coast Management Scheme had developed effective techniques for dune stabilisation and recreation management. Experience demonstrated the high costs that can result from a lack of management and emphasised the need for appropriate long-term management. The total costs of this work between 1977–1985 were over 2 million Euros at 1985 prices with the employment of over 600 labourers (Wood 1985).

With many of the earlier problems, such as the trampling damage to the foredunes, under control, work in the 1990s focused on working with natural processes and developing a greater understanding of habitat and species management requirements. However, managers' adoption of new approaches to dune management was not always sufficiently supported by public information and education. Consequently, the managers sometimes found that their ideas differed from the views of sectors of the local community. There is a similar shared experience throughout north-west Europe where dune managers have found it increasingly important to listen to the views of local people (Edmondson and Velmans 2001; Geelen 2001; Zwart 2001). These authors advocate that it is no longer sufficient for managers to simply provide access or undertake conservation work without public consultation. The need for public support and accountability is becoming increasingly important. This has a direct bearing on the cost of management and, in some instances, community officers have been appointed to improve liaison with local communities.

The Sefton Coast, with several land-owning interests, multiple uses and social constraints imposed by a combination of local needs and local politics, requires a special form of management. Here, as in The Netherlands, the 'ideal' ecological or geomorphological position cannot be realistically achieved and management objectives must aim to satisfy a balance of interests.

16.4.3 The Sefton Coast in the 21st Century

A pattern of land use and land management has become well established on the Sefton Coast. The last remaining substantial area of private duneland was purchased by the local authority in 1995 and most of the dune area falls

within the Sefton Coast candidate Special Area of Conservation (a Natura 2000 site, based on the UK system of Sites of Special Scientific Interest). The co-ordination of management is guided by a non-statutory Coast Management Plan prepared by the Sefton Coast Partnership (formerly the Sefton Coast Management Scheme). The plan supports the statutory planning and sea defence functions of the local authority and develops more detailed strategies for nature conservation, woodland management and visitor management.

Recreation has changed considerably. In the early 20th century, visitors came primarily to the resort towns and beaches. Photographs from the 1930s onwards show beaches packed with cars (Fig. 16.3). These activities remain popular, but in recent decades the use of dunes themselves as a recreation area has significantly increased. Whilst beach activities are very seasonal, the use of the dune area (walking) is year-round. Part of this popularity is the general trend towards more active pursuits and gentle exercise, but also a growing local population who use the dunes as their open space. The town of Formby, e.g., grew from a pre-World War II population of 3000 to its current 30,000. Managers responded to the increasing pressure with greater use of paths, boardwalks, fencing and signposting.



Fig. 16.3. Car parking on Ainsdale beach, Sefton Coast 1938. Photograph by R.K. Gresswell, English Nature archive, Ainsdale Sand Dunes NNR

16.4.4 Recreation

16.4.4.1 Visitor Research

The pattern of landownership on the Sefton Coast helps to create a number of zones with differing levels of access. The area, as a whole, can provide for the four different kinds of nature identified by Korf (1997): semi-park nature, accessible nature, ‘wild’ nature and strict reserve.

In a situation similar to Meijndel, visitors to the Sefton Coast put a greater value on an introduced feature, the pinewoods and their associated red squirrels, than on the natural dune landscape. Dune managers, whilst naturally wishing to promote the conservation value of open dune landscapes, need to be aware of these popular opinions if they are to successfully work with their local communities and visitors.

16.4.4.2 Visitor Typology

On the Sefton Coast, a comparison can be made between the dune area managed as a National Nature Reserve by English Nature and an adjacent area managed primarily as an amenity by The National Trust (Fig. 16.2, Table 16.1). The National Nature Reserve is a relatively large area of ‘wild’ nature, whereas the National Trust’s property would fall into the semi-park category. Visitor surveys, however, reveal some surprising results. Most visitors to the nature reserve come to walk, relax and enjoy the scenery (only one of five visitors mentions ‘nature’ as a reason for their visit), whereas on the much busier

Table 16.1. Comparative costs of management for two sites on the Sefton Coast

Property	Estimated visitors/year ^a	Area ^b	Cost per ha/year ^c	Cost per visitor (Euros)
National Trust, Formby	340,000	345 (170 dunes)	880 Euros (1800 if only dune area considered)	0.9
Ainsdale Sand Dunes National Nature Reserve	55,000	495 (340 dunes)	285 Euros (415 if only dune area considered)	4.1

The National Trust figures are gross costs; income from admissions, members and other sources can achieve a surplus

^a Atkins (2001)

^b Areas include intertidal land

^c All costs associated with site management

National Trust property over 40 % of visitors cited 'nature' as a reason for their visit.

Such results are interesting for the management of multi-use or multi-ownership sites. Nature conservation is no longer the sole preserve of nature reserves. The promotion of biodiversity has shown that nature is everywhere, yet 'nature reserves' still have a place for society, and perhaps an increasing role as places of tranquility.

16.4.5 Costs of Management

Dune management encompasses elements of coast protection, nature conservation, landscape and amenity, access and recreation and sustainable commercial activities (e.g. forestry, water supply, golf). Studies attempting to measure the socio-economic costs and benefits of integrated coastal management (Firn Crichton Roberts and University of Strathclyde 2000) look at both qualitative and quantitative impacts. Qualitative benefits of multiple-use management can include better partner understanding, stronger community feeling, more sustainable activities and improvements to landscapes and habitats. Quantitative benefits included habitat protection (the value of safeguarding habitats from deterioration), local infrastructure and business and tourism benefits. To simplify comparisons, the costs in Table 16.1 do not include those for coast defence, the management of tourist beaches or research and monitoring.

Meijndel (along with the dunes of the Amsterdam Water Works and the Provincial Water Company of North Holland to the north) is a large area under single management regime. In contrast, the Sefton Coast dunes are divided between several owners and so, to achieve the same level of management as the Dutch sites, there is a need for a partnership approach. The cost of maintaining an integrated coastal management Unit for the Sefton Coast is 170,000 Euros per year. The costs of this are largely borne by the local authority, although the coordination activity of the unit helps to secure considerable external funding for nature and recreation projects.

A dynamic approach to management is now integral to the overall management of the coast. Much less effort is now needed in dune restoration work or in fencing to reduce damage to habitats. Recreation provision has to be worked into the natural processes operating along the coast. The introduction of a Beach Management Plan by the local authority in 1993 has zoned the use of the beaches, reduced recreational damage to the foredunes and encouraged the formation of new embryo dunes and slacks. There has been little additional cost to the manager for substantial nature conservation and coast defence gains.

16.5 The Meijndel Dunes (The Netherlands)

16.5.1 Area

The Meijndel dunes are situated north of The Hague in one of the most densely populated areas along the mainland coast of The Netherlands (Fig. 16.4). They stretch for 6 km along the coast and are 3.5-km wide. In these 2000 ha of dunes a rich variety of animals and plants are found. Meijndel is part of the Ecological Main Framework of The Netherlands. This framework is defined by the national government and areas within this framework have the highest degree of protection (LNV 1992).

Meijndel is managed as a nature reserve and a drinking water catchment area (see, e.g. Bakker and Stuyfzand 1993). It is of great importance for the production of drinking water for the people of the surrounding cities (1.5 mil-



Fig. 16.4. Meijndel in west Netherlands

lion people). Further, the dunes play a major role in sea defence by protecting the low-lying western part of the country against the sea. Last, but not least, it is an important recreation area for about 3 million people living within 25 km distance. About 1 million people visit Meijendel yearly; this does not include people visiting the beach.

16.5.2 Management by the Dunewater Company

The management of the area is done by the Dunewater Company of South Holland. It deals with the more or less conflicting interests of nature-conservation, production of drinking water, coastal defence and recreation. In a management plan for the area, the company sets out the goals for the future. In 2000, a new management plan for the years 2000–2009 was completed (Vertegaal 2000).

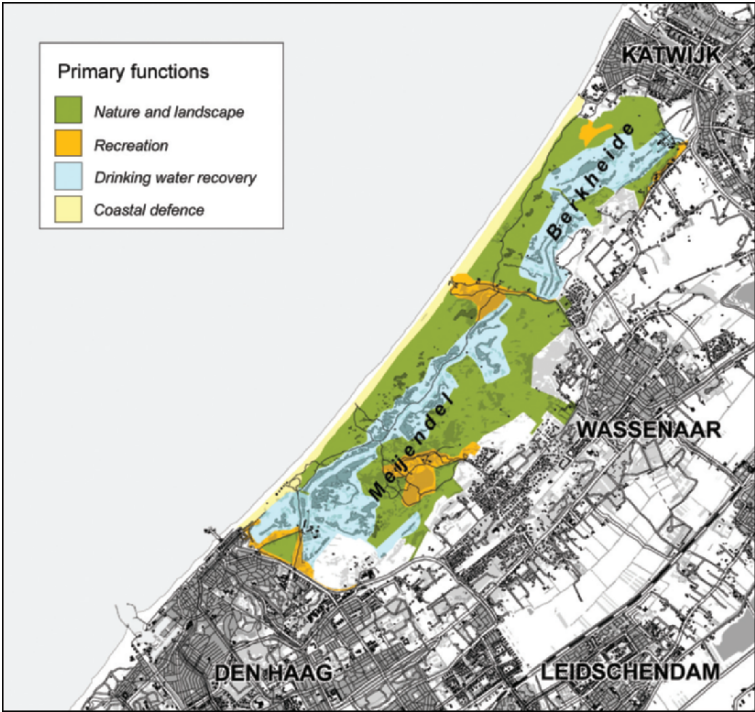
Zonation is an important tool in dealing with conflicting interests (Fig. 16.5). In some parts of the area, the production of drinking water has priority, while in others the priorities are coastal defence, nature conservation or recreation. Most important is that in the entire area, solutions are sought for in which particular functions take care of the interests of other functions. In the new management plan three main aims are formulated:

1. Better possibilities for recreation, e.g. better possibilities for people who enjoy nature.
2. The development of a so-called natural core area of some 700 acres within the dune area.
3. Optimisation of the production of drinking water in combination with nature conservation.

16.5.3 Recreation: Better Possibilities for People to Enjoy Nature

Since World War II, recreational use of the dunes has been planned. In the 1950s, the general idea was that large parts of Meijendel should be made attractive for recreation through the planting of trees and shrubs. Small cosy corners were created, where families could picnic or play. Meijendel should look more like a city park than a nature-reserve. An important development at the end of the 1950s was the increasing number of people coming to Meijendel by car: on sunny days, the central dune area (where day recreation was concentrated) was turned into an enormous car park (Schoep and van der Toorn 2001).

In the 1960s, the awareness grew that, together with the increase in recreation, the natural value of the area decreased. A better zonation for recreation was realised. Parking of cars within the area was limited. Cycle and walking paths were made. In the following years, the number of visitors was more or



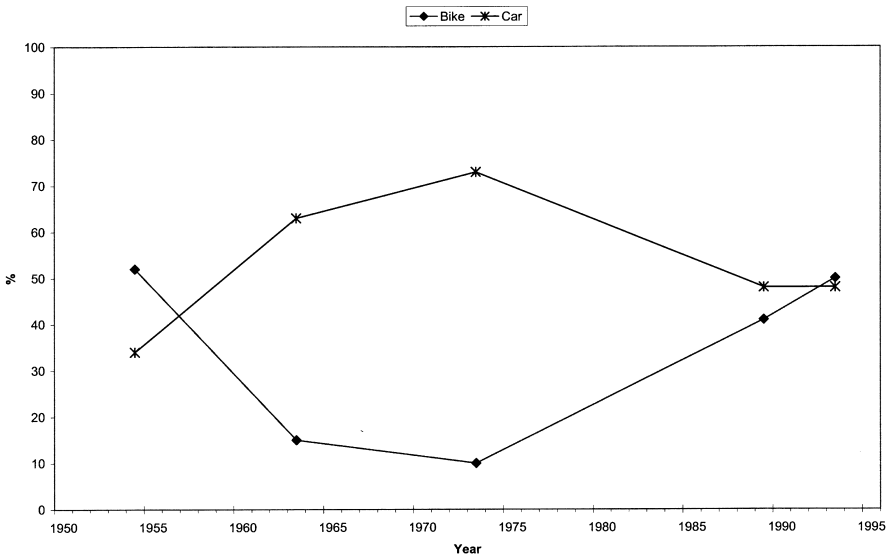


Fig. 16.6. People coming to Meijndel by car and by bike in 1954, 1963, 1974, 1990 and 2000

less stable, but the number of people who came to the dunes by bike increased (Fig. 16.6). The Dunewater Company did not stimulate recreational use but mainly dealt with nature conservation and production of drinking water. Recreation was “tolerated” and there was no clear vision on the way recreation should or could take place. Areas for the production of drinking water were not open to the public.

In the 1990s, this attitude changed. The company strived for more and better opportunities for people to enjoy nature. In the new management plan this is even one of the main goals. The general idea is that recreation concentrating on nature is far better to combine with the maintaining of natural values and the demands of the production of drinking water than was thought until now. Consequently, the public access to the area will increase and areas where the production of drinking water takes place are no longer strictly forbidden. In areas near the city, the infrastructure will improve, especially for walking, and more people will be allowed to enter and enjoy the dunes.

In 2000, a recreation study was carried out in Meijndel (Bakker 2001). Visitors gave their opinion on the management and on the recreational facilities.

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Fig. 16.5. (top) Zonation of functions in Meijndel

Fig. 16.7. (bottom) Artificial infiltration lakes for the production of drinking water in Meijndel

The main reason to visit the area appeared to be walking and enjoying nature. In general (80 %), visitors were very content with the area. Cyclists, dogs and bustle and noise were the most irritating items people mentioned. A surprising result was that people highly appreciate the most artificial type of landscape: the artificial dune lakes for the production of drinking water. An explanation may be that these lakes have a natural appearance, because existing dune valleys have been inundated.

16.5.4 Meijndel and the Production of Drinking Water

Fresh groundwater is scarce in the western part of The Netherlands. Beneath the dunes, a limited amount of fresh groundwater is present. This is well suited as a source of drinking water. In 1874, the extraction of drinking water started in Meijndel. A canal was dug in the dunes and collected superficial groundwater, which was delivered to The Hague. After decades, a lowering of the groundwater table by several metres occurred, and wet slacks dried out. After about 50 years, the amount of extracted water decreased so much that in places brackish water, unsuited for drinking water, was pumped up. A new technique had to be found. Water from the river Rhine was brought to the dunes via a pipeline and became the major source of “artificial” groundwater. Via artificial lakes this water “flows” to the groundwater and then into the extraction wells. Since 1976, pre-treated water from the river Meuse is used for this artificial recharge. The benefits of producing drinking water in this way include:

1. Artificial groundwater is free from pathogenic organisms.
2. Artificial groundwater has, unlike river water, a more or less constant quality and temperature.
3. Beneath the dunes, a huge fresh groundwater dome is present. In case of an interruption of the delivery of water from the river to the dunes, this water body serves as a reservoir of drinking water for months.

Nowadays, the amount of drinking water produced in Meijndel is 50 million m³/year (Fig. 16.7).

16.5.5 Development of a Natural Core Area

Because the production of drinking water takes place almost everywhere in Meijndel, hydrological circumstances are also artificial. Therefore, wet slacks and their vulnerable and rare biota are scarce. Another typical characteristic of dunes, the free mobility of sand, is restricted to a high degree, due to the planting of Marram grass for centuries.

As a consequence, man now steers two of the most important natural processes in dunes (cf. Fig. 16.1), the geomorphological and the hydrological

processes. The National Government emphasises the great importance of areas where circumstances are completely or almost completely “natural”. The creation of these “natural core areas” is an important item in the Ecological Main Framework of The Netherlands, to which all Dutch dunes belong. One of the objects in the new management plan is to create such an area in Meijendel . It will cover over 500 ha of the total of 2000.

To realise this, fairly big changes are needed in the way the production of drinking water now takes place. In parts of the area the production will have to stop. In other parts it will be intensified. Also, the way in which coastal defence, and more specifically the planting of Marram grass, take place, will have to change. Dunes, even foredunes directly at the seafront, should be allowed to be mobile again. During the last decade, nature conservationists showed to the public opinion and the public bodies that the systematic and complete fixation of dunes (which has been practice for over a century) prevents the free blowing of sand and damages the natural values, because rejuvenating of landscape and vegetation cannot take place. Nowadays, small-scale blowouts are tolerated and even stimulated at places. Figure 16.8 gives an idea of the amount of Marram grass planted since the 1950s. Because of a decrease in the amount of planted Marram grass, blowouts have increased, although only of small size and on a very small scale. There is no evidence that because of the stop of Marram planting, large-scale and uncontrolled blowouts develop. At present, the idea is that large-scale blowouts and parabolic dunes will only occur under specific climatic circumstances and perhaps even under specific human influence.

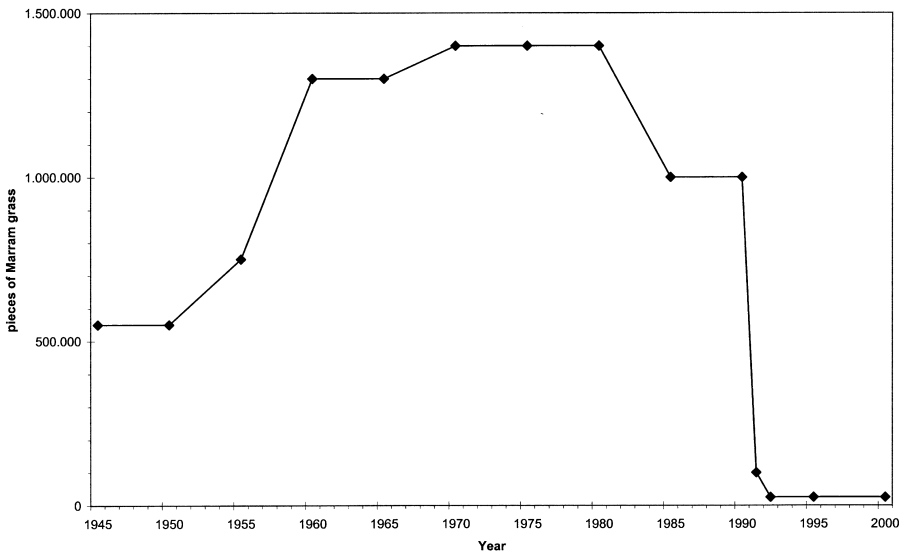


Fig. 16.8. Total amount of planted Marram grass for the years 1950–2000

Recreation in a nature core area will only be possible on foot. The costs of creating such an area are high. The changes in the way the production of drinking water is going to take place will cost some 10 million Euros, to mention just one aspect. Part of this amount will be paid by the drinking water company in the course of the regular investments.

To establish a nature core area, as mentioned above, it will be necessary to produce drinking water in a smaller area. To realise this, the drinking water company uses a concept called: "optimal artificial recharge". The area where drinking water is produced must be minimised, while the natural values of that area should increase at the same time. Artificial lakes and wells are constructed in such a way that natural values of the area are high. On the other hand, civil engineers will construct the lakes and wells in such a way that the amount of water produced per unit of space is higher than before.

16.5.6 Costs of Management

The total costs of management of Meijendel (including surveillance by some 15 wardens) amount to 3.2 million Euros per year. All this is paid by the company, although only a small part (0.65 million Euros) is a direct consequence of the production of drinking water: maintenance of infrastructure such as roads, wells and artificial lakes. The yearly income of the company is some 84 million Euros. All this money comes from the customers by selling drinking water to them. Compared to this amount, the costs of nature management (3.2 million Euros; only 4%) are remarkably small. Especially, when we keep in mind the benefits of the dunes for the production of drinking water as mentioned above.

Nature management and recreation management cost 960 Euros ha⁻¹ year⁻¹. As shown in Table 16.2, this is, compared to other Dutch organisations dealing with nature conservation, a large amount of money. To explain this big difference two facts are important:

1. Meijendel is situated in the middle of a very densely populated area, directly bordering large cities. Efforts to develop recreational areas are larger than at an average nature-reserve.
2. Meijendel is not a nature reserve *pur sang*. A huge amount of drinking water is also produced here. This has negative effects on the natural values of the dunes. Intensive management reduces these effects.

Table 16.2. Average costs of management of some Dutch nature reserves, according to annual figures of 1999. (Natuurmonumenten 2000; Staatsbosbeheer 2000). Natuurmonumenten is a more or less private organisation (comparable to the National Trust in England) and manages some 85,000 ha all over The Netherlands. The State Forestry Department is a former state organisation (comparable to English Nature as owner and manager of state land) and manages some 220,000 ha all over The Netherlands

	Average costs of management per ha/year (incl. costs of wardens)	
	All costs including drinking water, infrastructure (Euros)	Nature management infrastructure (Euros)
Dunewater Company	1200	960
Natuurmonumenten		460
State Forestry Department		390

16.5.7 Visitors Appraisal

We have explained that the management of Meijendel has changed considerably over the past 20 years and that still more changes will take place. The manager has asked the visitors about their opinion on all this. A majority (60–70%) feels these changes are positive. For some aspects, such as the regeneration of artificial lakes into natural dune habitats, and the closing of parking areas, the views are less positive.

In 1997, research was done under the “customers” of the Dunewater Company (NIPO 1997). Of course, the production and distribution of reliable drinking water were regarded as the main task of the company. Good nature management was regarded as one of the other important tasks. About 70% of the customers were willing to pay more for their drinking water, in order to make this good management possible. About 90% supported the fact that the costs of nature management are paid as a part of the drinking water fees. In general, it appears that visitors have a very positive view on the activities of the company, both on the production of drinking water and on the way the dunes are managed.

16.6 Dune Management in a Changing Society

In modern western European society, more and more people have free time and money to spend. A considerable amount of time is spent in the open air walking, cycling, jogging and enjoying nature. At densely populated coasts,

dunes meet an enormous need, as can be seen in the examples of Sefton Coast (England) and Meijndel (The Netherlands).

Dune managers aim at nature conservation and recreation (for nature). It is found that maintaining natural values of dunes is far better to combine with such forms of recreation and even with the demands of the production of drinking water than was thought until now. At the same time, an important economic use, such as the production of safe, healthy drinking water, is a strong legal form of protection, which is indispensable in densely populated areas.

More than 50 years of management have shown that negative effects of recreation and drinking water production can be minimised to a large degree so that the damage to the coastal ecosystem is relatively small. Active restoration of ecosystems (dune slacks and mobile sands) is also taking place. Management is done in adherence with the natural processes, rather than against them. This is best done in areas of at least several hundreds of hectares in size or more.

The overall costs are considerable, but for the time being, society is willing to bear these costs in turn for more access to the dunes and for more information on the “what” and “why” of the manager’s activities. The future will tell us more about the sustainability of these efforts and if all this leads to a real win-win situation, both for society and for nature.

References

- Arens SM, Jungerius PD, Meulen F van der (2001) Coastal dunes. In: Warren A, French JR (eds) *Habitat conservation: managing the physical environment*, Chap 9. Wiley, New York
- Atkins WS (2001) Quality of coastal towns: sustainable tourism on Merseyside; assessment of coastal visitor facilities. Unpublished report for Sefton Council (available on www.seftoncoast.org.uk)
- Bakker JG (2001) Recreatieonderzoek in duingebied Meijndel in Zuid Holland. Report, JG Bakker, Bennekom. 23 pp
- Bakker TWM, Stuyfzand PJ (1993) Nature conservation and extraction of drinking water in coastal dunes: the Meijndel area, In: Vos CC, Opdam P (eds) *Landscape ecology of a stressed environment*. Chapman & Hall, New York, pp 244–262
- Bakker TWM, Klijn JA, Zadelhoff FJ van (1979) Duinen en duinvalleien, een landschapsecologische studie van het Nederlandse duingebied. Pudoc, Wageningen
- Doing H (1988) *De landschapsoecologie van de Nederlandse kust*. Stichting Duinbehoud Leiden, 228 pp plus kaartbijlagen
- Edmondson SE, Velmans C (2001) Public perception of nature management on a sand dune system. In: Houston JA, Edmondson SE, Rooney PJ (eds) *Coastal dune management: shared experience of European conservation practice*. Liverpool University Press, Liverpool, pp 206–218
- Firn Crichton Roberts/University of Strathclyde (2000) An assessment of the socio-economic costs and benefits of integrated coastal zone management. Report to the Euro-

- pean Commission. Fim Crichton Roberts Ltd. and Graduate School of Environmental Studies, Univ Strathclyde
- Geelen LHWT (2001) Habitat restoration and public relations: a restoration project in the Amsterdam water supply dunes. In: Houston JA, Edmondson SE, Rooney PJ (eds) Coastal dune management: shared experience of European conservation practice. Liverpool University Press, Liverpool, pp 171–176
- Harkel MJ ten (1998) Nutrient pools and fluxes in dry coastal dune grasslands. PhD Thesis, Univ Amsterdam, 152 pp
- Houston JA, Jones CR (1987) The Sefton Coast management scheme: project and process. *Coastal Manager* 15(4)267–297
- Korf B (1997) Recreation in the North-Holland dune reserve. In: Drees JM (ed) Coastal dunes recreation and planning. EUCC, Leiden, pp 76–80
- LNV (1992) Structuurschema Groene ruimte. Het landelijk gebied de moeite waard. Dutch Ministry of Agriculture, Nature Conservation and Fisheries, The Hague
- Natuurmonumenten (2000) Samenwerken aan natuur. Jaarverslag 1999. Natuurmonumenten, 's Graveland, 91 pp
- NIPO (1997) Imago-onderzoek waterbedrijven. Rapport DZH. 25 pp incl appendices. NIPO, Amsterdam
- Schoep J, Toorn B van der (2001) Onderzoek naar waardering en recreatiewensen voor het Noordhollands Duinreservaat. Report for NV PWN
- Staatsbosbeheer (2000) Jaarverslag 1999. Staatsbosbeheer, Driebergen, 53 pp
- Vertegaal CTM (2000) Beheersplan Berkheide, Meijendel, Solleveld 2000–2009. Deel A en B. Duinwaterbedrijf Zuid-Holland, Voorburg/Katwijk; Staatsbosbeheer, Nieuwegein
- Wood P (1985) Dune restoration at Formby Point: report of environmental improvement works carried out by Merseyside County Council 1977–1985. Report, Merseyside County Council, Liverpool
- Zwart F (2001) Dune management and communication with local inhabitants. In: Houston JA, Edmondson SE, Rooney PJ (eds) Coastal dune management: shared experience of European conservation practice. Liverpool University Press, Liverpool, pp 219–222