Climate Change and Armed Conflict

Hot and Cold Wars

James R. Lee

Routledge Studies in Peace and Conflict Resolution

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Owing to the accumulation of greenhouse gases in the atmosphere, current trends in climate change will not appreciably alter over the next half century even if drastic action is taken now. Changes in climate will produce unique types and modes of conflict, redefine the value of important resources, and create new challenges to maintaining social order and stability. This book examines the consequences of climate change, and argues that it has and will produce two types of different types of conflict: "Cold Wars" and "Hot Wars". *Cold Wars* will occur in northern and southern latitudes as warming draws countries into possible conflict due to expanding interests in exploiting new resources and territories (inter-state conflict). *Hot Wars* will break out around the Equator as warming expands and intensifies dry areas, increasing competition for scarce resources (intra-state conflict). Conflict is not inevitable, but it will also be a consequence of how states, international institutions and people react to changes in climate. Climate change and conflict have always shaped human experiences. This book lays out the parameters of the relationship, shows its history, and forecasts its trends, offering future conditions and opportunities for changing the historical path we are on.

This book will be of great interest for students of climate change and environmental security, peace and conflict studies, and IR/security studies in general.

James R. Lee is a Professor in the School of International Service, American University, Washington, DC, and Associate Director of American University's Center for Teaching Excellence. He is author of several books on international relations, including, most recently, *Exploring the Gaps: Vital Links Between Trade, Environment and Culture* (2000).

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For Linda

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Acknowledgments

I appreciate the help from many individuals who directly worked on this book. Many more people, indirectly, had a hand in the enterprise.

In 1997 I started a project called the *Inventory of Conflict and Environment*, or ICE. ICE was an attempt to start a more formalized discussion on conflict and environment issues. This area lacked a coherent center, and isolated case studies were not adding up to a field of study. ICE meant to fill part of this gap with a series of categorical cases. The ICE website is at www.american.edu/ted/ice/ice.htm.

I developed a graduate course for the School of International Service at American University that combined digital skills and emerging global issues. Students in the course researched the topic of conflict and environment, and built case studies following a formal coding framework. The case studies covered a wide variety of intersections between the two areas, including climate change's relation to conflict. This community served as a basis for thinking about critical issues, and this book is one output.

The idea for this book was mine, but bringing it to life would not have been possible without particular assistance. I appreciate the feedback on the manuscript I got from David Singer and Ashok Swain, as well as from anonymous reviewers. In editing and reading through the work, a time-consuming task, Marysa Szymkowiak, Beth Scudder, Alex Kizer, and Heath Henderson were all generous and insightful, helping out with the manuscript. I am grateful to Matt Marhefka, Valentina Assenova, and Justin Lini for preparation of the maps. Molly Doran, Nick Kong, and Munnaye Makonnen helped me with research. My heartfelt thanks to all.

1 The Climate Change War

The Cold War ended in the early 1990s. As the Berlin Wall fell and the Soviet Union disintegrated, climate researchers saw signs of a planet warming at an unprecedented rate. These suspicions gradually accumulated and hardened over time as evidence became more clear-cut. In 2007, the Intergovernmental Panel on Climate Change (IPCC), a team of scientists from around the world, provided the most definitive confirmation of these initial indications. The Earth was rapidly heating up, and human activity probably the major cause.

The Cold War was a 45-year global struggle. It was a slow-moving war between two great Powers, with conflict often indirect and fought out through proxies. Each side allocated enormous resources not only to gain military power, but also to obtain advantages in technology, culture, and science. It is fortunate that the Cold War stayed cold and nuclear catastrophe was avoided.

Just as in the Cold War, the threat from climate change has the potential for dire consequences – namely, armed conflict. What does the end of the Cold War have to do with climate change? John Ashton, UK Climate Change Representative, tied the two issues together:

> There is every reason to believe that as the twenty-first century unfolds, the security story will be bound together with climate change. … The last time the world faced a challenge this complex was during the Cold War. Yet the stakes this time are even higher, because the enemy now is ourselves, the choices we make.
>
> (Vogel 2007)

Alarm at the warming trend is shared by climatologists and others. Defense agencies see the link between climate change and conflict. A 2007 report by retired "senior admirals and generals" laid out a casual chain from climate instability to political instability. The latter opens the door for conflict and military involvement, and produces feedback that is a "threat multiplier" (CAN 2007:1). The seeds of conflict will lie in massive migrations, border tensions, and disputes over essential resources.

At the urging of the United Kingdom, the United Nations Security Council debated the climate change and conflict link in April 2007. The argument was

that climate change would exacerbate traditional and long-standing security issues. Six areas of linkage were identified: border disputes, migration, energy supplies, resource shortages, societal stress, and humanitarian crises.

The Cold War lasted nearly half a century. The Climate Change War will be a global period of instability that will last centuries. The period of greatest instability will be the twenty-first century. As in the Cold War, it will be a long struggle over core issues regarding rights and responsibilities in society. Throughout this period, there will be a new Cold War, and an existing Hot War that will intensify. Changes in climate will produce unique types and modes of conflict, redefine the value of important resources, and create new challenges to maintaining social order and stability.

The scientific community has reached broad consensus on the existence of climate change. Research on the relation to social instability and possible violent conflict has lagged far behind. Jon Barnett believes the linkages are largely indirect in nature:

> As recent developments in environmental security research suggest, the concern with direct international conflict is misplaced, and the security impacts of environmental change will take less direct and more multifarious routes. Surprisingly, despite climate change being the most prominent and best-studied of the suite of environmental change problems, it has thus far received little systematic analysis as a security issue.
>
> (Barnet 2001: 2)

The political context of climate change and conflict can be visualized on two political dimensions that intersect. One dimension for conceptualization is on the outlooks themselves. Are the forecasts faithfully considering a full range of options, and what are the implications of those not considered? At some point in forecasting, science gives way to beliefs on the course of history and the essence of human nature. How do optimists and pessimists view these forecasts?

The second conceptual area concerns the approach policy makers and people should take in responding to the climate change challenge. Some will argue that the state, acting in its national interest, is the best mechanism for dealing with an issue that will vary geographically in impact. Others believe that global norms and mechanisms need to be the basis for cooperation and progress. This dichotomy of vision creates realist and idealist camps.

Intensification of the climate change and conflict nexus has been unfolding for several millennia. The interaction between climate change and conflict has become much more rapid, types of conflict have grown, and territorial impacts have expanded. This book traces the history of the climate change and conflict relationship through the use of case studies, and examines how it will impact power and livelihood in the future.

The major theme is that the impacts of climate change will differ by geography. As a result, it will produce varied types of conflicts in various parts of the world. Ragnhild Nordas and Nils Petter Gleditsch believe that climate change

"effects would vary considerably both geographically and by sector" (Nordas and Gleditsch 2007: 634). This range of impacts is important to realizing the meaning of climate change, in that it will not be a uniform experience.

There is momentum, to some degree, of climate change because of historic emissions into the atmosphere. The rate of emissions will probably reach a maximum in the first half of the century before starting to level off in the century's second half. Climate change will differ by time as well as place.

Climate change will do more than just raise the temperature

The path from climate change to conflict will not be a direct one. For that matter, most roads to conflict are indirect and lie in structural and behavioral patterns that make the path easier to travel. There are three structural pathways from climate change to armed conflict: sustained trends, intervening variables, and the need for conflict triggers.

First, conflict only emerges after a sustained period of divergent climate patterns. People can survive aberrant, short-term climate change through exploitation of saved resources, but this strategy has temporal limits. The issue is not one of surviving a particularly fierce rain or a harsh winter, but the accumulation of many rain events and many harsh winters. Human society is capable of enduring events and seasons, but as these events and seasons accumulate over many years or even decades, accumulated wealth begins to draw down and eventually dissipates. Without renewal of society's wealth, human health and well-being decline, and over time the society itself may collapse.

Societies with few savings will be more vulnerable to adverse impacts from climate change. Societies that already heavily exploit their environment will be closer to possible conflict than those that do not. Brian Fagan offers a context for climate-induced conflict in places where people already live on the edge of survival:

> In a telling analysis on nineteenth century droughts, the historian Mike Davis has estimated, conservatively, that at least 20 to 30 million people, and probably many more, most of them tropical farmers, perished from the consequences of harsh droughts caused by El Ninos and monsoon failures during the nineteenth century, more people than in virtually all the wars of the century.
>
> (Fagan 2008: 235)

Second, climate change alone will not cause conflict, but along with other factors, will contribute to it and shape it. With sustained climate change, social wealth will decline and the social fabric will weaken with each passing year, becoming more vulnerable to future challenges. It is not to say that societies are incapable of responding to changes and adapting to create conditions for survival. Adaptation is not a linear survival strategy. Rather, adaptation is part of a complex network of social interactions.

The complex of human experiences embeds adaptation within a whole range of social experiences that contain a wide variety of intervening variables. Adaptation becomes part of the political system, religious customs and rituals, patterns of demography and economic subsistence, types of social structures, locations of settlements, and modes of habitation, to name a few. Jon Barnett describes these multiple impacts:

> It has not been shown that environmental factors are the only, or even important factors leading to conflict. Other factors such as poverty and inequities between groups, the availability of weapons, ethnic tension, external indebtedness, institutional resilience, state legitimacy and its capacity and willingness to intervene, seem to matter as much if not more than environmental change per se.
>
> (Barnet 2001: 6)

The complex network of intervening variables has an enormous impact on the transmission of climate change to conflict. In human history, climate change has been a factor that fostered important breakthroughs in technology. It has also been a reason for the collapse of civilizations in orgies of killing and widespread savagery. Ability to adapt may make conflict less likely, allow countries to suffer fewer adverse consequences, or alternatively may serve to avoid conflict altogether. On the other hand, a mistaken or errant adaption may actually hasten and exacerbate conflict.

It is not the point here to suggest or claim that there is a type of environmental determinism at work in the climate change and conflict relationship. The idea of environmental determinism was dispelled long ago, and there is no intention of giving it new life here. But within the mix of these intervening variables, climate change is a strong and potent factor in determining the destiny of societies, and may in some cases serve as an essential piece to explaining conflict.

Some argue that assertions of climate change as a threat to human lives are a simple extrapolation of Malthusian treatises. They are not. The two frameworks have a considerable difference in dynamics. Malthus saw conflict between the exponential growth patterns in human population juxtaposed against the linear advances in agricultural production. In climate change models, population growth is assumed to eventually level off and perhaps even decline. The former is a static model, the latter dynamic.

Third, climate change can create structural conditions for conflict, but a trigger is required to set off strife. Triggers have historically included assassinations, extreme natural events, or random acts of group violence. As climate-induced stresses are sustained over time, and as they mix with intervening variables to create a social construct, there still needs to be a spark that completes the link to conflict and sets off the fire.

Rwanda in the 1990s is one example of a spark that set off a brewing conflict. The country had a dense population of livelihood farmers. During a generally drier climate period, coupled with extensive land-use change, there was a sus-

tained period of deterioration in the carrying capacity (the resources needed by people compared to those available).

Against this backdrop was a colonial legacy and a society divided along ethnic lines, between Hutus and Tutsis. Rapidly increasing populations needed fertile land, and there was little available. In this structural milieu, many events could have set off the conflict. The Rwandan genocide was sparked by the assassination of the country's President, whose plane was shot down under mysterious circumstances.

Given the fulfillment of these three conditions (structural incongruity over time, intervening variables, and the existence of triggers), along with some delays in timing, conflict emerges with changes in climate. The manner in which conflict occurs is, however, a different matter. It is possible to imagine three differing behaviors that can lead from climate change to conflict: scarcity, abundance, and issues of sovereignty.

First, climate change can lead to conflict due to scarcity. Suppose drying conditions and melting glaciers lead to loss of arable land, imposing extreme stress on vegetation and animal life, and causing a decline of fresh-water resources. Competition and conflict will increase as these resources become increasingly scarce. This will be especially true as demand grows and exceeds a region's carrying capacity.

Scarcity can also be broken down into four differing types. First, physical scarcity usually pertains to limits on the availability of finite resources. Second, geopolitical scarcity involves the distribution of resources between countries, both finite and renewable. Third, socio-economic scarcity describes distribution differences within countries. Finally, environmental security refers to the availability of renewable resources, like rivers and forests (Rees 1991).

Global warming can cause displacement of people. In extreme examples, a desiccated ecosystem may cause entire populations to evacuate an area. Displacement, however, can be either a prolonged or a sudden event.

The growth of the Sahara Desert was a prolonged trend over many millennia. Drying and desert conditions thousands of years ago slowly nudged people out of the inland region of northern Africa and into great river valleys like the Nile and the Niger. The current degree of climate change will again threaten the ecological and social stability of these great river systems and the people who live there. Incremental but prolonged rises in sea levels will also slowly uproot hundreds of millions of people.

Examples of sudden displacement are the 2005 hurricanes "Katrina" and "Rita" in the southern United States. Together, the two events forced millions of people to suddenly leave Louisiana, Mississippi, and Texas, with several thousand dead. Some researchers believe that climate change will lead to more severe extreme weather events, and cite Katrina as an example of things to come. Consider these hurricanes in a different geographic context. In 1991, a cyclone in Bangladesh displaced two million people and killed 138,000.

Whether rapidly or slowly, persons displaced by sudden events will eventually stop and settle down. For most of human history, a reservoir of unclaimed

lands served as a "pressure valve" that tamped down conflict. Today, this reservoir no longer exists except in the very least hospitable parts of the planet. Areas now largely uninhabitable because of cold temperatures may eventually become habitable due to warming. Displaced persons will move into these places, provoking conflict. In the first millennium, for example, invading Mongols pushed Germanic tribes further west in Europe, where their conflict with the Roman Empire was inevitable. Rapid climate change exacerbates migration trends.

Migration is, however, a complicated phenomenon. There are internal and external dynamics, as well as differences between patterns in developing and developed countries. Jon Barnet notes that "Most migration is not international but rather occurs within individual countries, and most international migration occurs between developing countries" (Barnet 2001: 9). Today, most migration is cyclical. In the future, it is more likely to be a permanent condition. Like conflict, causes for migration are complex: "People rarely migrate for environmental reasons alone. A range of factors, including economic opportunity, operate in unison, and these are in flux as a consequence of the economic and cultural effects of globalization" (Barnet 2001: 9).

Migration of displaced persons on a short-term basis may not seem significant. However, as migrants accumulate over an extremely long period, perhaps half a century, there will be substantial demographic impact. Shifting demographic patterns due to climate change will eventually force realignments in domestic, regional, and global power relations.

Climate change may cause resources to be more or less available, thereby altering relative wealth of individuals and countries. It is during these periods of change in relative power, driven in part by climate change, that conflict is often more likely. Scarcity, therefore, is not an absolute calculus, but a relative one.

Second, climate change may also lead to conflict due to an increase in abundance. Again, this will need to be a relative rather than an absolute measure. Suppose a resource becomes more available because of climate change. For example, the warming of extremely cold areas may allow resource extraction that was previously non-economic. Oil and gas fields in northern Canada, Alaska, and Siberia are likely to become accessible with warming, and thus economically viable. Both energy and mineral resources underlie Antarctica. Competition over newly available resources may lead to conflict, especially when these resources turn up in places where boundaries are not clearly set. New arable lands will emerge which will quickly become sought-after property.

Abundance will also impact migration, in this instance acting as a "pull" factor. New economic resources will create new jobs. The availability of fertile land for people whose only skill is farming may serve as an enormous enticement.

The idea is that the relative importance of resources accelerates and deepens with climate change. A change of a few degrees of temperature can accentuate the difference between a hospitable and an inhospitable climate. Likewise, a small relative change in resource volatility may accumulate over time and subsequently produce much higher levels of conflict.

Third, changing climate will invite national interest and issues of sovereignty. The Northwest Passage in Canada is becoming an ice-free corridor from Europe to Asia during summer months. Canada claims some portions as sovereign waters, while the United States argues that they are international waters. (The differences reflect average versus maximum distances between points of land.) The more the sea levels rise due to melting of glaciers and ice caps, the more international law (under the UN Law of the Sea or UNLOS Treaty) favors the American position. Canada also proposes extending the reach of its Exclusive Economic Zone (EEZ) from 200 to 500 miles.

In polar areas now covered by thick ice sheets, human habitation may become possible. Warming may expose land areas on the continent or on offshore islands. The value of such small islands would not be in the small rocks that might arise a few feet above the ocean. Rather, the value would be in the EEZ around it. There are also disputes over continental shelves. Denmark claims large parts of the North Pole because it is allegedly on the same continental shelf as Greenland (BBC News 2004).

Rising seas will slowly dislocate people. Remote islands, especially in the Pacific and Indian Oceans, are at risk. These islands include Tuvalu, Kiribati, the Marshall Islands, Tonga, the Maldives, and many others in the Alliance of Small Island States.

What are the sovereign rights of countries and their people for homes that are under water? Many questions would arise over the legal status of the people and government in such an eventuality. Do they lose their sovereignty if their territory disappears? Governments in exile have maintained sovereign rights in the past without a physical presence. After Germany conquered France and Poland in World War II, they maintained governments in exile. This situation was limited to a few years. Would the same principle apply to islands submerged by a warming climate?

With this brief construction of the behavioral mechanics and structural dimensions, it is now possible to discuss how climate change and conflict will be regionalized into Hot and Cold Wars. These wars will be spread out over swathes of the planet and create two global "tension belts."

The expanding Equatorial Tension Belt and the emerging Polar Tension Belt

Two geopolitical features, tension belts, resulting from climate change, will influence conflict patterns in the twenty-first century. First, there will be an intensification and expansion of an existing area of climate change and conflict, the Equatorial Tension Belt – a broad band centered on the planet's equator. The Equatorial Tension Belt will grow southward into Africa and extend deep into central Asia. Climate change will exacerbate and expand the existing Equatorial Tension Belt, which largely includes developing countries.

Second, a new Tension Belt, roughly located around the Polar Circles, will arise. In the short term, this will focus more on the northern hemisphere. Later in

the century, a southern focus will also be added. There will be a rush to claim and develop these areas where disputes have been frozen with the cold climate. The new Tension Belt, unlike the current one, will especially affect developed countries.

Intensification and enlargement of the Equatorial Tension Belt

The Equatorial Tension Belt (or ETB) girdles the planet roughly between the Tropics of Cancer and Capricorn, across the Equator. Climate patterns inherent to tropical and desert areas mark this region, places of both excess and limited water, but cold temperatures are absent for the most part. A key feature of this zone is the role of climate change in shaping human history, and part of the story includes conflict.

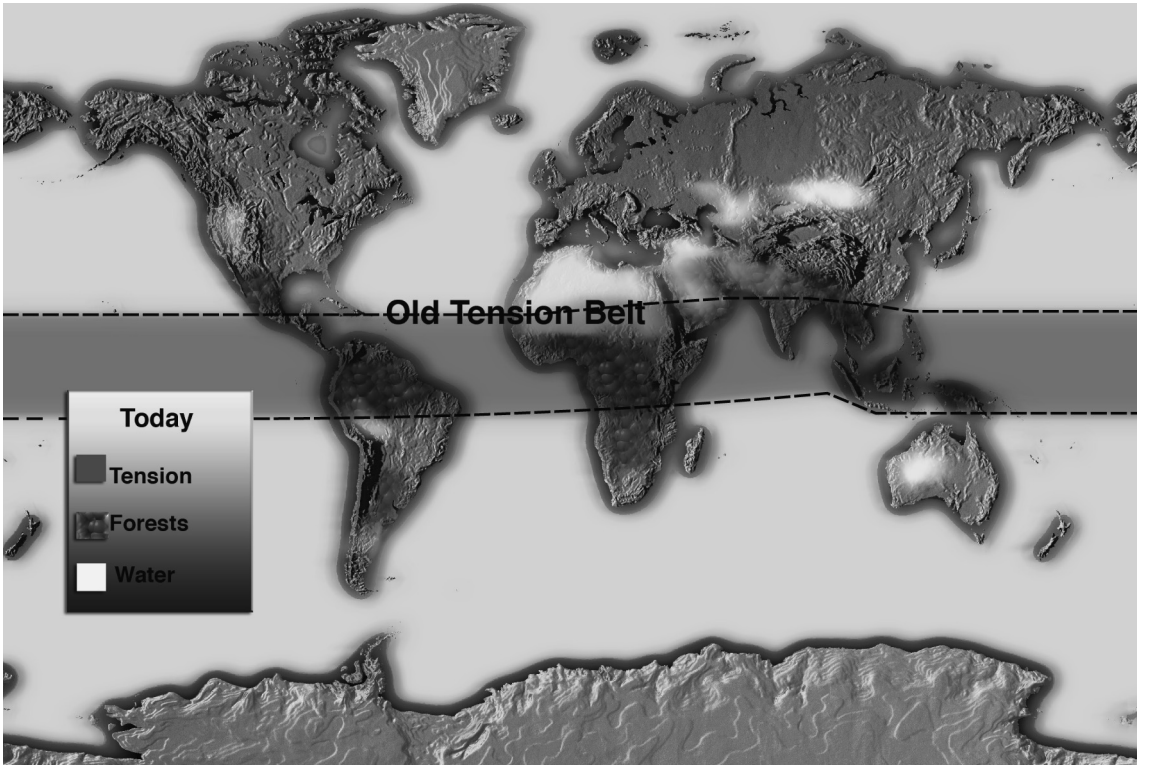
In the Western Hemisphere, the Equatorial Tension Belt includes the southern portion of North America (Mexico and Central America) and the northern portion of South America. Rates of deforestation and forest-burning have long been factors in the ecology. Central America suffered several severe hurricanes over the last decade, and could see a further increase in intense weather events. The combination of these factors may create social instability and serve as a breeding ground for civil conflict in this area, leading to higher levels of emigration. The Equatorial Tension Belt melds into South America, where it straddles the northern and western sides of the continent, and is also characterized by large-scale deforestation (see Map 1.1).

In Africa, the Equatorial Tension Belt stretches from North Africa, starting in Morocco and heading east towards Somalia. From there, the belt jumps the Red Sea into the Middle East and Mesopotamia, where it connects with Central Asia, including Turkey, Iran, Kazakhstan, and western portions of South Asia. This arid zone in turn links to East Asia north of the Tibetan Highlands, in Xinjiang and the Gobi Desert. Water is and will be a key source of conflict, and dry areas are also indicated in the map.

The Equatorial Tension Belt has long been driven by climate change, and five intervening variables explain its existence. First, this area is occupied by some of the oldest civilizations on the planet. Older societies accumulate environmental impact. With greater environmental impact, tension accumulates, because alterations to a habitat take time. Nile River water was for a long time sufficient in providing for Egypt's water needs and replenishing fields with new sediments. Given increased Egyptian needs and greater upriver takings, this is no longer the case.

A second explanation for the Equatorial Tension Belt is that population levels and demands have reached a point where the environmental resources are under extreme stress. The belt includes India, China, Indonesia, Brazil, and Nigeria – some of the world's most populous countries.

A third reason is the habitats themselves. The Equatorial Tension Belt consists of tropical and desert habitats. The tropical regions have been exploited for timber and year-round production of agriculture. The desert regions that are



Map 1.1 The Equatorial Tension Belt.

mostly river-centered have become too populous, requiring extensive irrigation to support populations. The result is human-induced climate change and widespread habitat alterations.

A fourth reason is historical legacy. Colonialism and other types of domination left this part of the world reliant on commodities and natural resources as a means of national strategy and survival. At the same time, the artificial boundaries that European Powers imposed on these countries have themselves been sources of conflict. The lines drawn on maps often divided peoples and environments, thus leading to conflict.

The fifth reason relates to resource distribution. Michael Klare points to resources in these regions as one key to conflict. He imagines the world's resources as distributed in belt-like bands:

> To better appreciate the nature of this emerging landscape, imagine a map of the world on which the major deposits of vital materials are represented by different colors: black for oil and coal, blue for water, white for diamonds and gems, green for timber, and red for copper, iron and other key materials … Although every area of the world would possess fragments of color, the greatest concentrations of hues on such a map would be found in a wide a band of territory straddling the equator.
>
> (Klare 2001: 214–15)

Climate change will tend to make the existing Equatorial Tension Belt hotter and drier, and these twin conditions are likely to lead to greater conflict. Forecasts suggest that problems will intensify as demographic and socio-economic factors add further pressures on resources. The areas in the Equatorial Tension Belt will tend to expand under anthropogenic pressures, and have a greater geographic coverage in adjacent areas. These changes will have differing implications for differing areas in the zone.

In both East and West Africa, the twin problems of deforestation and water shortages will appear. Water availability will become immensely more important due to growing populations, and in some areas the situation will become critical with drying. Growing scarcity will threaten both agricultural production and human health. Increasing demands for resources, especially minerals and oil, will invite conflict.

The water situation in the Middle East, on both the African and Asian sides, will go from critical to intense in the future. Oil will continue to be a key driver of the global economy, and its value will increase as demand surpasses supply. The struggle to gain access to and control of oil and water resources in this region will remain the drivers of conflict.

In South and East Asia, deforestation and access to resources will also drive conflict. These conflicts will be a combination of internal and external factors. The internal factor is due to the patchwork of ethnicities in many countries. Conflicts will also be external, since these ethnic populations live in areas that span national borders. There are also island disputes involving sovereignty claims –

for example, the Spratly Islands are claimed by China, Malaysia, Taiwan, Vietnam, and the Philippines.

The emerging Polar Tension Belt

Land retains heat more efficiently than water. Because most of the world's land mass is in the Northern Hemisphere, it will tend to heat up more from climate change. It is reasonable to suggest that the areas with the most climate change will have the potential for the most dramatic swings in conflict likelihood. The Polar Tension Belt (PTB) is a swathe that surrounds both the northern and southern parts of the planet around the Polar or Arctic Circles. There are two PTBs, the Arctic Tension Belt in the north and the Antarctic Tension Belt in the south. More change in climate will occur in the Arctic Tension Belt, at least initially.

Northern North America will see population increases as the environment becomes more habitable. Migrants may consider this an ideal place for resettlement, given economic opportunity, as they flee from the Equatorial Tension Belt. These transitions will not always be harmonious.

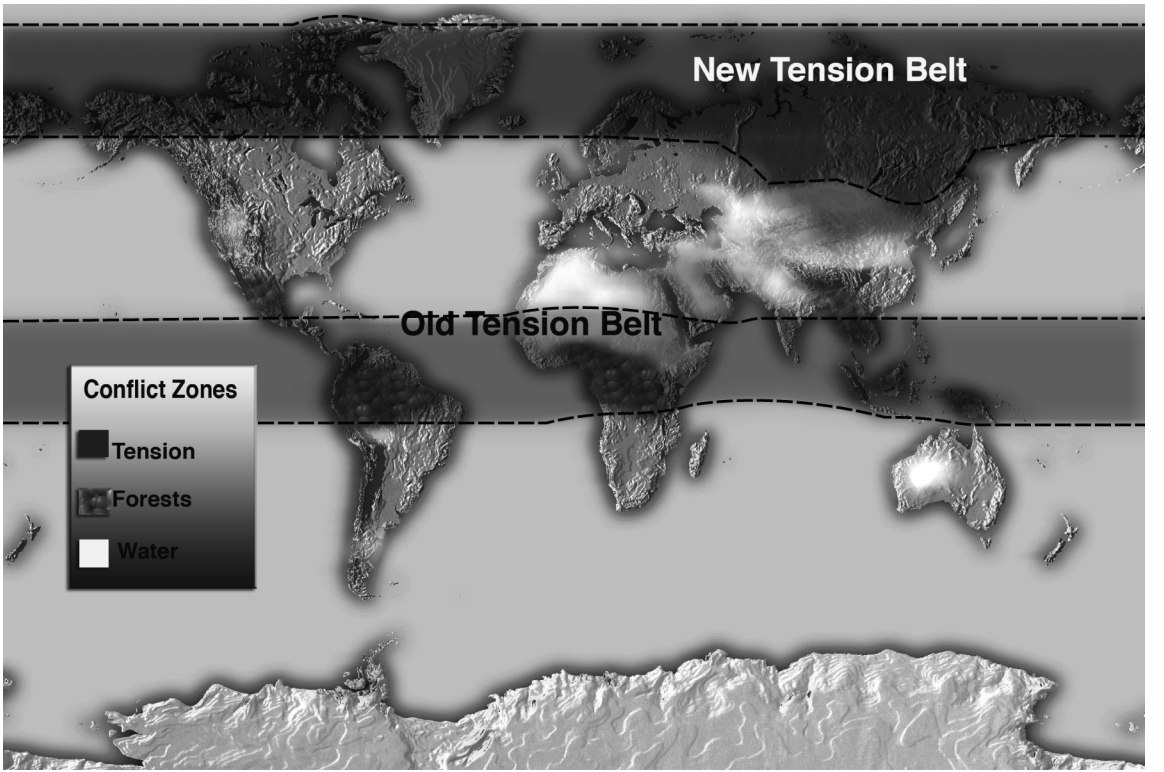
Warming climates will also draw migrants to Eurasia, where gradual warming will release frozen water resources. These same favorable conditions will affect Nordic countries such as Denmark (Greenland), Iceland, Norway, Sweden, and Finland. Whereas the Equatorial Tension Belt will suffer from too little water, the Polar Tension Belt will suffer from too much. Not only will gradual warming release frozen water resources; increases in precipitation are also expected in this new tension belt. In Map 1.2, the old and new tension belts are shown as bands, along with areas of expected deforestation and water scarcity that may be conflict conduits between the two tension belts.

What will the demography of these extreme northern areas look like in the twenty-first century? In Canada and the United States (Alaska), countries with somewhat open immigration policies, the influx will likely be of legal migrants, given the remote locations. Economic growth will act as a tremendous pull factor. Where will migrants come from? The south of Mexico and Central America fall within the Equatorial Tension Belt. Due to increasing climate intensification and fast-growing populations, the pressures are sure to increase on these peoples to migrate from tropical to colder climates.

Climate change will reach further down the Eurasian continent compared to North America, because of the extent of its landmass. This means that climate change in Eurasia will push southward into Central Asia, Mongolia, Siberia, Xinjiang, Tibet, and Northern China.

Siberia will see a change in the ability and economy of human survival. The result will be the influx of millions of people. Perhaps the transition will be comparable to what is happening in the Amazon, where migration is a chance to claim economic opportunity. A major driver in this case is flight from deteriorating and overcrowded urban conditions.

Climate impact will especially affect Russia and, more generally, the areas previously governed by the Soviet Union. Warming of Siberia may open vast



Map 1.2 The Equatorial and Polar Tension Belts.

new lands for colonization and allow greater access to resources (fossil fuels and minerals). New migrants from other parts of Russia will move to Siberia, but so too will legal and illegal migrants from other countries. This may result in some amount of domestic conflict. Ambiguous border claims also abound, and conflict in Central Asia may spill over into Russia. China once owned large parts of Eastern Russia in and around Siberia, and has not renounced all claims.

The focus of interest on Antarctica will be delayed, but will also reflect events in the northern Tension Belt. It may well begin in the Antarctic Peninsula, on the part of the continent that extends out beyond the Antarctic Circle towards South America. This part of the continent will see a substantial rise in temperature. Many countries maintain research stations there, and it marks the closest point in Antarctica to any of the world's major land bodies. On a map, the Antarctic Peninsula appears as an extension of South America and the Andes Mountain range. Chile and Argentina both claim this adjoining territory, which in turn contradicts claims of the United Kingdom.

Antarctica is colder, drier, higher, and windier than any other continent. The current part-time population per year is about 1,000. Even knowing about Antarctica is relatively recent in history. The first sighting of Antarctica did not occur until 1820, when a Russian ship spotted it. In theory, there are citizens of Antarctica: two children have been born there, one from Argentina in 1978, and a second from Chile in 1986.

The extents of the two tension belts differ in both scope and type. The Equatorial Tension Belt is much larger. At the Equator, the circumference around the world is 24,902 miles. At the Polar Circle (60° north), the distance required to go around the world is much smaller (10,975 miles).

There are more than 40 countries in the Equatorial Tension Belt. The number of countries in the Polar Tension Belt is considerably smaller – less than ten. (This does not count territory claims in Antarctica.) This is not only a function of the smaller area, but also because some of the largest countries are in the northern hemisphere (the United States, Denmark with Greenland, Russia, and Canada). Other countries that have territory within the Arctic Circle include Norway, Sweden, Finland, and Iceland (with less than a square kilometer within the Arctic Circle).

The Polar Tension Belt will produce conflict in the developed part of the world. The Equatorial Tension Belt has a decidedly developing-country focus. The focus of security organizations, especially NATO, may switch from external problems to those more of an internal security nature due to climate change and related habitat issues. NATO does recognize the role of climate change in possibly fostering conflict that will have direct or indirect consequence.

Hot Wars and Cold Wars

Climate change leads to two different conflict types: Hot Wars and Cold Wars. Hot Wars, located around the Equator, have a long historic precedence. Climate change has led to and will exacerbate Hot Wars. Cold Wars, located near the poles, especially in the north, have been relatively rare. Climate change will mark the ascendance of Cold Wars. The Cold and Hot Wars can be conceptualized and compared on eight dimensions (see Table 1.1).

The terms "hot" and "cold" with respect to war refer to differing types of response to climate change that may result in conflict. The two zones characterize the basic types of seasonality that occur in the world, one based on wet and dry seasons (Hot War lands) and the other based on warm and cool seasons (Cold War lands). By altering seasonality patterns, climate change will upset prevailing patterns of subsistence. In some instances, this means humans will no longer be able to survive. In other instances, the type of technology and economy must adapt to the new conditions.

The role of climate change in conflict can be significant or contributory, meaning that as a causal factor it can be large or small in consequence. Climate change and other factors produce inter-twined, dynamic outcomes. The role of climate change, though, can be one of an instigator of causal trends that have multiple influences.

A Hot War is conflict where climatic heating leads to loss of water and desertification of habitats, driven especially by changes in precipitation patterns. While some climate change may lead to increases in precipitation, a Hot War occurs when precipitation declines. There is, of course, feedback: a warming climate will lead to greater evaporation of water and will compound problems of aridity. A Hot War is prone to occur in the Equatorial Tension Belt, and there are three types of such wars, caused by changes in habitat, movement of populations, and adaptations to new types of economic systems.

The first type of possible Hot War is the "new desert", where a semi-arid area transforms into an arid area and the ability to support human populations substantially declines. This might be the case where, for example, fringe areas of the Sahel become even drier and lose what little vegetation exists. This Sahel area would be functionally "annexed" into the Sahara Desert. Nomads who live a

Table 1.1 Climate change and armed conflict dimensions

Dimension	*Hot War*	*Cold War*
Climate driver	Precipitation	Temperature
Conflict type	Contraction	Expansion
Conflict duration	Long-term	Short-term
Population migration	Push	Pull
Level of development	Low	High
Driver of conflict	Desperation	Opportunity
Resources	General	Specific
Adaptability	Low	High

meager and marginal existence in Sahel would be forced to move to areas that match their style of subsistence and economy. Other nomads, however, might already be living in these places, or might also be fleeing from other areas of desert annexation. This sets up a possible conflict situation.

The second type of hot war is the "new transition zone", where a temperate or tropical region loses precipitation and becomes semi-arid or Sahel-like. In this circumstance, the size of the population that can be supported substantially decreases. A significant part of the population will need to migrate to other places, and economic systems may be substantially impacted. This might occur due to changes in water availability, through both loss of precipitation and greater evaporation. This is possible in areas of Kurdistan in Iraq (for example), where the region is expected to dry and become more like the marginal areas of western Iraq.

The third type of Hot War is when a tropical region dries or deforests and the region transitions from a tropical forest to tropical grassland. Tropical forests are known to create some of their own precipitation patterns, and deforestation would probably combine climate and human pressures. The change would require adjustment of economic and livelihood systems over a long period. Ancient Clovis peoples in North America who depended on the woolly mammoth for survival needed to alter their subsistence patterns and technologies once the creatures died out. Levels of population may not decline – they may actually increase – but there will need to be a transition from one economic type to another. This type of Hot War is already occurring in large parts of Amazonia.

The Hot War conflict is usually internal to the state. The Equatorial Tension Belt has generally weaker state governments, and forced movements of people will generally fall along ethnic or tribal lines. The duration of the conflict in a Hot War occurs over the long term, with "push" migration factors. The areas usually have lower levels of development, and resource impacts are generalized into concerns of water, arable land, and forest resources. Conflict drivers are livelihood based, meaning they are often issues of human and not state security, though at some point the two meet. "If climate change results in reduced rainfall and access to the natural capital that sustains livelihoods, poverty will become more widespread, leading to increased grievances and better recruitment opportunities for rebel movements" (Nordas and Gleditsch 2007: 631).

A Cold War involves a different process, that of temperature changes. The Cold War also relates to changing patterns of precipitation. In this instance it is not more or less, necessarily, but a frozen versus a liquid form. In a Cold War, an area that is relatively uninhabitable to humans due to cold temperatures becomes habitable. The Cold War type is most often common to the Polar Tension Belt. The degree of change over time in a Cold War is more episodic compared to the long-term nature of Hot War conflict in the Equatorial Tension Belt.

The Cold War is driven by temperature increases and the warming of cooler parts of the planet. Where the Hot War is characterized by the breakdown of state functions and internal strife, the Cold War exemplifies conditions of

expanding state control and external conflict. These conflicts are often short term, and witness more pronounced swings in climate and habitat conditions.

There are two types of Cold War. The first is where lands that are not productive due to the cold weather become arable and capable of supporting much larger populations. One could imagine that the Great Plains of North America will extend north into Canada with warming, and create new areas for grain and other crop cultivation. This new-found arability serves as a pull factor for migration in these areas, often attracting migrants who are pushed out of Hot War regions.

The second type of Cold War is where warming changes the economic calculus of resource extraction so that it becomes economically viable. This situation might occur when known deposits of precious minerals, metals, or energy sources cross a threshold of business profitability. The use of coal for heating became widespread after forests in Europe and China, for example, were cut down. As the price of firewood rose, the coal alternative, along with new technologies, became viable. This transition depends on more than the cost of extracting the resource. The calculus also relies heavily on modes and ease of transportation of people and equipment.

In a Cold War, there are high levels of development, conflict drivers are opportunities, and resource types are specific. Conflicts are related to expansion of national interest, and actual periods of warfare may be short but intense.

The ability to adapt to climate change in the two conflict dimensions substantially differs, and this differentiation is key to the type of conflict that subsequently emerges. "Cold War" countries, which are largely developed, will face fewer adaptation issues. In fact, livelihoods may be easier in some areas due to a warming temperature. Some adaptations may be required, but these countries susceptible to Cold War conditions (developed countries) have sufficient "stored" resources to allow them to respond.

The situation is quite different in "Hot War" countries. There, climate change through loss of precipitation will cause livelihoods to deteriorate. These areas consist largely of developing countries that lack substantial stored resources. The result is that where more adaptability is needed, less ability to adapt exists. The greater the adaptability gap, the greater the chance for conflict. This relationship may not be linear; conflict may be more likely as the gap becomes apparent, rather than at its widest point. By the point of the most extreme gap between resources and demands, simple survival may be paramount.

The comparisons reveal, starting with the drivers, two entirely different types of systems and behaviors in Cold and Hot Wars. Precipitation and temperature changes drive the context, but in differing ways. The relation to conflict is the process of adjusting to declining and increasing resources.

Optimists and pessimists, realists and idealists

This section lays out a conceptual framework for understanding and explaining climate change and conflict, both in the past and in the future. It focuses on two

separate but related issues. One issue is how researchers look at the future and their perceptions of human adaptability, divided along lines of those who are optimistic about the future and those who are pessimistic. The second issue divides the path to solving such problems, and leads to two groups; those that see policies emerging out of state (realists) versus those who see the need to rely on international institutions (idealists).

What kind of future? Optimists and pessimists

H.G. Wells imagined the future in his 1895 book *The Time Machine*. The book is about a man, simply called the Time Traveler, who ventures out from his London laboratory at the turn of century in 1900 and travels to the year 802,701.

The Time Traveler finds the future London to be a city of dichotomy. The city is a veritable garden of greenery and splendor. But the human imprint on the landscape is minimal. There are decaying buildings and a world with a post-human species, known as the Eloi. (Wells may have derived the term from the Greek word *Eleutheroi*, or men of leisure.) The Eloi are an androgynous race, and smaller than the people of today at four feet in height. The Eloi spend their time on leisure activities, with no interest in technology or intellectual thought. The machines in the museum and the books in the library are useless to them. They do not grow their own food or make their clothes. The Eloi descended from the upper class and devolved into this pampered existence.

In the night, the Time Traveler meets the other human species, the Morlocks. Descendants of the working class, Morlocks are the sub-human servants of the Eloi. In the book, they are imagined as human spiders that live underground and provide the food and clothing for the Eloi. Morlocks possess a crude knowledge of using machines, but could not invent one.

The Time Traveler went to this far-off year to see the glorious heights of human development. He flees the world of the future after learning the horrible secret of the Eloi–Morlock relationship. In the evenings, the Morlock hunt their prey – the Eloi. Wells' revelation is a warning to society about reforming class relations before they skew history and depreciate the human condition. The Eloi are the sheep of the Morlocks, tended with care, and served up as food.

Wells himself sympathized with the conditions of working people at the time, which, during this phase of the Industrial Revolution, remained barbaric by today's standards. Wells' science fiction work reflected his social viewpoint, just as in his 1898 book, *War of the Worlds*.

The point is that forecasts of the future involve complex interactions where the distinctions about what is an optimistic and what is a pessimistic future are not so obvious. What emerged appeared to be a steady-state, sustainable society, but not one we would want. Wells surely means that this is a pessimistic future.

Forecasts of social conditions possess moral cleavages that make neutral suppositions of futures impossible, since the models rest on assumptions of future behavior. Forecasts inherently carry biases, and we need to understand them in order to evaluate the full impacts of climate change.

It is possible but not perfect to substitute developed countries (Eloi) and under-developed countries (Morlocks) into the lexicon of Wells. I surely do not suggest that cannibalism is the natural outcome of climate change. Rather, the evolution of people in a time of high climate change will be a complex affair with surprising outcomes. The outcomes will differ for developed and developing countries.

In the twenty-first century, the human–nature balance in some parts of the world will approach an environmental use maximum or carrying capacity. There are differing theories as to how global society will respond. No doubt some types of dependencies will arise and become fixed relationships.

The modern pessimists see ominous trends already in place. In 1968, Paul Ehrlich warned about the problem of overpopulation (Ehrlich 1968). Later, the *Limits to Growth* argued that stresses on the environment would result in an "overshoot and collapse" scenario occurring about the year 2050 (Meadows *et al*. 1972). In this scenario, declining environmental resource availability would lead to massive food and resource shortages, with human populations collapsing in some areas.

> If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next 100 years. The most probable result will be a sudden and uncontrollable decline in both population and industrial capacity.
>
> (Meadows *et al.* 1993)

In the United States, the Carter Administration adopted the *Limits*' assumption and commissioned a report to the President on the country's coming issues related to sustainability. The result was the *Global 2000 Report*. The Reagan administration, which saw a future inherently possessing a technology fix to environmental and sustainability problems, came into power in 1981, and immediately disavowed the report.

Barry Commoner is in the pessimistic camp and sees the world in two distinct realms. One realm is the physical world that has evolved over several billion years and developed a distinct global environment (or "ecosphere"). The other is the much later arrival of human beings and the world they created (the "technosphere"). Commoner sees a mismatch between the cyclical system of nature and the linear system of humans. He believes that the "technosphere" is now overwhelming the "ecosphere" (Commoner 1990: 15). Pessimists are more likely to promote change in current behaviors and social structure.

Michael Klare sees a future where "resource wars will become, in the years ahead, the most distinctive feature of the global security environment" (Klare 2001: 213). Klare focuses on energy (especially oil), water, minerals, and timber. Two of these resources are finite (energy and minerals) and two are renewable (water and timber). "Terrorism is likely to become a common feature of future resource wars" (Klare 2001: 222). In habitats where resources wars are likely,

inhabitants may find themselves in asymmetric wars against larger and more advanced military forces.

Pessimists like Wells, Ehrlich, Meadows, and others, believe that current trends are untenable. On the other hand, there are optimists who believe this environmental challenge can and will be solved by technological adjustment.

The optimists also recognize some approaching limits to environmental sustainability, but claim that human history is replete with similar challenges. In each case, humans were able to make a transition through the use of new technologies. The optimists charge that *Limits to Growth* and theories like it are simple Malthusian extrapolations, and not reflective of modern industrial society and its capacity for change and adaptation.

Herman Kahn provided a rejoinder to the 1980 *Global 2000 Report* on the idea of overshoot and collapse with an article titled "Globaloney". Rather than a world of crisis and catastrophe, Kahn saw a "great transition" period in human history that will solve these earthly problems through technological advancement. The great transition constitutes a period lasting from the years 1800 to 2200, a time when future economies will be based on high technology. Kahn saw the era as "so dramatic and so startling that we may usefully think of it as almost by itself encompassing the historical watershed" (Kahn and Schneider 1981: 146).

The optimistic view also carries the potential for conflict. As new technologies arise to meet coming environmental problems, the need for evolution and restructuring will be a source of conflict. The constant evolution required to maintain a sustainable level of demand means a constant state of turmoil (for some segments of society) and permanent triggers for conflict.

Kahn himself is somewhat pessimistic about tomorrow. He sees no ideal future or Utopia emerging even after the great transition: "The future may be plagued by disorder and unrest or subjected to regimentation [and] major pockets of poverty will probably still persist" (Kahn 1979: 15). This eventuality will be a source of ongoing low-scale conflict with the potential for igniting bigger fires.

Similar arguments about the promise of technology and human ingenuity echo in the works of Julian Simon and Ben Wattenberg. Simon is optimistic that, because of population growth and the opportunity provided by having more people, there is a greater chance that one might be the next Einstein. "Simply put, Simon was arguing that human beings have the intellectual resource to improve existence and only in economic systems where individual ingenuity and ambition was cultivated and cherished" (Lacy 2005: 62).

Managing conflict: realists and idealists

Climate models do not articulate the role of conflict. Conflict likelihood is, nonetheless, expected. No nation will wait until after a vital resource is depleted before acting in its national interest. The national interest has a primary purpose in acquiring the necessary resources for the people and industry of a nation, including the use of violence. The consequences of the pessimistic overshoot

scenario will necessarily involve large-scale political conflict out of desperation. The optimistic scenario offers the potential for conflict out of opportunity.

Mark Lacy sees two approaches to managing conflict that are generally grouped into "realist" and "idealist" archetypes. These categories emanate from roots of a much older distinction between those who see the world as it *is* versus those who see it as it *ought to be*. The realist approach centers on the state as the principle actor serving the national interest. The realist assumption is that the quest for national power will remain the paramount driver of the international system.

One realist approach to climate change and conflict comes from John J. Mearsheimer, a theorist of international relations. For Mearsheimer, the managers of global security are the Great Powers. For these and other states, there is a hierarchy of security that generally can be divided by short- and long-term problems or, alternatively, problems that are more or less certain. "Offensive Realism" is a first-order national interest, and focuses on opportunities for gaining power and responding to traditional threats. "Defensive Realism," a second-order national interest, centers on structural stability, and is a non-traditional threat. Climate change would fall into the latter category.

> Mearsheimer may respond that even if climate change were to become a source of geopolitical instability a "Great Power" would be able to "manage" the insecurity that emerged. As he comments in The *Tragedy of Great Power Politics*, there is little evidence that any of these non-traditional threats are "serious enough to threaten the survival of a great power".
>
> (Lacy 2005: 39)

Within the realm of second-order structural problems, certain regions will show various levels of stability in the face of change. Thus, there are "tame" (developed country) and "untame" (developing) zones on the planet that are characterized by vastly different levels of conflict. Lacy concludes that "this Realist perspective rests on geopolitical pessimism coupled with technological/economic optimism" (Lacy 2005: 91).

Thomas Galen Moore is a realist with a different perspective. Moore regards climate change as a net positive for humanity and the costs either unjustified or exorbitant. He argues that warm periods are more beneficial for humans than cold ones. Moore puts events in a long-term context. Transitions between the climate types will cause some turbulence, but overall there will be advantages of warm weather:

> Transitions from warm to cold periods or vice versa were difficult for people who lived in climates that were adversely affected yet benefited those who inhabited regions in which the weather improved. On average, however, humans gained during the centuries in which the earth enjoyed higher temperatures.
>
> (Moore 1988: 24)

For people in developing countries, Moore asserts that climate change will not be the major factor in their lives. "Climate change will probably be small in tropical areas, so the population of equatorial regions will be largely unaffected" (Moore 1988: 7). For developed countries, geography will offer a blessing. These countries are clustered nearer to the poles than to the Equator, and will experience improved economic conditions. "Although not everyone will find a warmer climate in his or her interest, the evidence shows that most individuals, especially those living in higher latitudes, will experience a gain" (Moore 1988: 4). The more territory and the further north it is, the greater the benefits to a country. "The Russians, for example, have indicated that they would probably do well in a warmer world" with greater access to Siberia's resources (Moore 1988: 7).

Moore is optimistic about the ability of mammals and plants to survive climate change. He adopts a Lamarckian outlook that presupposes animals will find the proper niche in which to survive:

> If the earth warms slowly, as expected, almost all mammals could migrate to a climate they found most suitable. Ocean fish need not fear climate change; at worst they have to swim further north. Were local temperatures to rise to the point at which some species had difficulty reproducing and surviving, humans could and would transport and transplant many of them to more favorable climates.
>
> (Moore 1988: 97)

Plants cannot move as freely as animals, but they could find a warmer world much more to their liking. They will like not only the warmer temperatures but also the higher levels of greenhouse gas concentrations: "Evidence suggests that rising levels of CO_2 have already hiked plant growth worldwide" (Moore 1988: 114). Moreover, land near to the poles will have longer growing seasons.

Moore worries that without complete agreement in combating climate change, countries will take the opportunity to benefit themselves. Thus, an international solution is unwarranted and unwise. "Free rider problems – that is, the temptation to leave the burden to others – may make international agreement to abate emissions difficult if not impossible" (Moore 1988: 7).

Moore's solution is to wait and see. Given the potential costs and the overall benefits, he suggests delaying any action on climate change until more facts come in. He is optimistic about handling the problem. "In any case, delaying action by 20 to 30 years appears to be the only truly prudent, 'no regrets' policy. Technology will advance. Incomes in Third World countries will multiply" (Moore 1988: 157).

The idealist position is partly a reaction to the realist position, but of course it is more than that. The idealist often takes a position on future trends that is more pessimistic. On future trends, there is less reliance on technology as a panacea for social problems. Idealists see potential catastrophe looming, absent corrective actions. Social relations are often key aspects of the idealist viewpoint.

The idealist solution has a basis in international cooperation that stands in contrast to the national focus of the realist. Free riders to any global pact on climate are to be expected, but majority consensus will lead to benefits for all. Individual winners from climate change will find that losers are not countries far away, but places linked to them through the global economy. Al Gore and others have called for a new global Marshall Plan to counter a cavalcade of environmental problems, particularly climate change:

> The scope and complexity of this plan will far exceed those of the original; what's required now is a plan that combines large-scale, long-term, carefully targeted financial transfer to aid to developing nations, massive efforts to design and then transfer to poor nations the new technologies needed for sustained economic progress, a worldwide program to stabilize world population, and binding commitments by the industrial nations to accelerate their own transition to an environmentally responsible pattern of life.
>
> (Gore 2002: 297)

Hans Gunter Brauch sees the need for international political dialogue on containing conflict induced by climate change. Dialogue and implementation will be a combination of two learning strategies (Brauch 2002: 100). Strategy for responding can be anticipatory (crisis prevention) and forward learning (crisis management).

Brauch suggests that in response to climate change, regions of the world enter into "survival pacts". These pacts link promises of vital commodity supply. Europeans may benefit from climate change in that certain commodities, such as grains, might be more productive. This is not the case for its neighbors to the south, in northern Africa along the Mediterranean Sea. These countries, however, may have energy to trade, both hydrocarbons and solar. The pact would commit the parties to exchange these commodities. Similar survival pacts could exist between the United States and its neighbors, especially Mexico (Brauch 2002: 101–2).

Environmental stress and population growth may lead to violence within and between states (Kahl 2006). There are untame zones characterized by failure, where states are weakened by stress, and internal conflict occurs. There are also tame zones characterized by exploitation, where states that are stable are nonetheless reliant on resource imports. This resource need can lead to external violence.

The idealist view of international relations is built on three assumptions that are comparable to the realist position. A key point on which the realists and the liberals agree is that there are "tame" zones, or areas of relative peace and prosperity.

First, there is a zone of states that are prosperous and economically interdependent that suppresses the urge for inter-state conflict, since this very prosperity is put at risk by conflict. These states have not been prone to conflict in the post-World War II era, but war has occurred on some occasions. The relatively low level of international conflict today is atypical. These tame countries have a long tradition of warfare.

The second tame zone is among democracies, which are loath to wage war on one another (Lacy 2005: 90). There is considerable overlap in today's collection of states that are both politically and economically liberal, and they are certainly not a perfect match. China is becoming quite liberal in an economic sense, but is definitely not a democracy. The same could be said of the states along the Persian Gulf.

The third assumption is where the realists and idealists part company. Both agree that climate change is a threat to the "untame" zones, but pessimists look to the state for solutions. For optimists, by ceding state sovereignty and power to international institutions, the tame zones of economics and politics can be managed. Further, cooperation through institutions can extend the tame zones to untame areas. Through international institutions, cooperation between states can assist in the avoidance of failed states.

> Climate change may have many other indirect negative effects that can undermine legitimacy, it may: undermine individual and collective economic livelihood; affect human health through reduced availability of freshwater and food, and by exposing people to new disease vectors; undermine state wealth and military capability; and exacerbate inequalities between people.
>
> (Lacy 2005: 4)

The pathways from climate change to conflict will be indirect and varied. Indirect impacts will be a complex web of social consequences that create many pathways. These consequences will be concentrated in certain areas where the pathways may converge. These pathways will include major highways as well as less-travelled roads.

The book proceeds along the following path. Chapter 2 examines the role of climate change and conflict through history via case explorations into periods of climate change and how they induced or coincided with conflict. These cases illustrate how Cold and Hot Wars have occurred in history and produced significantly different impacts around the world.

Chapter 3 turns to the future, and the forecasts of climate change and conflict. These forecasts show differing outcomes in terms of likely trajectories. In some instances, the two will overlap and produce an intensification of trends. In other instances, the two trends will diverge but may point to new areas of regional dispute and potential conflict.

Chapter 4 starts with a series of forecast scenarios as possible points of conflict in the next century that may arise coincident with climate change. These scenarios are built on the historic cases and the climate and conflict trends.

Chapter 5 places the cases, trends, and scenarios into political contexts. It also looks forward to how responses can and should evolve. The contexts and responses are viewed quite differently by the optimists and pessimists, as well as the realists and idealists.

2 A brief history of climate change and conflict

Climate change and conflict cases are a mix of short- and long-term processes. Short-term conflict may occur as the gap between resource demand and supply reaches a critical point, similar to how earthquakes occur when tectonic plates move. Nature can also cause rapid changes that lead to substantial casualties in a brief period. These sudden events will directly kill people. The aftermath, by destroying food stocks, ruining crops, or spreading disease, may also indirectly kill people over a prolonged period.

Due to climate change, the chances for conflict will gradually accumulate and appear as a long-term process. Consider the Climate Change War as being more like an extended Cold War and unlike World War II, which was short and extremely violent. Although the Cold War did not result in all-out nuclear conflict, it was the cause of millions of deaths over nearly half a century. Major wars such as those in Korea, Vietnam, Ethiopia, Angola, and other places produced substantial fatalities.

Deaths from slow conflict build up over time, and have a certain momentum. Consider a "fast" war, where 20,000 die in a year. Now think about a "slow" war, where 2,000 die annually for 20 years – or 40,000 dead in total. The latter conflict will cause twice as many deaths as the first, and its prolonged effect may do more to destroy the social fabric for many more years to come. In the end, slow conflict may be more dangerous and more volatile.

Climate change is a type of slow-moving environmental disaster, and conflict in it will occur over a long period. As the gap between needs and resources increases, so too will the intensity and duration of the potential conflict. Where short-term (or sudden) conflict may last a few years, long-term (or prolonged) conflict will continue for ten or 20 years, or more. The civil war in Colombia began around the same time as the Cold War, yet it continues today.

This chapter examines climate change periods and related types of conflict through a series of cases. The cases are unique, because they represent historic periods where temperatures varied from a general baseline. As noted, even slight variations in temperature can lead to significant impacts on climates and the people in them. A change of a few degrees in temperature can, over time, lead to substantial hardship and social disorientation.

There are eight cases, from four periods, each reflecting a different Hot or Cold War event. Each case examines the aspects of climate change and conflict.

The most significant determinant of impact is change in temperature, which may either increase or decrease. Precipitation patterns also change in these periods, but regional differences make it harder to know what type of impacts will occur (more on this in Chapter 3). Whether the event is a type of Hot or Cold War depends on the extant climate in the area.

To conceptualize this relationship, consider how changes in temperature might affect migration in the two tension zones. Cold areas that become warmer invite immigrants, while hot areas becoming hotter push emigrants out. Of course, there will be differences in motivations for migration, whether to claim fertile land, to access renewable resources like wood or water, to seek out finite resources like gold or oil, or to obtain transit routes (see Table 2.1).

The four periods cover diverse instances of natural and human interaction. Comparing and contrasting the periods and cases can reveal some general typologies for climate change and conflict. The Holocene Warming Period marked a period of intense warming that began the end of the current Ice Age. In the Medieval Climate Optimum, during the Middle Ages, a warming and favorable climate allowed human institutions to recover after the Dark Ages in Europe. In the Little Ice Age, conditions became cooler in the latter half of the second millennium. These conditions sometimes reversed gains in the medieval warm period. Finally, the current Anthropogene Warming Period, like the Holocene Warming Period, marks a return to dramatic warming conditions.

The point of the following case studies is not to prove a hypothesis related to Cold Wars and Hot Wars. History and these cases are much too messy to draw one-to-one comparisons. The cases do, however, show trends that suggest how Hot and Cold Wars evolved in the past, and how the lessons from them can be meaningful in the future. Each case represents an instance where climate change, along with a variety of other intervening variables, leads to conflict.

Holocene Warming Period

To understand a future climate that is rapidly warming, it is useful to examine an earlier period of momentous and relatively rapid heating of the planet. To find a comparable condition today, it is necessary to look back to the end of the last Ice Age during the onset of the Holocene Warming Period (HWP). The HWP marks

Table 2.1 Climate types, changes in temperature, and migration impacts

Climate type/temperature change direction	*Temperature increase*	*Temperature decrease*
Cold zone wars	Immigration from several differing points, fueling inter-state conflict	Emigration and deterioration of existing social places, increase of intra-state conflict
Hot zone wars	Emigration and deterioration of existing social places, increase of intra-state conflict	Immigration from several differing points, fueling inter-state conflict

the retreat of the glaciers from North America and Eurasia. This period of warming is what created the climate we live in today.

The term "ice age" generally refers to a period when large glaciers covered extreme latitude landmasses, especially in the northern hemisphere. While the extent of ice today is certainly much smaller than 50,000 years ago, the current Ice Age is not over. There are, after all, significant amounts of year-round ice remaining on Greenland and Antarctica.

The Earth's climate always varies over time. Warm eras dominate in alternating cycles with cold eras. Periods of wide-scale glaciations occur over millions of years. The HWP is but one of many cyclical periods in global temperature change that produce ice ages. The Saale Glacial period took place 130,000 to 200,000 years ago. About 110,000 years ago, the Weichsel Glacial Period ended a warm period known as the Eemian Interglacial Period that began 130,000 years ago. The Weichsal Glacial Period produced widespread cold patterns lasting about 100,000 years.

The glaciers in the Weichsal Glacial Period reached their maximum extent about 21,000 years ago. Even as the Weichsel Glacial time was ending, a final breath of cold emerged for a millennium before finally giving way to full Holocene Warming. The brief cold interstitial was the Younger Dryas period. The period name comes from an Artic flower (*Dryas octopetala*) whose pollen is often a key marker in dating finds in Polar areas (see Table 2.2).

The relationship between climate change, human development, and conflict is extremely old. It is intrinsic to human history, and evident through two examples

Table 2.2 Major recent historical climate cycles

Historic climate cycle	*Years before present*	*Characteristics*
Saale Cooling	130,000–200,000 B.P.*	Global scale cooling
Eemian Warming	Begins 130,000 B.P.	Generally warmer than today, sea levels 5–8 meters higher
Weichsal Cooling	Begins 110,000 B.P.	Global scale cooling
Cold Interstitial (Lower Plenigacial)	75,000–60,000 B.P.	Coldest recent time
Warm Interstitial	60,000–25,000 B.P.	Period of slight warming
Holocene Warming	25,000–12,800 B.P.	Rapid warming
Cold Interstitial (Younger Dryas)	12,800–11,500 B.P.	Period of sharp cooling
Warm Interstitial	11,500 B.P. to present	General warming, with some intra-interstitial periods

Source: Oak Ridge National Laboratory, 1997.

Notes
Naming conventions for periods differ on a geographic basis. The naming convention used here adheres to the Northern European standard.
* B.P. indicates years before present.

in the onset and aftermath of the Holocene Warming Period. Each example represents a case of Cold War and Hot War, illustrating how climate change respectively affected equatorial and polar areas. The first example focuses on the end of the last Ice Age and a Cold War, when humans first ventured into Eurasia and encountered the Neanderthals, another hominid species. The second example is the demise of the great city-state of Mohenjo-Daro, on the Indian subcontinent.

Cold War: Neanderthals and humans in a time of terra-forming

Terra-forming is a change in temperature that recreates climates on a large-scale basis. Both Equatorial and Polar Tension Zones are examples of terra-forming. During the last Ice Age, humans were largely absent in large parts of Eurasia except for small, isolated pockets confined to caves along river valleys. Many more Neanderthals lived in these frozen lands. As the ice sheet retreated, more flora and fauna invaded Eurasia, and humans followed.

This case shows how changes in extreme climate, through terra-forming, entice multiple migrant groups. The groups often come into conflict over claims to these new lands. The case illustrates how climate change works with other variables, such as technology, to produce a potent historical mix. Technological differences between two migrant groups may lead to the success of one and the demise of the other.

Did a changing climate create modern humans? Steven Stanley argues, in *Children of the Ice Age*, that the most recent cold period shrank the forests of Africa. Shrinking forests occurred during the Lower Plenigacial, the coldest point in the recent history timeline, perhaps 70,000 years ago. This cooler and drier period pushed humans out of temperate zones of Africa and north towards the Middle East. It was also a period of great hardship, and led to geographic isolation of small groups of humans. Small groups tend to have higher rates of mutation, and these changes in our genes differentiated us (Stanley 1998). Stanley's point is that the Ice Age created modern humans, not because we lived in that cold place, but because the temperature change also affected hot places.

The Neanderthal conflict begins after the emergence of the modern human around 50,000 years ago. The conflict largely predates large-scale conflict between groups of humans. Humans were in competition with other species, but also in competition with other primates having similar economic subsistence patterns. One of the most important intra-humanoid disputes was over environment and conflict involving our closest ancestor – the Neanderthal. Theories about the end of the Neanderthal are controversial and unresolved. There is, however, no question that human beings played a role in their demise. Humans entered lands that Neanderthals had lived on for several hundred thousand years. Neanderthals survived several ice ages during this period. They could not survive both an Ice Age and human competition.

The Neanderthal was "discovered" in August 1856 by Dr Johan Karl Fuhlrott, a schoolteacher from the town of Elberfed, near the Dussel River in the western part of Germany. Technically, this was not the first Neanderthal skull ever found.

Researchers did not realize until the 1860s that a skull found in 1848 at Gibraltar was from a Neanderthal. Fuhlrott's find was in a valley called Neander (Tal or Thal means valley in German).

The Neander Valley's name comes from a seventeenth-century composer, Joachim Neander, best known for his religious composition "Praise the Lord, the mighty King of God". The truth is that this was not even his real name. Joachim Neumann, similar to other composers of his time, created a last name, a practice predicated on a classical language meaning. In Greek, *Neander* translates as "New Man", and was thus a suitable choice for Mr Neumann. Neanderthal was not a new man, but an old one.

Neanderthals had a long, narrow skull, with a large brain and a bony protrusion over each eye. Physically, the people were stout and strong, with short limbs and digits, and women had birth canals similar in size to those of modern human females. Neanderthals were beyond humans in physical capabilities, being much stronger and more agile. One critical find, in modern-day Israel, was at the Kabara Cave. A team of French and Israeli archaeologists found a hyoid bone, which links the muscles of lower jaw and neck, and is critical to speaking. This bone led some researchers to speculate that Neanderthals had language abilities, though not as developed as our own.

The warming in the Holocene Warming Period set off the human invasion of northern latitude lands. Neanderthals and humans came into conflict at least 35,000 years ago over control of and access to hunting grounds. These hunting grounds were once inhospitable places for humans, but with climate change they became prime areas for economic subsistence. The climate changed from from extreme polar to cool and, later, temperate.

There is significant disagreement between researchers on the human to Neanderthal relationship. Some researchers believe that Neanderthals were simply another race of humans. Most scholars, however, believe Neanderthals were a completely separate species of primate. Recent DNA analysis shows that humans do not directly relate to Neanderthals, but they do emerge from a common tree (Beale 2003). The meeting of these two primates was not a singular event, but one spaced out over time and among differing groups of humans.

> One of the first humans to encounter the Neanderthals were the Aurignacians, a people who entered into west Europe during a warm interstitial period but retreated during a cooling period. The Gravettians followed the Aurignacians. Neanderthals were nearly as evolved as the Gravettians, who did possess advanced weaponry like long-range spears or other projectiles.
>
> (Viegas 2004)

Neanderthals themselves were a heterogonous group, with great diversity in form and feature. Neanderthals ranged over a large area, and experienced a wide range of climatic variations that influenced the development of their physical features and culture (see Map 2.1). The image of Neanderthal as a brute is slowly being replaced, at least in the scientific world, by that of a more sophisticated

Map 2.1 The extent of the Neanderthal at the end of the Weichsal Glacier Period.

Note
The grey areas indicate the extent of Neanderthals.

and advanced creature, with social ties and cultural relations, and as a people who buried their dead.

The conflict over environmental resources is inimical to human nature. Clear evidence for organized human warfare dates back more than 9,000 thousand years, to the early Neolithic Age (Ferrill 1985: 20). It surely existed in the war against the Neanderthals, and environment was a key factor in that war.

Humans spread into Europe during the Holocene Warming Period, but the first encounter between human and Neanderthal probably occurred earlier in the Middle East. Similar to today, the narrow stretch of greenery (known as the Fertile Crescent) in the Middle East was a corridor for interaction between Asia, Africa, and Europe, and sought-after territory.

Over time, humans pushed Neanderthals back into the less hospitable parts of Europe. The Neanderthals retreated to lands where game was not as abundant and temperatures much colder. This deterioration in access to resources no doubt led to long-term pressures on survival. Humans possessed advanced weaponry and social organization that, over time, pushed Neanderthals even farther north.

Changing climates create intersections for conflict as people, technologies, and subsistence patterns meet up. In some cases, these technologies and patterns change and people adapt over time. In other cases, people move to a new climate that more or less resembles their old one, and therefore simply transplant their technologies and economic patterns needed to survive.

The conflict between humans and other primate species occurred through direct and indirect warfare borne out through differences in technology. The

direct conflict was probably a relative draw: the greater Neanderthal physical attributes matched the more advanced human technologies. Competition was more than in weaponry, and it was indirectly that humans prevailed. Humans developed better clothes to survive the cold, and their more sophisticated language made communication a vital part of social organization.

Human weaponry did, however, play a key role. It allowed people to best Neanderthals in direct confrontations, and to take more of the available game. This latter advantage indirectly contributed to declining food sources for Neanderthals, since their diets were largely dependent on meat (Tzedakis *et al*. 2007: 206–8; Delson and Harvati 2006).

Neanderthal hunting and warfare technology did limit their subsistence strategy. Anthropologist Eric Trinkhaus notes that a Neanderthal's hunting style would have involved close contact, using rather unrefined, stone implements. Daniel Lieberman and John Shea suggest two other advantages in economic survival that humans held. First, humans migrated, sometimes over great distances, and took advantage of seasonality and animal migrations. Neanderthals were much more sedentary and confined to a certain area. Second, in addition to being better hunters, humans were better gatherers. The Human–Neanderthal War may have been a gradual struggle of technology and adaptation.

Because of the difference in technology, Neanderthals spent far more time hunting for sustenance compared to humans. Consequently, they had less leisure time for developing new tools. Both groups used a basic set of tools known as Mousterian technology, but the level of human refinement was far superior. Humans adopted some Neanderthal techniques and improved upon them. Neanderthals did control fire, but not to the extent of humans, who used it to make pottery and weapons. The twin forces of slightly changing climate and slightly changing technologies over a long period proved to be an overwhelming force.

The 30,000-year overlap period between the human invasion of Eurasia and the demise of the Neanderthals is a long time for two peoples to co-exist without serious conflict (or mating). James Shreeve suggested in "The Neanderthal Peace" that Neanderthals might have met differing groups of humans over time (Shreeve 1995). Perhaps they were in conflict with one group and at peace with another.

What determined the state of affairs between peace and war between humans and Neanderthals was in many ways a function of the size of the two relative populations and the animal protein available in the areas. At some point, the resource demands of the two together exceeded the carrying capacity. At this stage, it was a question of who got more of the declining resource. During this period many of the mega-fauna died out (such as the woolly mammoth and the giant red deer), and were replaced by bison, deer, elk, and other species. Humans were better at adapting tools for the changing animal prey in the environment. For humans, the warming also permitted the introduction of agricultural practices honed in Middle-Eastern river valleys.

For both humans and Neanderthals in the Holocene Warming Period, there was a greater range and abundance of wild foods and medicines. It was a time of

expanding resources, with human populations quickly increasing. The slow-moving, demographic flood of humans eventually swept away the Neanderthals.

Neither climate change nor any single climate event doomed the Neanderthals. Rather, evidence suggests that the Neanderthal society was one weakened by prolonged periods of cold that reduced their numbers. About 24,000 years ago, during the Younger Dryas Cold Interstitial, cold temperatures pushed Neanderthals out of northern lands and into Southern Europe, where they encountered modern humans who were pushing north.

Hot War: climate change and carrying capacity in Mohenjo-Daro

The Sahara at the end of the Ice Age was a temperate expanse with abundant plants and wildlife. The wetter climate was a temporary phenomenon related to precipitation patterns driven by melting waters from the vast glaciers in Eurasia.

> During the Holocene period of the past 10,000 years there was a 'warm' climatic optimum roughly 5,000 years ago. At that time, conditions were more humid and lakes existed even in parts of the central Sahara. The current state of climate was reached roughly 3,000 years ago.
>
> (IPCC 2001a: 493)

At that time, drier patterns again dominated and created the vast desert. The inhospitable conditions forced people out of the interior of Northern Africa and into urban centers along large river systems like the Nile.

Urban centers coalesced along the Nile River to become the nation of Egypt. After consolidation of their downstream empire, Egypt needed to control lands upstream to maintain mastery of the Nile River resources. Access to Nile River resources remains core to Egypt's foreign policy to this day.

In Mesopotamia, people also built cities along the Tigris-Euphrates River. The city-states were not self-sustaining. In particular, they needed enormous imports of wood, because forest cover was extremely limited. This imported wood built the city structures, and provided the charcoal used to heat and furnish the houses. Wood was the most important resource of the day, and it was worth a fight.

The Epic of Gilgamesh, a document pre-dating the Bible, tells the story of Nebuchadnezzar, who launched wars of conquest for the main purpose of owning and removing forest resources, especially the cedars of Lebanon. The combination of forest cutting, further warming climate, and introduction of ungulates such as goats and sheep that feasted on young saplings, turned the Fertile Crescent from an area with abundant forest resources into a scrub desert. The pattern of climate change and development during this time also played out in South Asia.

The Mohenjo-Daro case is an example of how climate change pushes people with differing patterns of economic livelihood, particularly pastoral and farming peoples, into conflict situations. For the people of Mohenjo-Daro, the climate

moved from a temporary surplus of water to a deficit, and the viability of the city began to wane. The warming climate and population growth pushed the limits of the region's carrying capacity and the types of livelihood it could support.

At the end of the Ice Age, melting glaciers created great rivers in South Asia, such as the Saraswati River. With the slowing of Himalayan glacier melt and a drying climate, the river began to dry up and no longer flowed into the Arabian Sea. The many cities that developed along the Saraswati and other rivers eventually expired. The only cities to develop outside of these river systems were Harappa and Mohenjo-Daro.

The Mesolithic age began around 8000 BC, and people spread into the Indian subcontinent around 4000 BC. This was a generally wet period, with some interstitial dry periods. Plant cultivation appeared on Chotanagpur Plateau in central India. Urban settlements began in South Asia, as they had in the Middle East, originating in river valleys. There was considerable technology transfer between Middle East and South Asian riverside societies over a long period that included ideas of social organization.

Extensive excavations at the key cities of Harappa and Mohenjo-Daro suggest that Dravidian culture was fully in place by 2500 BC. The Dravidians were among the first people to enter India in the Indus River valley. They found huge forests, cut them down, and settled the land.

Where Mohenjo-Daro sat was part of a wet area ripe for agriculture. As the climate changed, the monsoons slowly stopped reaching that high in latitude, turning the area into a dry zone (Marshall 1931: 4). Drought fell across large parts of West Asia and Africa about 2000 BC:

> As the tragedy of the Tell Leilan unfolded [in the Akkadian Empire in the Middle East], others were suffering too. In the Indus Valley, Mohenjo-daro and Harappa spiraled into catastrophic decline between 2200 and 2100 BC. In Egypt, the Nile shriveled to the point that scribes report people walking across the riverbed.
>
> (Linden 2006: 54)

People moved out of caves, but recreated them in these early cities as houses and buildings. The infrastructure of cities such as Mohenjo-Daro utilized the newest building technology: standard-sized, baked bricks. Over the centuries, the need for wood to make brick led to a denuded countryside. The deforestation may in turn have contributed to the long-term downfall of the city by soil loss and heat effects.

The technology of agricultural production that began along the Tigris-Euphrates River spread more rapidly to the east than the west. South Asian, Southeast Asian, and East Asian cities arose and adopted similar subsistence production systems. These large, fertile river valleys experienced seasonal fluctuations of flooding. Specialization led to surpluses, trade, and the development of external relations. Mohenjo-Daro and Harappa developed trade relations to the west in Mesopotamia and to the East in China and Burma.

The Indus Valley civilization of the Dravidians, and Mohenjo-Daro, lasted from about 2500 BC to 1700 BC, dying out with the invasion of the Aryans. Several factors aided the Aryan success. The changing course and availability of water in the area's rivers may have weakened the city-states. The resulting food shortage would lead to structural weakness, and vulnerability to Aryan raiders.

The Aryan peoples began moving from their home in the steppes of Eurasia sometime around 2000 BC, pushed by climatic and demographic factors. Their lifestyle was nomadic. They did not live in settled cities, and were pastoral, with an agro-economy based on raising cattle and horses. Aryan peoples entered the Punjab about 1500 BC from the grasslands and steppes of central Asia, and conquered the Dravidian peoples (and others). By the time the Aryan invasion occurred, around 1450 BC, anthropologist C. Scott Littleton suggests that it was possible that the natural disasters "partially destroyed or at least socially disorganized" Mohenjo-Daro and the Indus civilization to the point where they could not resist an invasion (Littleton 1970: 49).

The Aryans were illiterate, but spoke an Indo-European language. They replaced or melded with the earlier Dravidian cultures and imposed a new social order, creating the basis for India's caste system, that favored themselves over the Dravidians. The Indian epic poem *Maharabata* recounts the struggle between the cultivating Hindus and the invading pastoralist Aryans (Gadgil and Thapar 1990).

Mohenjo-Daro died out. Perhaps it was the drying of river resources. Perhaps it was due to the Aryan invasions. Perhaps some catastrophic event, like an earthquake, caused a change in the Indus River course (Porter, 2004). Rockslides could have blocked the Indus River and kept it from flowing downstream. People may have unintentionally drowned the city:

> People dammed the water along the lower portion of the Indus River without realizing the consequences: temporary but ruinous flooding up river, flooding that would explain the thick layers of silt thirty feet above the level of the river at the site of Mohenjo-Daro.
>
> (Wheeler 1966: 77)

Anthropologist Gregory Possehl disagrees with the theory that a series of floods caused a natural dam that doomed Mohenjo-Daro. He suggests a more gradual decline of the city. Possehl thinks that the silt found in the excavated Mohenjo-Daro sites could be the result of irrigation or other non-flood-related deposits (Possehl 1967). Even if a 100-foot dam created a large-scale flood in Mohenjo-Daro, its abandonment could be a result of the fact that the city was only a settlement, not a major capital. The flooding (or several small floods) could have just pushed the inhabitants onto new settlements (Possehl 1967: 38).

The nature–human relationship at this point was very one-sided. At this time, nature completely determined human actions and the likelihood for conflict. The success of the civilization was heavily dependent on carrying capacity, or the ability of the land to support humans and their styles of economic subsistence.

While climate change was weakening the structure and cohesion of Mohenjo-Daro society, it also influenced the Aryans, pushing them to migrate south from drying steppe regions. As in the Neanderthal case, the outcome may have been, in part, the result of differences in military technology, set in motion by changes in climate.

Medieval Climate Optimum

Several scholars refer to a historic period called the Medieval Climate Optimum (or MCO), that lasted from AD 500 to 1000. The MCO created a period of sustained progress in Europe, because warmer conditions brought longer growing seasons for societies that were almost entirely agriculture based. Some researchers suggest that temperatures rose in the MCO by, on average, about 2°C over the period. Many climatologists regard the MCO as the warmest period in the past 4,000 years.

Herbert Lamb, a British meteorologist, was the first to identify the Medieval Climate Optimum or the Medieval Warm Period. Lamb found a period of four or five centuries "that brought good harvests to Europe and permitted the Norse to land in Greenland and North America. The Medieval Warm Period gave way to six centuries of highly unsettled climate and cooler conditions: the Little Ice Age" (Fagan 2008: xi).

The idea that climate change forces humans to alter their lifestyles and even locations of habitation is not new. "Humans have always lived in unpredictable environments, in a state of flux that requires them to adapt constantly and opportunistically to short- and long-term climate change" (Fagan 2008: xiii). Beginning 1,500 years ago, the period is not an iso-morphic sentinel that foretells the future, but suggests homo-morphic similarities that may reoccur. "The Medieval Warm Period tells us much about how humans adapt to climate crisis, and offers forewarning of lengthy droughts when warming occurs" (Fagan 2008: xviii).

Human activity abetted the change in climate. Warming allowed population levels to explode in Europe, increasing the demand for wood for housing and warmth. Forests stood in the way of expanding agricultural lands required to feed the growing populations.

> The scale of deforestation during the warm centuries is mind-boggling. In AD 500, perhaps four fifths of temperate western and central Europe lay under forests and swamps. Half or even less of that coverage remained in 1200, and most of that clearing took place during the Medieval Warm Period in a massive onslaught on the environment.… Stripping Europe of its primordial forests was an act thick with cultural, economic, and political overtones.
>
> (Fagan 2008: xiii)

The Medieval Climate Optimum had a significant impact in Central America. The warming climate lowered rainfall for these people, and they suddenly found

themselves in near-drought conditions. The drier climate could support only a smaller population, and disparity in ecological carrying capacity contributed to internecine warfare.

During the Medieval Climate Optimum, rainfall totals fell in China between the years 700 and 900 due to weak summer monsoons that failed to develop in the Pacific Ocean. Gerald Haug and other researchers concluded that these failing rains led to the collapse of the Tang Dynasty in China. In Central America, the drying climate led to the collapse of the Mayan civilization (Haug *et al.* 2003).

In the Northern Hemisphere, warming allowed the Vikings to traverse the Atlantic Ocean and arrive in Newfoundland in modern-day Canada. The good fortune of the Vikings in having warmer weather was also the good fortune of Native Americans, who also moved into the region, and these good fortunes led to conflict.

Hot War: livelihood war in the Maya Empire

Several historians discuss the role of climate in the growth of civilization, including Will and Ariel Durant and Fernand Braudel (Durant and Durant 1968; Braudel 1982). Braudel divides time constructs of history into a series of three differing perspectives. The first perspective is geographic, with historic ebbs and tides that are extremely long term in duration. The second perspective is that of society, and the rise and fall of civilizations that can be millennial. The third perspective is that of trends more than a century in duration. In addition, a fourth perspective might focus on particular tipping points within a time horizon of several years. The Climate Change War will be relevant from all four perspectives.

One key aspect of climatic regimes is the existence of ecotones, or transition areas, that connect them. An ecotone serves as an ecological and cultural niche. Jared Diamond explores microclimates, or ecotones, and how they affect societal development, in his book *Guns, Germs, and Steel* (Diamond 1997).

Archaeologist Carole Crumley finds that ecotones define behavioral limits of certain cultural and ethnic groups. For example, Bantu groups in Southern Africa are able to thrive in areas with heavy summer rains, but farther south, with Mediterranean-like climates, their agricultural techniques are quite ineffective. Technologies fit the climate. As climate changed, these technologies, and related economic subsistence systems, failed. Crumley examined changes in Europe's major ecotone regimes (oceanic, continental, and Mediterranean) from 1200 to 500 BC. Crumley finds that change in political boundaries mirrors change in climate, and that cultural and agricultural systems are not easily transmissible to new climates and lands (Crumley 1993).

People moved to the Mayan lowlands of southern North America in about 8000 BC, beginning large-scale farming around 2000 BC. Around the year 500 the Mayan population rose from four to 14 million, to become one of the largest centers of civilization for that time, and stretched through the Mexican Yucatan,

Guatemala, Belize, El Salvador, and Honduras. By the year 500, the Mayans had developed advanced writing, agriculture, astronomy, and other breakthroughs during a time when Europe was in the Dark Ages.

Dry conditions began about 760, and over the next 40 years there appears to have been a slight long-term drying trend. This period culminated in even more intense aridity that began about 810. After a 50-year wet period, drought again set in about 860. Finally, sediments in the Cariaco Basin, offshore from Venezuela, indicate that there was the onset of yet another drought around 910. The boom and bust cycles of rainy and dry periods led to the population growth and subsequent decline of the Mayans.

Archaeologist T. Patrick Culbert reported that pollen found in underground debris suggests there were almost no tropical forests left at the time of the Maya collapse. Culbert found evidence of three massive droughts behind the decline of the Mayan civilization (Haug *et al.* 2003), and the droughts coincided with major cultural upheavals (*Science News* 2001: 15).

> We suggest that the rapid expansion of Maya civilization from AD 550 to 750 during climatically favorable (relatively wet) times resulted in a population operating at the limits of the environment's carrying capacity, leaving Maya society especially vulnerable to multiyear droughts.... The control of artificial water reservoirs by Maya rulers may also have played a role in both the florescence and the collapse of Maya civilization.
>
> (Lecero 2002)

Water played a critical role in Mayan society. Vernon Scarborough found a sophisticated reservoir system in Tikal and other landlocked Maya cities. Since those cities depended on stored rainfall, during the four dry months of the year, they would have been extremely vulnerable to a prolonged drought. Richardson Gill believes there was more to the collapse than simple drought. In fact, it was a sustained period of dry climate: "Sunny days, in and of themselves, don't kill people ... but when people run out of food and water, they die" (Gill 2000: 4). Tikal was the greatest of the Mayan city-states, and a city reliant on water.

> Rulers built enormous water catchment systems. Two or three years of little or no rain would not cause problems for Tikal's water managers, though such a long drought would have a drastic consequences for the small villages that held most of the dispersed Mayan population. But even Tikal's water system was inadequate for sustained, multiyear droughts.
>
> (Fagan 2008: 146)

Overpopulation was the other side of the problem. Based on data collected from about 20 sites, Culbert estimates that there were perhaps 200 people per square kilometer in the southern lowlands of Central America, stating that "This is an astonishingly high figure; it ranks up there with the most heavily populated parts of the pre-industrial world. And the north may have been even more densely

populated" (Culbert 1977). These urban areas relied on a few major sources of fresh water.

Agricultural systems became exhausted, and there was "a collapse of the environment's carrying capacity due to population pressure" (Lowe, 1985: 46). This is not to suggest that the Mayans were unsophisticated. They had a complicated system of economic exchange and subsistence strategy (Lowe 1985: 46) – for example, they genetically developed crops suited to a terraced landscape.

External and internal warfare was a key factor in the collapse of the Maya civilization. There were ongoing wars between peoples because a rising population suddenly encountered declining resources. Torture and human sacrifice were a regular part of social practices, including religious holidays, sporting events, and building dedications. Uncontrolled warfare was probably one of the main consequences of the decline in soil arability. In the centuries after year 250, the start of the Classic period of Maya civilization, the occasional skirmishes grew into vicious wars marked by scorched-earth polices, where the total existence of the enemy was erased in the aftermath.

Arthur Demarest's excavations in Central America suggested two distinct periods in Maya history: before year 761, and after this date. Before then, wars were well-orchestrated battles to seize dynastic power and procure royal captives for very public and ornate executions. After 761, "wars led to wholesale destruction of property and people, reflecting a breakdown of social order comparable to modern Somalia" (Demarest 2005). It became a tool for population control.

In 761, the king and warriors of the nearby city-states of Tamarindito and Arroyo de Piedra besieged the Mayan city-state of Dos Pilas. "They defeated the king of Dos Pilas and probably dragged him back to Tamarindito to sacrifice him" (Demarest 2005). One explanation for the abrupt change in behavior was the intense rivalries for power among its members. These rivalries, alongside shrinking food resources, perhaps exploded into civil war and triggered social collapse and state failure.

One inevitable consequence of overpopulation and a disintegrating agricultural system is malnutrition. Researchers see undernourishment in children's skeletons from the late Classic period, suggesting hunger. Climate change created a structural gap between population and economic productivity. What set off the Mayan demise was a behavioral trigger which "could have been something totally trivial – two bad hurricane seasons, say, or a crazy king. An enormously strained system like this could have been pushed over in a million ways" (Culbert 1977).

Arthur Demarest and his team translated some recovered glyphs and found a complex state of international affairs. The two superpowers at this time were Tikal (northern Guatemala) and Calakmul (southern Mexico), separated from each other by about 60 miles. The inscriptions indicate that Dos Pilas was a puppet state to one or the other for many years.

> Rather than being an independent actor, as previously thought, it now appears that Dos Pilas was a pawn in a much bigger battle. In today's terms,

> Dos Pilas was the Vietnam of the Maya world [at the time close to its collapse], used in a war that was actually between two superpowers.
>
> (Demarest, 2005)

The vertical Maya society built on a failing economic strategy that was exposed by climate change. Population grew, but resources grew scarce. Political economy was an important factor in the Mayan world, since the subsistence strategy relied on a structured landscape and most of the population labored in this sector. The land use defined in many ways the structure of society, and implemented it through cultural practices. Political sovereignty based on culture and conflict had a long tradition. When climate change reduced agricultural production, the conflicts between the various city-states spiraled out of control and into savage tactics aimed at populations.

The Mayan case is an example of overshoot and collapse due to exceeding the regional carrying capacity. In this instance, the technology, size of population, and intensity of agriculture overwhelmed the land. Declining agricultural yields, coupled with dry climatic conditions, precipitated the collapse. It was a collapse of not only human but also natural systems. Richardson Gill believes that the "collapse occurred of external natural circumstances that the Mayans neither controlled nor caused" (Gill 2000: 4). Experts point to the substantial environmental aspects of the Maya decline. Culbert believes that "the Maya were overpopulated and they overexploited their environment and millions of them died" (Culbert 1977: 3).

Scholars differ on how far one can generalize about the Mayan experience and its historic lessons. Culbert adds, "Knowledge isn't going to solve the modern world situation, but it's silly to ignore it and say it has nothing to do with us" (Culbert 1977: 3).

Cold War: Vikings, climate, and the North American migrations

Historically, humans have always packed up and moved when climates become unfavorable to their survival practices. Migration is a key consequence of climate change. Immigrants target unclaimed lands that contain both general and specific resources. Several peoples may covet these valued resources. In the long term, those who can adapt to the conditions most effectively will have a survival advantage. It may not be that the best technology always wins out; rather, it is the most appropriate technology that is important.

Between the years 500 and 1000, a warming climate made northern lands more hospitable. The Vikings coalesced as a distinct group around the year 780, and rapidly spread in many directions. Viking populations surged in Scandinavia and, as land became scarce, began to emigrate. After invading Britain, to raid and in some cases settle, the Vikings traveled farther north and west to the Shetland and Faroe Islands.

Eugene Linden describes the Viking demographic expansion during the Medieval Climate Optimum. Norse sailors made it to Iceland in 874. Settlers

from Scandinavia continued to arrive, and by 954 there were perhaps 50,000 people living there; all lands were claimed long before, perhaps by 930 (Linden 2006: 12).

A Viking with a criminal streak was instrumental in forging the way west. Convicted of murder in 962, Norway banished Eric the Red. Eric headed west to Iceland, where he lived for 20 years. Again convicted of murder in 981, Iceland then expelled him.

Eric the Red took off and headed west again. His expedition found Greenland, as had the Eskimos who lived there. Eric called it "Greenland", but even with the relatively warmer conditions then, this was quite an exaggeration – or a public relations move to attract settlers. In 986, Eric returned with 450 people. More emigrants from Iceland came, and within a few years the population had grown to 4,000.

From Greenland, the Vikings still kept exploring westwards. As they sailed south along the coast of modern-day eastern Canada, they could see plumes of smoke and knew some type of people lived there (Fitzhugh and Ward, 11). The first Viking to reach continental North America was Bjarni Bardarson, who lost his way, in 986, on a voyage to Greenland. Leif Ericsson, son of Eric the Red, took an expedition farther south in 1002, into modern-day Newfoundland, beginning a limited Viking presence for hundreds of years.

> According to the sagas, Ericson's party first headed northwest across Baffin Bay and came upon a rocky coast they called Helluland, present-day Baffin Island. Then they sailed south, hugging the shore, to the wooded place they named Markland, probably Labrador. Finally, they entered a shallow bay and waited for high tide to bring them ashore to a green meadow. Here at L'Anse aux Meadows, they established a base camp, their beachhead in Vinland.
>
> (Wilford 2000)

In Newfoundland, the Vikings settled in a place known as Vineland, because the early explorers found wild grapes. (Later accounts verify these events. Adam of Bremen wrote in 1070 that in Vineland "there grow grapes".) The grapes are further evidence of a warmer climatic period at the time of the Viking settlement. These areas are now colder, and wild grapes no longer grow there.

This period of Viking expansion was different from earlier ones. Earlier expansions reinforced a plundering lifestyle. This changed as the Vikings became agriculturalists and adopted settled lifestyles. "The era of Viking marauding had long since passed. To some scholars the Norman invasion of England in 1066 was the last great Viking raid" since the Normans descended from earlier Viking raiders (Wilford 2000).

This new Viking lifestyle marked a dramatic change in socio-economic context. "The [Viking] style of living they developed is called crafting: growing some vegetables, catching some fish, keeping sheep for wool and meat, raising cattle for milk and meat, and growing enough hay to see the animals through the

winter" (McAleese 2000: 12). This lifestyle required a temperate environment. In reality, Greenland was really still a cold climate despite the name.

Scandinavian migrants came in several differing waves. The first wave consisted mostly of explorers, along with some hardy families. The second phase of migration consisted of conquerors and raiders. The third phase was mostly farmers.

> The Vikings were infamous raiders and looters, but they were also farmers and herders at home and no less sophisticated in arts and invention than other medieval Europeans.… They were successful ship builders who engaged in ever-widening trade, east to Russia and south to Rome and Baghdad. In their Iceland colony at the end of the 10th century, these people created the first democratic parliament. Their further western expansion brought about the first tenuous contact between the Old World and the New.
> (Wilford 2000)

There were complex push and pull factors at work in the expansion of the Vikings from Scandinavia into the rest of Europe, and later even into North America. There were several push factors: "developments in ship construction and seafaring skills; internal stress from population growth and scarce land; loss of personal freedom as political and economic centralization progressed; and the rise of Christianity over traditional pagan belief have all been cited" (Fitzhugh and Ward 2000: 17).

Land was the major pull factor: "The motivating force for the Norwegians sailing west, the colonization of the lesser Atlantic islands, and thereafter of Iceland and Greenland, and the attempted settlement of America, was a need for land and pasture" (Jones 2001: 269). The need for wood resources was another pull factor in the Viking expansion: "It has been suggested that the motive for such voyages [to North America in 1347] was more likely for the acquisition of timber for Greenland's construction needs (Fitzhugh and Ward 2000: 241).

Within a short time, the population exceeded the carrying capacity of Greenland. No forest resources remained on the entire island. In Greenland, emigration was necessary because "the Norse population reached the carrying capacity of the habitat, which may itself have been decreasing" (Fitzhugh and Ward 2000: 291).

The fortuitous climate played an inviting role for many. When the Vikings arrived in North America, they found that other peoples had preceded them. The Beothuk tribe lived in Newfoundland, and the Maliseet and Micmac tribes lived around the Gulf of Saint Lawrence and in Nova Scotia (Fitzhugh and Ward 2000: 193). The region witnessed several periods of expansion and contraction in populations. The Dorsets themselves were migrants, and displaced older Maritime Archaic peoples, who had been in the area since 6000 BC. The Inuit in turn displaced the Dorsets tribe, because of their better hunting and warfare technology. The Eskimos came to North America relatively late, during the eleventh century.

The Norse encountered both Native Americans and Eskimos. The Native Americans were "probably Beothuk, related to the Algonquians who occupied the coastal regions of Newfoundland during the summer, fishing and hunting sea mammals and birds – these would be puffins, gannets and related species – from birch bark canoes" (Wahlgren 1986: 16). The Beothuk also prized the new lands opened up by a warming climate. "Later expeditions in search of Labrador's timber came in contact with numerous Beothuk people, who fought them so fiercely that the Norse never settled permanently on the western shore (Fagan 2008, 91).

The Vikings interacted with the Native Americans in terms of both commerce and conflict. Forged metal objects beyond Inuit technology began appearing. Conflict, though relatively rare, proved fatal for the Vikings. "The outbreak of hostilities between Skraelings [the name the Norse gave them] and Norsemen was decisive for the Vineland venture" (Fitzhugh and Ward 2000: 21). There were simply not enough Norse to withstand attacks by Native Americans.

While the Vikings did have more advanced technology than the native peoples, the advantage was not overwhelming, as "the Norsemen had no marked superiority of weapons, their lines of communication were thin and overlong, and there was an insufficient reservoir of manpower back in Greenland" (Jones 2001: 303). The attempt to colonize Vineland probably lasted only until about 1020.

The Medieval Climate Optimum drove the westward migration of the Vikings. The Little Ice Age cut short the warming period. The Little Ice Age led to the cooling of the planet's northern extremes, thus rendering uninhabitable many of the places the Vikings had settled.

> During the eleventh and twelfth centuries ice was virtually unknown in the waters between Iceland and the Viking settlements in Greenland, and the temperature in these settled areas was 2 degrees centigrade to 4 degrees warmer than at present. From the beginning of the 13th century a mini-ice age affected the northern hemisphere, plunging the seawater temperature to between 3 degrees centigrade and 7 degrees (about 23 degrees below the present day temperature). This change was enough to bring the ice farther and farther south. Seasonal ice floes began to appear in the sailing lanes and near the settlements; their quantity increased, the ice season lengthened, and the ice floes were followed by ice bergs.
>
> (Logan 1983: 78)

People hastened deteriorating environmental conditions. The environmental impact of the small colony on the fragile environment was enormous. Soon after the Viking arrival in Greenland, the few trees of birch, willow, and elder were soon gone and replaced with sorrel, yarrow, and wild tansy, which were invasive species. When the Greenland colony disappeared, the trees soon returned.

Human overuse of resources, such as extreme deforestation, hurt the Viking chances for survival in Greenland. The Vikings brought animals along, particularly cattle and sheep, which quickly stressed the limited greenery. As in the

Middle East, the animals ate tree saplings, native grasses, and flowers. Over time, the habitat became denuded and deforested. As domesticated animals started to die off, "the colonists grew more dependent upon seal for subsistence" (Fitzhugh and Ward 2000: 74).

After 1200, there was cooling in the Arctic regions as the planet grew colder. By the middle of the fifteenth century, the climate reverted to a colder state. Over much of Europe, the glaciers advanced, tree lines crept south, and the alpine passes used for trade and travel were often impassable. "Climatic tables indicate, after a level, comparatively ice-free period 860–1200, a sharply rising level of marine ice in the years around 1260, declining thereafter only to rise again after 1300" (Wahlgren 1986: 24–5).

> The northern coast of Iceland grew increasingly beleaguered by drift ice; and off Greenland as the sea temperatures sank there was a disabling increase in the ice which comes south from the East Greenland Current to Cape Farewell, and then swings north to enclose first the Eastern and then the Western settlement.
>
> (Jones 2001: 308)

The Vikings thought the western lands would be as hospitable as Scandinavia. They were not. In the northern latitudes, the western edges of continents have warmer climate conditions for human settlements, owing to the circulation of planetary winds and the Atlantic Gulf Stream.

> This explains why 20 million Scandinavians can live at latitudes north of Goose Bay [Canada] today. It also explains why even 1,000 years ago there were at least a million farmers in Scandinavia, but fewer than 10,000 hunter-gatherers in Newfoundland and Labrador.
>
> (McAleese 2000: 15)

William Fitzhugh and Elizabeth Ward believe the Viking demise in Greenland was due to a number of factors, but that "an explanation that stresses climatic changes and plays down politico-economic factors probably lies as near to the truth as we can get" in the failure of the Greenland colony (Fitzhugh and Ward 2000: 176). "A conjunction of debilitating forces," including environmental, economic, psychological, and spiritual, led to the collapse (Fitzhugh and Ward 2000: 176).

In Greenland, "the Western Settlement was the first to be deserted. After 1349, and during the time of the Black Death, the Eastern Settlement's ties were hard-pressed" (Fitzhugh and Ward 2000: 97). The demise of Greenlanders probably took a very long time, and some Europeans lived there into the early 1500s. Eskimos massacred most of those that remained.

What was remarkable about the journey of the Vikings was that their voyages to the New World effectively made the reach of human beings a global one for the first time in history.

> Our ancestors left Africa between 100,000 and 120,000 years ago. Coming up out of the Middle East, some of them turned left at Europe, and others turned right into the farther reaches of Asia. Their descendants would not meet until 100,000 years later, at the Strait of Belle Island [in New Foundland, Canada].
>
> (McAleese 2000: 8)

This first global encounter did not have a peaceful outcome. "It's a pity that the first contact between the descendants of the People Who Turned Left and the People Who Turned Right should have ended in killing [each other]" (McAleese 2000: 21).

In 1492, ironically, Columbus arrived in North America just as the Greenland colony was dying out. The Scandinavians eventually abandoned Greenland, and it remained uninhabited, at least by Europeans, for hundreds of years. The church played a key role in the process of re-colonization many years later, with the help of the cleric Hans Egede, who arrived from Copenhagen in 1721. It is largely through his effort that Denmark now owns Greenland.

The Vikings, however, were unable to plant their culture and system onto this New World. They might have been better off adapting to conditions, but they stubbornly held onto lifestyles simply transplanted from Europe. As the climate changed, the gap between their population needs and the sustainability of their society grew wider. Imagine if they would have adapted or if the climate remained favourable: "Had the weather remained good, it's entirely possible that some parts of what is now Canada and the eastern United States would today be speaking Norse, not English" (Linden 2006: 19).

Little Ice Age

A third period that shows the impact of climate change on conflict has to do with cooling conditions and the onset of the Little Ice Age (LIA). Scholars differ exactly on how long the LIA lasted. Some believe it started as early as 1000 in some northern regions. Historian Brian Fagan believes the LIA lasted from 1300 to 1850 (Fagan 2008). Agriculture records from the period show that vineyards gradually disappeared from England, and the cultivation of oranges in north China was no longer possible. The movement of crop zones suggests patterns of climate change.

As growing seasons became shorter in the Little Ice Age, people moved from colder areas to warmer ones. Famine spread, especially during a cold period around 1600, where agriculture production was at a minimum in Scotland.

> When crops failed again in 1612 because of the weather, King James VI kicked many Irish out of Ulster, which was slightly less affected by the savage weather, and allowed Scottish farmers to move in. By the end of the century, 100,000 Scots had established themselves, setting the stage for the religious conflict between Protestant and Catholic that has dogged the region for the past three hundred years.
>
> (Linden 2006: 82)

The same scene played out in the Baltic area, and many in Estonia starved to death. The cold climate especially affected Sweden by increasing death and migration, both of which greatly weakened the state. During the Great Northern War, which occurred in an extremely cold period (1700–1721), Sweden lost most of its empire to Denmark, Poland, and Russia. The socio-political impact of the Little Ice Age followed Europeans to the New World.

Climate change can produce short-term, volatile conditions. The Little Ice Age led to periods of climate extremes that had a substantial impact on conflict. Sudden and violent summer storms in 1588 doomed the Spanish Armada. The year 1812 was one of the cruelest Russian winters, and helped decimate Napoleon's army. The Little Ice Age played a significant role in these two events that were of consequence to European history: "The Little Age represented a minor perturbation of climate, it seemed to have outsized effects on European history" (Linden 2006, 28).

The Little Ice Age was not singular in its impact. Southern Europe no doubt benefited while Northern Europe suffered. Since the period extended for many hundreds of years, the impacts also fluctuated over time with the intensity of the cold.

> Those who argue against a single event cite the fact that the LIA began at different times in different parts of Europe. The first frigid breath hit Iceland early in the thirteenth century, while Italy escaped the brunt until the fifteenth century.
>
> (Linden 2006, 172)

Two cases focus on extremes during the Little Ice Age. The first case concerns the collapse of precipitation patterns in transition zones and the disappearance of the Anasazi. The second case focuses on shorter-term periods of extreme cold and the year without summer.

Hot War: the Anasazi ecotone

Climate change in a single period often produces very different outcomes for peoples and societies in the Equatorial Tension Belt compared to the Polar Tension Belt. Hot periods benefit areas of cooler climate, in that they become more habitable. Cold periods benefit areas of warmer climate, as they become cooler and often wetter. For transitional areas or niche ecotones, the warming changes in cooler areas will cause immigration that may lead to conflict. For warming changes in warmer zones, the result may be emigration. In the past, migrations were to nearby areas, so there was not a lot of movement from the Equatorial Tension Belt to the Polar Tension Belt.

Migrations are often trickles of people over a long period rather than a sudden exodus. Migrations, however, look different regarding where the people come from versus where they are going. Emigration is usually quite concentrated, so that continuing departures begin to sap the ability of the community to survive.

Where the people go is fairly diffuse, and could be in any direction or distance. If migration is sufficiently slow, the migrants mix with local populations and slowly, over time, "disappear" into a different demographic group.

The first people in the Southwest part of the United States were nomadic people who arrived around 10,000 BC. They were part of the Clovis culture, and became settled around 900 BC. The Anasazi were a Native American people descended from this original group.

The Anasazi lived in the Four Corners region (where four US states come together: Colorado, Arizona, New Mexico, and Utah) around 100 BC. The area is extremely dry, but the Anasazi perfected a system of subsistence that built along the narrow canyons and ribbons of water. The habitat provided shelter, safety, and housing.

The Anasazi evolved in five periods. They moved to the area around the year 100 and evolved from hunter-gatherers to agriculturists, settling and becoming sedentary around 450 (Breternitz and Smith 1975: 36.). There was an emphasis on relatively simple technologies during that time, which was known as known as the Basket Maker Period.

A period of further refinement followed, called the Modified Basket Maker Period, which lasted until 750 (see Table 2.3). One change was the development of new weaponry for hunting game and fighting with other people. Over this period, the Anasazi replaced the atlatl with more advanced tools. The atlatl was a wooden device for propelling a spear, and an adaptation from the earlier and larger Clovis point weapons used by mammoth hunters. Later, the development of bow and arrow technology proved to be a much more useful weapon in the group's arsenal, and permitted hunting of a larger variety of game. This led to food surpluses, but the limited supply of game was quickly exhausted.

Simple technological advances built over time, and slowly the rural lifestyle became urban. This led to the Developmental Pueblo Period, which capped a long process of evolution. Anasazi populations reached their maximum around the year 1000, largely through more efficient farming techniques. The Pueblo Period marked the culmination of this urban lifestyle.

Urbanization brought its own problems. The culmination of the Pueblo Period also meant that hunters needed to travel farther and farther from the city for game. Michael Allen and Robert Stevens compare the urbanization of the Anasazi with modern problems that result from exceeding tipping points in sustainability:

Table 2.3 Anasazi periods of growth and decline

Time era	*Period*
1–450	Basket Maker
450–750	Modified Basket Maker
750–1100	Developmental Pueblo
1100–1300	Pueblo
1300–1600	Decline

> With their more settled lifestyle came the need for more permanent housing for the slowly increasing population. Although the change was not immediately evident, these cultural adaptations gradually changed the relationship between the Anasazi and their land. The ultimate impact of disturbing the delicate balance between the use and abuse of the land took several hundred years to manifest fully.
>
> (Allen and Steven 1996: 156)

This gradual process of technology improvement was too successful and, over time, Anasazi population exceeded the region's carrying capacity. This was the Decline, or the fifth period, in the history of the Anaszi. The Anasazi subsequently disappeared. Apache and Navaho tribes followed as the next residents in the region. Spanish invasions pushed them out of their own homes.

The Anasazi survived a long-term drought and many smaller ones. Why were they unable to cope with this drought? Climate change and conflict, along with a multitude of intervening variables, is a likely explanation. The drought was widespread. Similar to their Anasazi cousins, the Hohokam (to the southwest) and the Mogollon (to the south) tribes also declined after 1300. These neighbors might not have been in a welcoming mood for emigrants.

The special climate ecotone the Ansazi exploited was a thin slice within a larger inhospitable zone of existence. Even small shifts in climate can upset such a delicate social calibration. Chaco was a key city of the Anasazi for cultural, economic, and political reasons. Chaco linked out to the rural areas through a radiating road system. It was a key point for importing of resources, including great timbers that built the houses of the city.

Chaco was built on a fragile foundation. Chaco's history mirrored that of the Mayans. The population grew during a favorable climate, but collapsed when the climate turned drier and the carrying capacity fell. "Chaco had developed rapidly during a long period of relatively plentiful rainfall by San Juan standards.… Agricultural productivity withered, water supplies slowly evaporated" (Fagan 2008: 134–5).

A number of researchers believe the Anasazi were victims of climate change. Some precipitation changes were incremental but some were wholesale. Other changes in rainfall were more dramatic, and even seasonal rains failed:

> Careful scrutiny of tree-ring records seemed to establish that in the late 1200s a prolonged dry spell called the Great Drought drove these people, the ancestors of today's pueblo Indians, to abandon their magnificent stone villages at Mesa Verde and elsewhere on the Colorado Plateau, never to return again.
>
> (Johnson 1996: c-1)

The drought is responsible overall for the fate of the Anasazi, but other factors made the precarious climate situation more complex and deadly. Climate change set off a chain reaction:

> [The] so-called Great Drought … simply was not bad enough to be the deciding factor in the sudden evacuation, in which tens of thousands of Anasazi … moved to the Hopi mesas in northeastern Arizona, to the Zuni lands in western New Mexico and to dozens of adobe villages in the watershed of the Rio Grande.
>
> (Johnson 1996: c-1)

Even more telling is evidence that the Anasazi had weathered many severe droughts in the past (just as the Neanderthals had weathered several Ice Ages). Why did the drought in the late 13th century cause an entire population to abandon the settlements they had worked so hard to build?

Archeological evidence shows that in this period, perhaps as a reaction to drier weather, people in the Mesa Verde area began building dams and canals to trap water and divert it to terraced fields. How do we link the record to the theory? "Correlating these tree data (dendrochronology) with information on productivity of various soil types, modern crop yields, and detailed geography, Adler concludes that enough corn could have been grown during the drought to support the population" (Johnson 1996: c-1). Archeologists believed the Anasazi suffered from long-term issues of malnutrition, shorter life spans, and increased infant mortality, but there is little evidence of any short-term catastrophe.

Some climatological evidence, based on tree-ring and pollen studies, suggests that Anasazi farmers may have kept moving to higher, moister grounds in reaction to the drying trend. Nevertheless, this strategy was flawed: lower elevations were too dry for farming, and higher ones too cold (Van West 1994).

The drought was important, but not sufficient to explain the Anasazi collapse. "The peculiar character of the abandonment is its completeness, its rapidity. This suggests that some kind of 'pull' was operating as well – or an ideology favoring migration" (Van West 1994). There were numerous religious symbols found on rocks or pottery, and a distribution of ceremonial structures, suggesting that the Anasazi may have left their homeland for a new religion, perhaps to the south.

Recent climate studies suggest a disruption of rainfall patterns in a way that perhaps disillusioned Anasazi with their old religion. Suddenly, the customary pattern of heavy snows in the winter followed by summer monsoons became unpredictable. Even if there was not a great drought, moisture may have been coming at the wrong times. The summer rains, so necessary to keep the spring crops from dying, were no longer reliable. The rain dances no longer worked.

There are also links to the Mayans that helped shaped Anasazi culture. There were Meso-American influences on culture and architecture (great houses), and technologies for agriculture, ceramics, and weaving came from the south. Some researchers surmise that the introduction of teeth-chiseling and possibly cannibalism came from the Mayans. Perhaps the Anasazi knew the fate of the Mayans and their apocalyptic collapse.

The declining resources led to three stages of conflict. First, the Anasazi cities, like Chaco and Mesa Verde, fought against one another, just as the Mayan cities, like Tikal, Tamarindito, Arroyo de Piedra, and Dos Pilas, had done.

Second, as the city-states gradually weakened under the weight of climate and conflict, conflict would have focused on livelihoods. Once livelihoods become unsustainable, societies slowly evaporate. The third phase was desperation. The Anasazi may have turned to a new food source: each other. In New Mexico, the remains of 12 Anasazi were found; seven of them seemed to have been eaten (Fagan 1994).

Extreme events and the year without summer

Periods of rapid climate change may produce more extreme events. Some extreme events have geological causes that can alter trends of climate, especially in the short term. Along with the changing climate, there may be weather or external natural events, such as colliding asteroids, that may produce extraordinary spells of flood, drought, heat or cold.

Extreme events are the link between the short and the long term in climate change and conflict cases. They compress climate patterns and trends into shorter, destructive episodes. In pre-modern times, these extreme events could and did play major roles in history.

There were sharp extremes in temperature during the Little Ice Age. The period actually had two temperature low points, one during the late 1400s and early 1500s, and another during the late 1700s and early 1800s. This latter extreme cold period, coupled with a catastrophic geologic event in 1815, produced the year without summer.

Against this longer-term climate trend was a volcanic event. In April 1815, Mount Tambora on the Indonesian island of Sumbawa threw a massive amount of volcanic dust into the atmosphere, one of the largest volcanic explosions in modern times. When it exploded in 1815, Tambora sent more dust into the upper atmosphere than "any volcano between 1600 and the present. Tambora would be the most explosive eruption in the last 10,000 years" (Stommel and Stommel 1983: 3). The eruptions continued from April until July. About 70,000 people died immediately. On nearby Subawa Island, there were 12,000 residents before the eruption; only 26 people survived.

The Tambora eruption was one of the most cataclysmic natural events in recent history. Tambora ejected 100 cubic kilometers of material into the atmosphere. In comparison, the eruption at Krakatoa in 1883 ejected ten cubic kilometers, while Vesuvius in AD 79 and Mount Saint Helens in 1980 ejected one cubic kilometer each. Due to the debris in the air, points within 200 miles of the Tambora Volcano were in total darkness for three days following the eruption (Stommel and Stommel 1983: 10).

> Between 1450 and 1850 global temperatures were between 1.0 and 2.0 Centigrade cooler than they are now. Within that, the settlers were living in what some climatologists say was a cooling trend between 1809 and 1820. And in the middle of that came the 1815 eruption of Tambora.
>
> (McGuigan 2003)

The eruption may have been part of a series of global geological events. Mt Tambora's outburst followed other major eruptions: of La Soufrière Volcano on Guadeloupe Island in the Caribbean (1812), and of the Philippine Mayon Volcano on the island of Luzon (1814).

Tambora's dust spread worldwide and blocked the sun's rays, cooling the climate. In Canada and New England, heavy snow in May killed newly planted crops. The cold weather did not end until the summer of 1817, and in 1816 most of the crops and livestock were lost. Ice formed in rivers and lakes as far south as Pennsylvania, well into the summer.

In June 1816, temperatures in New Haven, Connecticut were 7° Fahrenheit below average, and led to the coldest June on record. Killing frosts occurred in New England in June, July, and August. Corn was, at the time, the staple crop in New England, and three-quarters of it was lost. The cold was only part of the problem. There was also a prolonged drought in other parts of the country in 1816, notably in the south, from New York to Georgia.

One account from a diary kept by a resident of Alleghany County, New York, describes the conditions that began with snow in June and kept up through the summer of 1816:

> To the surprise of everybody, August was the worst of all. Almost everything green in this country and Europe was blasted with frost. Snow fell at Barnet, 30 miles from London, England, on August 30th. Newspapers received from England stated that 1816 would be remembered by the existing generations as the year in which there was no summer. Very little corn ripened in New England. There was great privation, and thousands of persons would have perished in the country had it not been for the abundance of fish and wild game.
>
> (Wood, 1930)

Several American scholars point to this cold period as a major impetus for a large population migration from the state of New York and from New England to the Midwest during this time. What enabled the migration process was the subsequent opening of parts of the Erie Canal in 1819 and its completion in 1826.

The consequences of the year without summer were important. In Canada, the province of Quebec banned the export of staple crops such as wheat, flour, beans, peas, and grains. Prince Edward Island, New Brunswick, and Nova Scotia followed suit, and halted exports of grain and other foodstuffs. Newfoundland turned away a boat full of immigrants. As in Canada, agricultural trade slowly stopped in Europe. "At the height of the famine, Swiss cantons sealed themselves off, prohibiting the export of grain to one another" (Stommel and Stommel 1983: 47).

"The cold summer of 1816 set many records in Europe" (Stommel and Stommel 1983: 46), and led to disease. Most people were still largely involved in agricultural self-subsistence. Cold weather led to lower agricultural production,

and human nutrition levels fell dramatically. "Ireland's famine led to a typhus epidemic that in the years 1815 to 1817 afflicted 1,500,000 people and killed 65,000. The typhus spread all over Europe" (Stommel and Stommel 1983: 44).

The eruption of Mt Tambora had great consequences for the world's climate, and this was especially true in Europe and North America. Contributing to the crisis were the social issues of the times. The eruption followed the Napoleonic Wars, that had left Europeans destitute:

> Two years after the battle at Waterloo much of Europe was facing famine. The aftermath of protracted conflict was marked by columns of refugees, some heading east into Russia (where food was still plentiful), whereas others moved west-ward to escape to the Americas by ship. In Germany and Switzerland people were eating cats, rats, grass and straw. In Italy, beggars flocked to cities, whereas in England demobilized soldiers and unemployed farmhands lined up to join food-for-work activities. Hundreds of thousands of Europeans died from the combined effects of typhus, exposure and starvation.
>
> (Webb 2002: 2092S)

Examining trends in staple crop yields and prices shows the economic impact of extreme cold climate in the year without summer. "Wheat yields in England, Ireland and France were at least 75% lower than the recent norm" (Webb 2002: 2092S). Patrick Webb tied crop prices to yields:

> Wholesale wheat and rye prices (set at 100 for 1815), roughly doubled in 1817 in many countries. The worst affected area was southern Germany, where prices increased fourfold within 12 mo[nths], the peak occurring from May through July of 1817. Such rapid and extreme instability in the price of basic foods resulted in a consumption crisis manifest from Scotland to Sicily.
>
> (Webb 2002: 2092S)

Mortality rates rose significantly throughout Europe. Deaths were most concentrated in central Europe around Southern Germany and Switzerland, where there was widespread famine. The food crisis of 1817 threatened the stability of European countries, which responded with emergency provisions of food supplies for some of the starving people. This primitive food program could not stem the problem, and food riots erupted in England and France. An uneasy populace confronted the conservative monarchies that survived Napoleon, and there remained radical pockets, still inspired by the French experience. Revolutionary governments came to power in Spain and in Naples, Italy. A restored French monarchy invaded, and overthrew Spanish revolutionaries.

In the aftermath of Napoleon's defeat in 1815, France was a battered country with few reserves to fall back on. The struggle between the royalists and liberals provided the structural divisions in the country, and the cold summer provided a

trigger for violence. Riots broke out in Poitier when the government imposed a wheat tax. Farmers bringing their crops to market required armed protection to prevent angry mobs from stealing their wares. Al Gore discussed the year without summer, and the conflict consequences, in his book *Earth in the Balance*, saying: "As fears of revolution mounted in several countries, military force was used to control the growing crowds demanding food. An unprecedented wave of arson began to strike in almost every country" (Gore 2002: 56).

The impacts of the year without summer show two differing outcomes in Europe and North America. In Europe, the structural situation was dire. Napoleon's defeat at Waterloo in 1815 was the culmination of a long period of continent-wide warfare in Europe. In the aftermath of the war, basic livelihoods suffered and revolutionary fervor competed with a royalist resurgence. Population density was high and arable lands already claimed, leaving no pressure valves for populations put under temperature-induced duress. The result was social upheaval, riots, and disease.

In North America, the War of 1812, a conflict related to the Napoleonic Wars, was ending. Population densities were still rather low in the United States. The central government remained relatively weak, and the White House had recently burned. Unlike in Europe, however, there were ample lands to the west in the United States that provided migrants with opportunities, and the beginning of the Erie Canal in 1817 offered a means for them to take their chance. The pressure valve there worked quite well.

Anthropogene Warming Period

Theories of greenhouse gas emissions and climate change emerged in the nineteenth century for good reason. On the one hand, sciences such as chemistry and physics were at a point where research could advance on a scholarly basis. On the other hand, people could observe that climatic conditions were beginning to change. In 1861, John Tyndall started research into ice age theories. Tyndall was an avid mountain climber who no doubt saw the receding glaciers during his treks. Svante Arrhenius, in 1896, hypothesized that the amount of carbon dioxide in the atmosphere determined the temperature. He believed that the burning of coal would lead to a rise in temperature over time. In the 1920s, scientist Joseph Fourier speculated on the trapping of gases and heat determining climate.

The Anthropogene Warming Period (AWG) was born out of the Industrial Revolution, which got under way in the early 1800s, at least in terms of large-scale use of fossil fuels, especially coal. By 1900, these emissions had become significant and were accumulating in the atmosphere. The climate began to warm. The warming period of today is simply a later stage in the Industrial Revolution, one that is now spreading to other parts of the world such as China and India, where about one-third of the world's population lives.

Climate change can have quite specific implications for certain regions, especially when joined with human activities. There are examples of climate change on a much more regional basis. Extreme drought coupled with intrusive

agricultural practices led to enormous economic and demographic upheavals in the American Midwest in the 1930s (the Dust Bowl).

The following section looks at two climate change and conflict cases from the Anthropogene Warming Period. One example comes from the existing areas of climate change and conflict in the shifting domains of the Sahel. A second example focuses on the ability to expand into new areas, and the opening of the Northwest Passage.

The Fulani and the Zarma: regional changes in climate

For most of history, human contribution to climate change was non-existent or minimal. The ability of humans to cope with and adjust to climate change was vital to survival. Natural events like climate change often led to conflict, as occurred between the Fulani and the Zarma in West Africa.

Climate change creates new ecotones or transition areas of habitation that impact economic livelihood patterns. As climate zones move, so too do the people who live in them. People may bring along the old economic subsistence patterns and, because of this mismatch, these transformations are not always successful.

Desertification is a characteristic of a warmer climate period, and particularly of concern in the Equatorial Tension Belt. "Desertification exacerbates poverty and political instability. It contributes significantly to water scarcity, famine, the internal displacement of people, migration, and social breakdown. This is a recipe for political instability, tensions between neighboring countries, and even armed conflict" (UN 2008).

Desertification also is part of a feedback process with climate change: climate change can cause desertification, which itself can produce climate change (UN 2008). This feedback, coupled with rising populations, creates a downward spiral in carrying capacity.

There are also cases where farmers, who generally outnumber pastoralists, push into traditional grazing areas. Between 1940 and 1960, more precipitation than normal fell in the Sahel, and farmers pushed north and encroached on traditional pastoralist lands (Herrero 2006).

The Sahel is also an area that is one of the poorest and least developed portions of the world, and one that has long witnessed social instability, worsened by colonization. State control and impact in these areas has always been marginal. The influx of people fleeing drought areas also degraded environmental resources (Herrero 2006).

The conflict in Niger is a classic case of ecotone shift by climates and by people. The Sahara Desert, the largest arid area on the planet, moves periodically along a north–south line. The Sahel is one such ecotone, sitting between the extremely arid Sahara Desert and the tropical forests of west, central, and east Africa. This ebb and flow of desertification, brought on by changing precipitation patterns, brings people into confrontation. The line between habitable and inhabitable areas moves not only through Niger, but also through the countries

of Ethiopia, Somalia, Chad, Nigeria, Niger, Mauritania, Sudan, and other parts of Africa.

Archeologists believe there is a tendency for the Sahara Desert to "move" or "pulse" over time. Research shows pulses of climate and weather changes occurring 10,000 years ago. Climate oscillations corresponded to changes in the societal identity of Late Stone Age people. This behavior pattern is not unique to them. The longer a community stays in one place, the more sedentary it becomes, and the more sedentary the society, the more traditions it develops. When forced to move, traditions are upset, or lost, and specialization diminishes.

> Today, climate in the Sahel leaps abruptly and without warning from one mode to another in a completely different manner. It is likely that the same kinds of abrupt shifts occurred during the Medieval Warm Period, creating extraordinary challenges for people engaged in cattle herding, subsistence agriculture, and long-distance trade.
>
> (Fagan 2008: 69)

Climate change today magnifies the precarious balance between environmental supply and demand in some parts of the world. This is especially the case in Africa. Climate and weather conditions in fragile transition zones over the short term can have extreme consequences for inhabitants accustomed to seasonal and yearly migration patterns. No part of the world is as reliant on subsistence agriculture as Africa, exposing the people there to the vicissitudes of changing climate.

Climate change can be broken into more discrete categories, especially according to dimensions of time and geography. There are long-term climate patterns, but there are also shorter-term patterns that people ordinarily refer to as weather. Weather constitutes cycles of climate change that shift year-to-year or day-to-day, depending on the time perspective. Within certain climates and microclimates, changes in weather can be significant over the short term. Over the last century, Africa's temperature has been on the rise, mostly for natural reasons, like shifting rainfall patterns:

> Observational records show the continent of Africa is warmer than it was 100 years ago.… The 5 warmest years in Africa have all occurred since 1988, with 1988 and 1995 the warmest years. This rate of warming is not dissimilar to that experienced globally, and the periods of the most warming – the 1910s to the 1930s and the post-1970s – occur simultaneously in Africa and the world."
>
> (IPCC 2001b)

Several diverse ethnic groups in Niger live in three different climatic zones. The three zones divide latitude and the degree of intersection with the Sahara. The northern part of the country is the Sahara Desert. The Sahel, to the south, is a transition zone characterized by a combination of desert and scrub. In the far southeast is the Niger River Delta with a tropical climate.

Nomads like the Fulani inhabit the Sahel. Herding and animal husbandry characterize the livelihood of nomads. As animal stocks increase, grazing demands on the fragile ecosystem near the desert exhaust grassland supplies. These extra stresses on vegetation, in addition to the changes in climate, can heighten drought impact.

The Zarma are a cultivating people who live in the Sahel, primarily in western Niger, but there are also some pockets of Zarma in Burkina Faso and Nigeria. The Zarma grow subsistence crops, such as millet, sorghum, rice, corn, tobacco, and cash crops such as cotton and peanuts. This production mode requires some irrigation.

Milk is an important part of diet and culture for both the Zarma and Fulani. The Zarma own cattle, but it is the Fulani or Tuareg people who tend the animals. This complex rental system is an outcome of both economy and culture. When mature, the Zarma drive the cattle to coastal cities of West Africa for sale. Animal husbandry remains one of the main economic activities of Niger. Livestock products include cattle, sheep, goats, and dromedaries.

The Fulani, part of a family of peoples known as the Peule or Fulbe tribes, are a primarily Muslim people found in many parts of West Africa, ranging from Lake Chad to the Atlantic coast, with concentrations in Nigeria, Mali, Guinea, Cameroon, Senegal, and Niger. The typical Fulani are nomads, who make temporary camps of portable huts, exchanging dairy produce for cereal foods. After many years of integration with other cultures, and depletion of herds due to environmental conditions, they now rely on farming for livelihood.

Microenvironments that are safe havens during hot periods in the Sahel are disappearing. French colonization of Niger in the 1920s and commodity export policies produced desertification by overuse of resources. The result was a large-scale focus on grazing and cash crops that led to a decline in the health of the microenvironment.

The Niger government and multilateral aid agencies hope to increase water supplies (small dams and deeper wells, for example) but some warn that the increase in water without an increase in appropriate grazing land is a recipe for disaster. More water attracts more farmers to the arid lands of the Fulani.

Niger's agricultural policy intends to achieve food self-sufficiency regardless of climate change. Approaches include methods to survive short-term water stress (including dry cropping in rural areas), hydro-agricultural projects, and use of nitrogen-based fertilizers and manure. These measures will not be able to counter the larger trend of climate change, but only delay it.

Colonization skewed traditional relationships. In Nigeria, British courts tended to side with pastoralists over cultivators. Colonizers who favored one group over another to secure allegiance also pushed the traditional pastoral–farmer relationship into often politically untenable areas.

The conflict between the Fulani and Zarma is a recurring situation that exemplifies differing styles of subsistence systems. The tradition of pastoral versus farming lifestyles is a theme that reverberates throughout history.

The clash between pastoralists and farmers goes far back, being recorded in the Bible (Genesis 4) and other ancient documents. It began with the sons of Adam and Eve. Cain cultivated land and Abel tended flocks. Both made offerings to God from their labors. God favored Abel's offering, which angered firstborn Cain. Out of spite, Cain killed his brother.

Pastoralist people had the advantage of developing a warfare system based on the animals (horses) that they reared. The Mongols are an example of a relatively small pastoral population that conquered large parts of the farming world. A similar tension exists between the Woolofs in Senegal, who are farmers, and the Peule and Fulbe peoples, who are pastoralists (Puigdefraegas 1995: 65).

The line of the Sahel is a divide of more than climate. Not only does it separate pastoralists from farmers, but also pastoral peoples in the Sahel are largely Muslim and Caucasian while farmers are usually Christian or animist and Negroid.

Country boundaries have little consequence for the pastoralist–farmer conflict, and thus this type of tension is not limited to Niger. For pastoralists like the Fulani, water and grazing land are essential resources. Farmers, like the Zarma, need water (for irrigation) and fertile land. Irrigation requires digging wells and building a water supply system. Conflict occurs when the land and water needs of the two groups clash.

The southward drift of the Sahel in the mid-1990s during a dry period pushed Fulani herders south towards greener pastures. Unfortunately, this encroached on the lands of the Zarma. The two groups clashed over diminishing pasture and water resources.

In 1997, seven people were killed and 43 wounded in separate clashes between Fulani herders and Zarma farmers in Niger. Seven died near the village of Falmaye southeast of the capital Niamey (Furber 1997). Zarma villagers allegedly attacked a Fulani camp, avenging the death of a Zarma in an earlier fight with Fulani herders. Three victims burned to death. In 2002 and 2003, violence broke out between the Fulani and various cultivating groups in central and northeastern Nigeria. The extended conflict killed at least 2,000, while about 23,000 Fulani fled Nigeria for Cameroon (Herrero 2006: 122).

The Northwest Passage: warming, and new territory claims

One beneficial consequence of climate change is that it will allow people to work and live in today's extremely cold climates. The warming will allow new types of agriculture, resource extraction, and transportation modes. Sea traffic through the Arctic Polar areas will be increasingly possible with time, and offer the dream that many explorers have sought: the Northwest Passage through Canada and the Northeast Passage above Russia.

Climate change will have an impact on both military power and patterns of economic interaction through trade. By doing so, it can have a tremendous impact over time on national policy and the basic elements of security and

economic stability. Global terra-forming creates new opportunities, like those that lured the Beothuks and the Vikings, who expanded their territory during the Medieval Climate Optimum.

The idea of a Northwest Passage connection between the Atlantic and the Pacific Oceans was of interest to Spanish explorers in the sixteenth century, and has been so to many others since then. Martin Frobisher, an English privateer (a pirate licensed by England) and Henry Hudson (an English explorer and navigator) both sought the Northwest Passage.

The first expedition to attempt to traverse the Northwest Passage took place in 1845 under Sir John Franklin. He commanded two ships (*Erebus* and *Terror*) and "took a crew of 134 men and three years worth of supplies – including a piano, fine crystal, 1,200 books and the best technology of the time. Wives and girlfriends of crewmembers confidently sent their letters to China" (CBC News 2006). The letters were unanswered, because the crew never made it.

The first expedition to successfully traverse the passage (one way) between the Atlantic and Pacific Oceans occurred in the period between 1903 and 1906, and was led by Norwegian explorer Roald Amundsen. When he reached Nome, Alaska, in 1906, he learned that Norway had become independent from Sweden. Amundsen sent a note to the new king, Haakon VII, saying his journey was Norway's achievement.

After Roald Amundsen's 1906 expedition, the idea of the passage received new interest during World War II. Canada then attempted to improve on Amundsen's travel record and traverse the passage in both directions:

> From 1940 to 1942, the Royal Canadian Mounted Police schooner St. Roch navigated the passage from west to east for the first time as a show of Canadian sovereignty over the North. At the end of its journey, the St. Roch turned around and went back, making it the first vessel to complete the journey in both directions.
>
> (CBC News 2006)

US attempts to traverse the passage have been a source of controversy with the Canadian government. Two cases stand out. In 1969, the oil tanker *SS Manhattan* traveled the corridor without Canadian permission. Ostensibly, the idea was to test the waterway for transport of oil supplies with supertankers. The US Government was well aware of the *Manhattan*'s plans. The second case occurred at the height of the Cold War:

> In 1985, the U.S. Coast Guard icebreaker Polar Sea transited the passage – without asking the Canadian government for permission. The political fallout over what was considered the most direct challenge to Canada's sovereignty in the Arctic led to the signing of the Arctic Co-operation Agreement in 1988 by Prime Minister Brian Mulroney and U.S. President Ronald Reagan.
>
> (CBC News 2006)

The agreement was largely symbolic: it said that the United States must ask, but that Canada must then permit passage. There was no mention of the legal status of the waters. The benefits of a Northwest Passage are tangible, and translate into real economic benefits:

> The Northwest Passage is 7,000 kilometers shorter than the current shipping route through the Panama Canal. That amounts to two weeks saved in traveling time. From London to Tokyo via the canal, the distance through the Panama Canal is about 23,000 kilometers. Traveling east through the Suez Canal is also longer at 21,000 kilometers. The route through the passage is just 16,000 kilometers.
>
> (CBC News 2006)

The Canadian Government, under Prime Minister Stephen Harper, considers the Northwest Passage a key part of Canadian national security policy. In his 2006 inaugural speech, Harper stressed Canada's sovereignty over the Northwest Passage, in a message directed at the United States and other countries. As part of this Northern Policy, Harper claimed sovereignty over Hans Island. The island is near Greenland, and Denmark claims the island as its own.

Estimates on warming and use of the passage vary. On the one hand, "University of British Columbia Prof. Michael Byers said the Northwest Passage would be clear of ice during the summer months in 25 years, and he urged the government to take action" (CBC News 2006). Other research suggests that the route may be ice-free all year round in a range from 50 to 100 years. The likely outcome is warming that will free up some areas faster than others.

Interest in the Northwest Passage extends beyond the United States and Canada, as other countries are also likely to use the corridor. In 1999, a Russian company transported a floating dry dock through the passage and south to Bermuda. A Russian icebreaker plowed a path for the transport (Huebert 2001).

Russia is not alone in exploring its options. Later that year, a Chinese research vessel transited the passage, stopping at the remote village of Tuktoyaktuk. While the Chinese informed the Canadian government of its plans, the locals had no idea, and were startled to see a Chinese vessel docking (Huebert 2001).

The Northeast Passage has drawn serious attention from Japan. Japan is studying options for using the passage for shipping goods to Europe and the east coast of North America. The Russians provide icebreakers to other countries to facilitate explorations, and have assisted Japan. The Russians hope this tactic will strengthen claims by acknowledging Russian hegemony and historic claims.

Canada's view, then and now, is that since the 1880 deed transfer (of the Arctic Archipelago from the UK to Canada), the waters of the Arctic Archipelago have been Canada's internal waters by virtue of historical title (Huebert 2001). Canada could also use exceptions for cold climates found in the Law of the Sea Treaty to enhance its rights in the area. One area, for example, is the enforcement of environmental pollution standards.

> Canada could invoke more exacting environmental standards through the United Nations Law of the Sea Convention (UNCLOS). Article 234, the ice-covered waters clause, allows a State to pass legislation that exceeds international standards for any ice-covered waters within its 200-mile Exclusive Economic Zone (EEZ).
>
> (Huebert 2001)

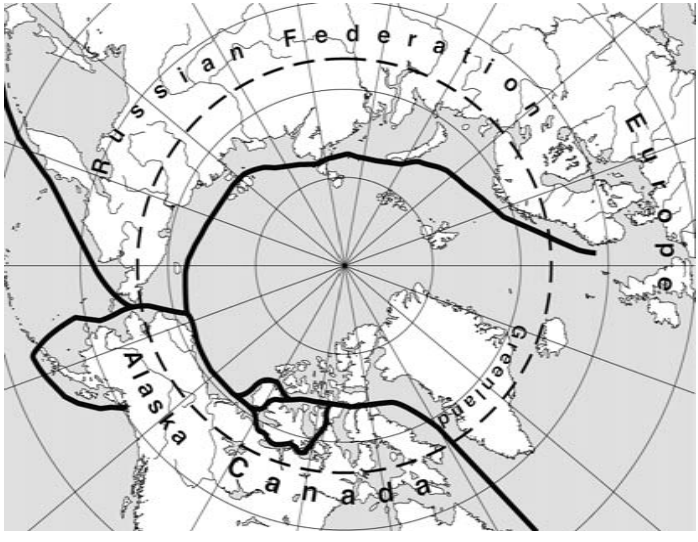
There are four security-related implications to the opening of both passages. First, traditional security problems of an international waterway will arise. This panoply of ills includes smuggling, crime, and other features of transportation networks. Second, the spread of new and exotic diseases via these trade routes can be a potential problem. Canadian airports, after all, were significant entry points for SARS for a variety of reasons. Third, even if Canada implements strong environmental regulations, the probability of an accident will increase with the corresponding growth of ship traffic. As the *Exxon Valdez* accident demonstrated, the grounding of a large vessel in fragile polar waters can produce an ecological disaster. Fourth, the lifestyle of Canada's northern Aboriginal peoples, as well as Russia's, will dramatically change with increased international shipping. There will need to be some support programs for such large transitions of demography and lifestyle.

This is not to say that the overall impact on Northern Canada or Russia will necessarily be negative. From an economic standpoint, this will be a boom area and a substantial opportunity for development.

> There are some advantages to the melting of the Northwest Passage. Singapore has demonstrated that with the proper planning, geographical location on an international strait can bring substantial economic benefits. Vessels transiting the Passage would require certain services. For example, Tuktoyaktuk and Iqaluit could conceivably become important ports of call if their port facilities were substantially improved.
>
> (Huebert 2001)

Canada has attempted to develop some protocols and potential routes (see Map 2.2). "New multilateral efforts to prepare for increased maritime traffic in the Arctic have also begun in the 1990s. An initiative of the Canadian Coast Guard led a group of Arctic coastal states and relevant international shipping companies to meet in 1993 to develop what is now known as the Polar Code" (Huebert 2001). The code sets some minimum standards for conduct.

What are international versus Canadian waters is debatable. Under the UNCLOS agreement, the definition of international versus national waters is determined by the distance from shoreline to shoreline. How that distance is calculated can be preferential to country claims. One way to calculate distance is by using shoreline averages. By this definition, the waters surrounding the Canadian Archipelago would be Canadian waters. Another way to calculate is by measuring the maximum and minimum points from continental to island points. This



Map 2.2 The Northwest Passages.

method of calculation favors the US view that these are international waters. A rise in sea level will work against the Canadian argument, because distances between land points will increase. UNCLOS provisions seem to support the Canadian claim, at least for the moment. In 1986, Canada claimed the sea area surrounding over 16,000 islands (Zorzetto 2006).

The dispute over the Northwest Passage right-of-way demonstrates how changing climate can invite conflict as the national interests of differing countries collide. New climates create new possibilities and opportunities, and draw in differences in ownership rules. A key travel route sought after for centuries will be a reality. It is akin to nature building a Panama or Suez Canal, or several of them.

Amundsen also led the first expedition to reach the South Pole and safely return. Amundsen outraced Britain's Robert Falcon Scott, who trailed by three months. Scott perished on the return trip, along with his team. Amundsen's exploration of the Northwest Passage was an honor for Norway, but the purpose of his exploration of Antarctica was to establish Norwegian territorial claims.

Explorers are leading indicators of country territorial claims and bases for legal sovereign rights. In the past, it did not matter if people were already living there. Today, and in the future, it will. Nevertheless, being the first there, in person, remains a benchmark for territorial claims.

Christopher Columbus' voyages, starting in 1492, laid the basis for Spain's extensive land claims in the Western hemisphere. The voyages of Roald Amundsen and Neil Armstrong will likely have similar historical reverberations in territorial claims in Antarctica and outer space for Norway and the United States, respectively.

The evolving role of climate change and conflict in history

This section summarizes the historic cases of climate change and conflict by providing two types of perspective. First, there is a comparison of the case attributes and characteristics. Second, a series of lessons are distilled from the cases.

Attributes of historic cases of climate change and conflict

Some general attributes of the historic cases are worth consideration. The attributes can help in creating a framework to imagine and categorize climate change on dimensions of comparability. The eight cases are broken into four historic periods. The periods begin 12,000 years ago and continue until today; some, presumably, into the future. The assumption is that the Anthropogenic Warming Period that began in the nineteenth century was the beginning of a longer period of climate change that will last hundreds of years.

Three defining attributes of climate change are location, type, and scope of conflict. The location of the case differs by size, and ranges from a locality to a continent. The climate change type includes changes in temperature, changes in precipitation, and extreme events (usually high levels of precipitation and wind). Conflict types include the scope of social dispute and the entities involved.

The locations of the cases show a global distribution. Three cases originate in Europe, two in temperate North America, and one each in Latin America, Asia, and Africa. One-half (or four) of the climate change types involve changes in temperature; three types involve changes in precipitation, while one type involves an extreme event. The conflict types are quite varied. One case involves inter-species conflict. Four cases are inter-state disputes, and three are intra-state disputes. The periods are by design equally selective, with the time span for cases gradually shrinking over time (see Table 2.4).

In many instances, the inter- and intra-state cases are likely to overlap. The cases largely reflect present day environmental conflicts. There are few cases today where the national interest is not part of a larger international tapestry of interests. The line between these two types of behavior is becoming increasingly blurred.

There are five attributes regarding climate change and the types of conflict to consider. These points occur in specific periods of warming and cooling, as a Hot War in the Equatorial Tension Belt and as a Cold War in the Polar Tension Belt.

First, with respect to the *area of conflict*, the climate changes produce two differential impacts. In the Equatorial Tension Belt, lands that are marginal gradually lose resource assets. Productive lands become marginal and marginal lands unproductive through desertification. In the Polar Tension Belt, the opposite occurs. Unproductive lands become marginal, and marginal lands become productive.

Second, the *conflict type* may be one between states or within them. By nature, the two areas again show divergent paths. In the Polar Tension Belt,

Table 2.4 Comparing the historic and current cases

Case	*Period duration*	*Location*	*Conflict process Type*	*Climate change type*
Neanderthal	50000–30000 BC	Europe	Cold	Temperature
Mohenjo	2500–1700 BC	South Asia	Hot	Precipitation
Maya	500–800	Central America	Hot	Precipitation
Vikings	100–1400	North America	Cold	Temperature
Anasazi	750–1600	North America	Hot	Precipitation
Year Without summer	1300–1850	Central Europe	Cold	Extreme event
Fulani and Zarma	1895–today	African Sahel	Hot	Precipitation
Northwest Passage	1942–today	Northern Canada	Cold	Temperature

since the now habitable areas were largely uninhabited, the conflict is between differing states that seek to exploit this new area. It is more likely in the Equatorial Tension Belt that conflicts over declining resources will involve regional neighbors.

Third, the *climatic cause of conflict* is a menu of differing types. In the Polar Tension Belt, the change in temperature indirectly drives conflict behavior. In the Equatorial Tension Belt, change in precipitation patterns is most important. Higher temperatures will lead to greater evaporation.

Fourth, the *resiliency of conflict* is quite different for the two areas. In the Polar Tension Belt, conflict is episodic. Cold Wars come and go with changes in temperature. Until today, humans simply could not survive in these areas except in limited numbers (for example, the Eskimos) because of climate harshness. Large-scale economic systems would not work in colder temperatures. This result is in part due to the nature of the impact of cold and hot temperatures on people. Cold temperatures will kill people more easily than hot temperatures.

In the Equatorial Tension Belt, the process is more gradual and continuous. Hot Wars often remain areas in conflict, as human population growth and changes in habitat tend to exacerbate changing conditions. These areas then enter perpetual states of conflict that heighten or lessen with changing climates.

Fifth, Hot Wars tend to create *livelihood conflicts* that lead to social tension within political entities, and thus cause intra-state conflict. Cold Wars are more often instances where push factors such as overpopulation and limited resources compel states to expand into areas that are newly habitable and exploitable. The cases are often inter-state in nature (see Table 2.5).

Climate change and conflict lessons

Six types of conflict situations span the eight cases. The lessons assist in understanding cases of climate change and conflict and putting these phenomena into context. With them, it is possible to prepare a template for considering future cases.

Table 2.5 Comparing conflict attributes in the Hot and Cold Wars

Conflict attributes/Climate war type	*Cold War*	*Hot War*
Area conflict	Uninhabitable lands become marginal	Inhabitable lands become marginal
Conflict type	Inter-state	Intra-state
Climatic cause of conflict	Rise in temperature	Decline in precipitation
Conflict resiliency	Episodic state of conflict	Permanent state of conflict
Conflict and livelihoods	Creating new livelihoods	Maintaining old livelihoods

Terra-forming

Dramatic changes in climate can lead to equally dramatic changes for humans who live in or move to a terra-formed region. The consequence is that several peoples, for a variety of push and pull factors, will migrate to the same area. In establishing claims, conflict is a natural outcome. Terra-forming usually takes on two characteristics that bring differing social groups into conflict.

The first type is the retreat of ice. The Holocene Warming Period had a small but vital impact on the higher latitude areas in the Northern Hemisphere. The focus of migration centered largely on modern-day Canada. From the west, humans traveled across the Bering Straits (and, scientists now believe, from other places) and populated the Western Hemisphere in the early stages of warming at least 30,000 years ago. From the east, people moved into Europe, hopped across several islands, and later landed in Greenland and the exterior of Canada. In the first instance, people migrated to terra-formed lands where no other humans resided. In the second instance, the descendants of an ancient Native American people and the Vikings disputed lands and resources.

The second type of terra-forming of consequence to humans in recent history is desertification. Desertification in some places, like the Gobi Desert, has advanced in large part due to human impacts. These marginal areas simply did not possess the carrying capacity for expanded human populations. The world's largest desert, the Sahara, has, since the end of the last Ice Age, undergone tremendous changes. During the Ice Age, the desert was actually larger than today. During the early Holocene Period, the desert shrank, especially in the south. These patterns reversed, and the desert expanded to its current area perhaps 3,000 years ago.

Carrying capacity

Climate change can be significant but not dramatic. What makes it dramatic is the combination of the natural forces and human causes over time. The combination of the two in roughly equal amounts can result in desertification conditions,

if the carrying capacity of humans exceeds some sustainable level. The phenomenon can happen in cold areas as well. In Greenland, exploding levels of Viking populations overwhelmed the limited resources. This deficit in turn led to further expansion, to Canada. Slow changes will gradually accumulate, just as populations do. Social decline is usually incremental, but can be dramatic when coupled with extreme events.

With carrying capacity, two trends operate in tandem. One trend is the relation of the people to the natural ecosystem, representing demands and economic subsistence strategies. The countervailing trend is the ability of the land to support the human demands, given sustainability and replenishment levels of renewable resources. Focus on non-renewable resources, such as oil or metal, came later in history. The carrying capacity for non-renewable resources is fixed, but non-renewable resources are not and can be sustainable. Non-renewable resources may decline as habits change (through deforestation or desertification) or as specific species of subsistence focus decline.

Conflict results in the search for declining resources. The choices are either to go to new places and confront possible inter-nation conflict, or to control existing resources against other domestic parties. The two pathways can cross. The Mohenjo-Daro case shows an example of carrying capacity problems that opened the door for invasion.

Livelihoods

Individual livelihood can suffer from climate change, and result in conflict. This is the point where the human factor takes over from the natural factor as the prime cause of change in economic subsistence. This type of conflict is a variation of carrying capacity, or perhaps an interim transition period seen in the long term.

Livelihood wars occur when the carrying capacity per person, family, or other social grouping drops below the survival rate. The drop is the push that forces migration, and is paired with the pull of terra-forming. Historically, these shifts have been over shorter distances.

There are at least two types of livelihood wars related to conflict. The first conflict type is over territory for agricultural self-sufficiency. This type is a matter of arable land and its availability. The second type occurs when livelihood takes the extreme form of large-scale criminal activity. In this instance, arable land is not available, and warfare is the only option for survival. The Maya case study shows an example of livelihood conflicts related to climate change.

Resources

Terra-forming may also permit the extraction of certain specific resources required by a societies' techno-sphere that is the basis for subsistence strategies. Hunters found vast mammoth herds as they traveled from Siberia to North

America. The warming of ice-bound regions has allowed greater extraction of valuable resources such as gold, diamonds, timber, and furs.

What constitutes a valuable resource, of course, naturally changes with the type of economic system and with time. Petroleum was of little use to Neolithic peoples. The extent of effort necessary to acquire the resources was a function of its value and the associated costs.

Resource-related conflicts are indirect effects of climate change. They are national interest issues that relate to individual country economic profiles and livelihoods. These resources may be in demand for domestic growth or for exports, or as input products to important domestic or international industries.

Ecotones

An ecotone is a transition area that possesses characteristics common to two larger systems, and is thus an area of overlap in climate types. Climate change might cause transitions from a wet to a dry zone, or a cold one to a hot one. In the ecotone, either of the economic subsistence patterns might be able to survive.

When there are climatic push factors, there is an inclination for peoples to exploit transition areas. Ecotones may grow or decline with climate change, and thus be areas for out- or in-migration. With the possibility that exploitation might come from more than one domestic group, the chances for conflict increase. The Fulani case exemplifies the ecotone issue.

Extreme events

Extreme events or cataclysmic weather result from rapid periods of climate change. They also can act as precipitating catalysts for conflict. In societies already under stress from other climatic factors, extreme events can act as key points in the ability of societies to survive in new environments. Extreme events in this context may be unusual weather patterns lasting for days or weeks, or they may be shorter-term impacts, perhaps caused by geologic activity, that might last months or years.

The demise of Mohenjo-Daro may have been related to geologic events in addition to long-term climate trends. Hurricane Katrina, perhaps like Noah's flood, shows how extreme events can have catastrophic impacts. During the Little Ice Age, the added impacts from geologic activity pushed a gradual cooling trend even further, and did so rather rapidly, creating the year without summer.

Summary of lessons

The lessons from the differing cases include elements that may be useful to understanding upcoming cases of climate change and environment. Each period theme corresponds to key case lessons (see Table 2.6). Some of the lessons are nature-driven, while humans drive others.

The next chapter takes these lessons as a framework for conceptualization. The framework follows a time track, in looking at future trends in climate change and conflict, separately and in tandem.

Table 2.6 Climate change and conflict lessons

Case	*Period*	*Lesson*
Neanderthal	Holocene Warming Period	Terra-forming pushes and pulls migrants and claimants
Mohenjo	Holocene Warming Period	Carrying capacity declines and increases intra-state social stress
Maya	Medieval Climate Optimum	Livelihood wars easily spread to other countries
Vikings	Medieval Climate Optimum	Resources that become economically viable become strategically important
Anasazi	Little Ice Age	Carrying capacity declines and increases intra-state social stress
Year without summer	Little Ice Age	Extreme events can radically change power configurations
Fulani and the Zarma	Anthropogene Warming Period	Ecotones are sensitive niches that can easily be upset
The Northwest Passage	Anthropogene Warming Period	Terra-forming creates new areas of national interest

3 Climate change and conflict trends

Linking climate change and conflict begins by looking at two major types of possible convergence. These convergences are especially pronounced on the regional level. First, a group of regions likely to show convergence would possess a greater than average level of conflict. In regions with existing high conflict propensity, it may not require too much climate change to exacerbate and incite conflict conditions.

Second, areas of higher than average climate change may converge with small levels of conflict to incite tension. There is the possibility that even in areas where there is little historic conflict, greatly increased climate change may reveal hidden conflicts.

The areas of convergence point to places where climate change will influence conflict. Each convergence embodies differing types and locations of conflict. Using forecast material on climate change and conflict, and employing lessons learned, this chapter looks at climate change and conflict potentials in different parts of the world.

To support the idea of Hot and Cold Wars, regions of climate change and conflict should occur in the Equatorial Tension Belt and the Polar Tension Belt. The ultimate goal, though, is to refine these broad swathes of the planet into more discernible genres of conflict, and identify the likely parties involved. Thus, there will be different regions even within a particular portion of the Polar Tension Belt or Equatorial Tension Belt that show attributes of climate change and conflict. Relying on the lessons from Chapter 2, it is also possible to discuss the nature of conflict in each of the specific regions within the two Tension Belts.

There are three main parts to this chapter. First, it lays out the dimensions and depth of future climate change based on the IPCC forecasts. These forecasts reflect regional configurations. Second, trends in conflict also need to be explored, both those in the recent past and those extending into the near-term future. Third, the climate change and conflict forecasts are examined on a regional basis. By examining the prospective areas of climate change and of conflict together, it is possible to identify where these two forces might converge and point to the lessons from historic cases.

The evidence for and forecasts of climate change

The most authoritative and extensive forecasts on climate change come from the Intergovernmental Panel on Climate Change (IPCC), a group of scientists from 130 countries (IPCC 2007a: 4). The IPCC 2007 report expressed much higher confidence in climate change forecasts than in previous reports. The Fourth Assessment Review (FAR) of the IPCC sees "changes in long-term climate patterns, including Arctic temperature and ice, changes in precipitation, greater or more intensive extreme events, and the like" (IPCC 2007a: 8). The report, along with other supporting evidence, lays out the extent and nature of the changes in climate. The IPCC approach recognizes that climate change consists of both natural and human elements. One major cause of climate change is global warming brought on by greenhouse gas emissions. There are other significant contributors, particularly habitat change brought on by tropical deforestation. A third cause is the increased atmospheric concentrations of aerosols.

The United Nations Environmental Program created the IPCC in 1998, when evidence of climate change began to accumulate and questions on anthropogenic factors arose. The group meets and disseminates research findings every four years. The FAR consists of reports from three working groups. Working Group I is concerned with "The Physical Science Basis" (released 2 February 2007); Working Group II is concerned with "Impacts, Adaptation and Vulnerability" (released 6 April 2007); and Working Group III is concerned with "Mitigation of Climate Change" (released 4 May 2007). A fourth report in November 2007 was a synthesis across the three working groups.

The scope and reliability of reporting has increased with each assessment: "The understanding of climate change and the human role in it has markedly improved since TAR [Third Assessment Review] and there is now a very high confidence that global warming is largely due to human activities" (IPCC 2007a: 5). FAR is also thought to be more reliable than TAR because many more policy simulations were run to illustrate differing policy outcomes. Moreover, there was more model testing regarding the sensitivity of forecasts to exogenous influences (IPCC 2007a: 12).

The Fourth Assessment Review is definitive in saying that "Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years" (IPCC 2007a: 2). It is certain that the primary cause of climate change is through fossil fuel use, followed by land-use change. The magnitude of change is likely to be unique over an extended time span. Only the inter-glacial period 125,000 years ago is comparable in magnitude.

> Changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation and land surface properties alter the energy balance in the climate system. These changes are expressed in terms of radiative forcing, which is used to compare how a range of human and natural factors drive warming or cooling influences on global climate. Since the Third Assessment

> Report (TAR), new observations, and related modeling of greenhouse gases, solar activity, land surface properties and some aspects of aerosols have led to improvements in the quantitative estimates of radiative forcing.
>
> (IPCC 2007a: 2)

There is the expectation that warming will in general move species nearer towards the poles to continue to live in the ecosystem to which they are best suited. There will be "pole-ward and upward shifts in ranges of plant and animal species" (IPCC 2007b: 2). The shift will also occur in the ocean and other waterways, where there will be "range changes and earlier migrations of fish in rivers" (IPCC 2007b: 2). The creatures living at the poles, few as they are, will of course not be able to move pole-ward.

The IPCC forecasts of climate change derive from historical evidence on emissions and concentrations of greenhouse gases. A clear agreement is that temperatures worldwide, and especially at the extreme latitudes, will increase by a substantial amount. Less certain is where changes in precipitation will occur, the nature of this precipitation, and what the extent of extreme events will be.

The IPCC considered a range of six possible scenarios for climate change, with a gamut of possible policy implications, and developed two families of forecasts based on views of how globalization will continue to unfold in terms of two key issues: incomes and technology.

The "A" family of scenarios differs according to the degree of globalization. The assumption is that more globalization will lead to rapid economic growth and a convergence of incomes worldwide. This economic growth will in turn reduce birth rates and produce more efficient technologies. An alternative scenario in the family posits less globalization and remaining income differences. This outcome would witness areas where birth rates remain high.

The "B" family envisions a future where technological capacity also has global and regional possibilities. From a global perspective, the assumption is that technologies will be widespread and available. From the regional perspective, differences in technologies will remain and result in differing mixes of energy consumption (fossil fuel, non-fossil fuel, or mixed). The scenarios differ as to whether they would be market- or distribution-driven.

There are six key driving assumptions in the forecast scenarios: population, economic growth, per capita income, primary energy consumption, distribution of hydrocarbon use, and land-use changes. The scenarios provide mixes of these six key drivers that guide the parameters of the IPCC forecasts.

Two of the scenarios are somewhat similar, so the focus will be on four major scenarios from the IPCC. The A1 scenario reflects a "market" approach to the future. This vision entails relatively little differences in income worldwide (there are several approaches to this, called the A1B scenarios). The A2 scenario is also a market approach, but one based on "regions" with differences in income. The B1 scenario represents a "green" approach to the future, with a global distribution of technologies. The B2 scenario is a "sustainable" one, where technology distribution remains regionally differentiated (See Table 3.1).

Table 3.1 The scenario assumptions and outputs

Scenario	*Input assumptions*					*Model outputs*		
	Economic growth	*Per capita income*	*Energy use*	*Hydrocarbon use*	*Land-use change*	*Population (billions)*	*Temperature increase, ºC*	*Sea level rise, meters*
A1: Markets*	Very high	Very high	Very high	Low to very high	Low	7	2.8	0.35
A2: Regions	Medium	Low to medium	High	Low to medium	Medium	15	3.4	0.37
B1: Green	High	High	Low	Very low to high	High	7	1.8	0.28
B2: Sustainable	Medium	Medium	Medium	Low to medium	Medium	10	2.4	0.31

Note
* This forecast is based on an assumed balance in use of fossil fuels. There were two other scenarios that assumed more and less amounts of fossil fuel use (the A1B series).

Most of the scenarios imply significant policy directions. The A2 Regions scenario is most like a baseline for considering future trends. This scenario envisions limited changes in lifestyle and technology compared to the other scenarios. Population in this scenario rises to 15 billion by the year 2100. There will continue to be distinctive differences between regions. There is assumed to be moderate economic growth, with global income per capita still low to medium, high amounts of energy use, low use of hydrocarbons, and medium amounts of land-use change. The output suggests that temperatures would increase globally by 3.4°C (6.7° Fahrenheit) and sea levels increase by 0.37 meters (1ft 2in).

The other three assumptions carry with them ideological goals that act as solutions to the problems, or at least trends favorable to solving greenhouse gas concentrations. Outside of the A2 scenario, the other three scenarios are optimistic in their outlook on climate change patterns.

The Markets scenario (A1) assumptions include a population level less than half that of the Regions scenario (A2), at seven billion in the year 2100. This population level results from very high levels of economic growth and per capita income that in turn reduce birth rates. There is uncertainty about hydrocarbon use but high optimism in improved land-use patterns, no doubt due to the lower population level. Despite the optimism in the model inputs, the outputs are not very different, suggesting the model is somewhat inelastic. Temperatures increase by 2.8°C (an 18 percent drop from A2) and sea levels rise nearly as much as in the A2 baseline.

The Green scenario (B1) also has, intrinsic to its vision, a large decline in birth rates and again a population level of seven billion in 2100. High economic growth and income levels drive down birth rates. At the same time, new technologies enable citizens to have a low level of energy use with a mix of hydrocarbons. The Green scenario would, however, lead to a high level of land-use change, presumably related to differing types of agricultural practices. The result is a temperature increase of 1.8°C (almost one-half that of the A2 scenario) and a sea level rise of 0.28 meters (a decrease of about one-quarter).

The Sustainable scenario (B2) is a little less optimistic than the Markets or Green scenarios. Here, population falls by one-third, to ten billion, from the baseline. Almost all of the factors are in the medium range, so that it stands between the other two approaches to the baseline. The temperature rise is 2.4°C (a drop of 27 percent from the A2 scenario), and the sea level increase is 0.31 meters (about 18 percent less).

The translation of these inputs into the model produces a much more muted impact, at least measured by degree of variance. Temperatures under any scenario will rise, as will sea levels. Temperatures will increase by at least a couple of degrees worldwide in the most optimistic view, yet even this, in some places, nearly equals the temperature change that took place at the end of the last Ice Age. In all scenarios, the Equatorial and Polar tension areas will expand. The only difference is a matter of degree and the rate of change. Sea level changes very little within the range of the various scenarios.

The scenarios do assume that greenhouse gases will accumulate for a period and gradually diminish past some high watermark. There are assumptions in the model that envision a declining birth rate and more efficient use of energy. The baseline scenario (A2) from the IPCC is used here for the sake of comparison with conflict data. No greatly pessimistic scenarios were considered by the IPCC, probably because they were politically untenable.

Changing the direction of the greenhouse gas emissions in a growing world will be difficult. While demand will grow, it will be necessary to reduce the volume of emissions from today's levels, and not merely to reduce the rate of growth. The IPCC finds that stabilization of human-induced influences on climate change (450 parts per million of carbon dioxide), a far-off target, would mean that cumulative emissions over the twenty-first century would need to fall from 670 to 490 gigatons of carbon (GtC) per year (IPCC 2007a: 17). The likely impacts from the climate change scenario can be broken down into three types: temperature, precipitation, and extreme events. These changes can also be the basis for thinking about convergence with conflict.

Temperature

The IPCC looked at a wide range of temperature studies and surveyed the findings. Data since 1970 show that "Of the more than 29,000 observational data sets, from 75 studies, that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming" (IPCC 2007b: 3).

The model shows noticeable "effects on agricultural and forestry management in Northern hemisphere higher latitudes" resulting from higher temperatures (IPCC 2007b: 4). These effects are generally positive in terms of increasing agricultural productivity. Some areas are already encountering negative impacts. "In the Sahelian region of Africa, warmer and drier conditions have led to reduced length of growing season with detrimental effects on crops. In southern Africa, longer dry seasons and rainfall that is more uncertain are prompting adaptation measures" (IPCC 2007b: 4).

One indicator of a changing climate is the frequency of years with the highest overall average global temperature. The IPCC results show an unmistakable upward trend: "Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850)" (IPCC 2007a: 5). Other scientists disagree on the human causes for warming, and attribute trends to naturally occurring solar and orbital variations.

Warming, however, will be unevenly distributed: "Warming is expected to be greatest over land and at most northern latitudes, and least over the Southern Ocean and parts of the North Atlantic Ocean" (IPCC 2007a: 15). Warming will increase desertification north and south of the Sahara desert and in heavily populated South Asia.

A second indicator of warming focuses on the extent of mountain glaciers and polar ice sheets. Melting of glaciers and polar ice areas is the result of higher

temperatures. "Average Arctic temperatures increased at almost twice the global average in the past 100 years. Arctic temperatures have high decadal variability, and a warm period was also observed from 1924 to 1945" (IPCC 2007a: 8).

Glaciers are in full retreat worldwide, and most will disappear in the twenty-first century. "Mountain glaciers and snow cover have declined on average in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rises" (IPCC 2007a: 7). Polar land ice sheets are also rapidly shrinking. "New data since the TAR show that losses from the ice sheets of Greenland and Antarctica have very likely contributed to sea level rise over 1993–2003" (IPCC 2007a: 7). At least in the short-term, there will be "increased run-off and earlier spring peak discharge in many glacier- and snow-fed rivers" (IPCC 2007b: 2). In the long-term, there will be less glacier run-off in the summer when it is most needed.

Higher temperatures near the poles will also reduce snowcaps and sea ice. "Snow cover is expected to contract. Widespread increases in thaw depth are projected over most permafrost regions" (IPCC 2007a: 16). These regions are very concentrated in Russia and Canada. Seasonal permafrost is also on the decline. "The maximum area covered by seasonally frozen ground has decreased by about 7% in the Northern Hemisphere since 1900, with a decrease in spring of up to 15%" (IPCC 2007a: 8).

Critical to transportation corridors is the prevalence of sea ice. "Sea ice is expected to shrink in both the Arctic and Antarctic under all SRES [Special Report on Emissions Scenarios] scenarios. In some projections, Arctic late-summer sea ice disappears almost entirely by the latter part of the twenty-first century" (IPCC 2007a: 16). This reduction in sea ice renders the Northwest Passage more viable as a transportation corridor, and more likely to be a source of conflict.

A final indicator of a changing climate is the rise in sea level. During colder periods, there is more water locked up as ice and sea levels fall. During warm periods, sea levels rise. "There is high confidence that the rate of observed sea level rise increased from the 19th to the twentieth century" (IPCC 2007a: 7). This outcome is in part a consequence of the three earlier conditions indicating higher temperatures.

It is useful to consider the IPCC findings from a paleoclimatic perspective. The last half century has witnessed the warmest temperatures for the last 1300 years, or since the Medieval Climate Optimum. If temperatures continue to rise at current and expected rates, they may soon exceed highs of any time since the end of the last Ice Age and the Holocene Warming Period. As noted, the last interglacial period of comparable warmth was about 125,000 years ago (IPCC 2007a: 10). The IPCC forecasts a warming of 0.1°C per decade for the next two decades (IPCC 2007a: 12). A simple calculation reveals that over 20 years, temperatures would rise by 2°C.

> Numerous General Circulation Models (GCMs) project a global mean temperature increase of 1.4°C to 5.8°C by AD 2100, a change much more rapid

> than any experienced in the past 10,000 years. The most significant temperature changes are projected to occur at higher latitudes and over land. In addition, greatest warming is expected to occur in winter and spring, similar to the trends measured recently, although warming is projected for all seasons. Although GCM [Global Climate Model] projections vary, in general, winter temperatures are expected to rise by 6°C to 10°C and summer temperatures by 4°C to 6°C over much of Canada and Russia, with a doubling of atmospheric carbon dioxide (CO_2).
>
> (Natural Resources Canada 2007)

The momentum of current trends is only part of the story. Accumulated greenhouse gas emissions will actually accelerate climate change by about 2030. There is nothing possible in the short term to prevent this change. By 2030, warming is "very likely to be at least twice as large as the corresponding model-estimated natural variability during the twentieth century" (IPCC 2007a: 13).

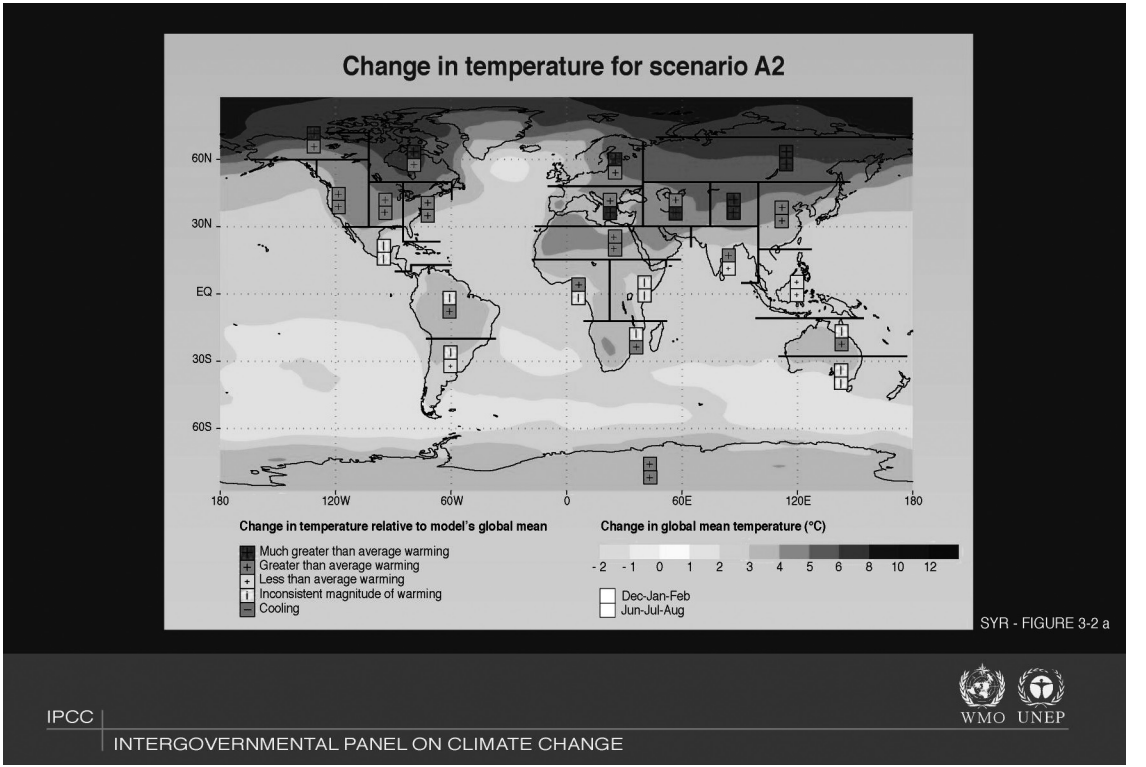
Greenhouse gas emissions will continue to grow, supplemented by changes in land use. As tropical forests are burned to create farmland, not only is a carbon sink lost but the carbon is also released into the atmosphere.

The IPCC forecasts are based on inter-linked regional models. Seeing the temperature distribution across the regions reveals the varied impacts. The climate models are broken down into 23 regional land groupings (see Map 3.1). The hotter temperatures for the period 2090–2100 are darker, showing warming that is higher than average. There is also a two-sided bar for each region, indicating differing amounts of change in temperature in the winter and summer seasons.

The most extreme rises in temperature will occur in the winter; December to March in the northern hemisphere, and June to August in the southern hemisphere. The melting of glaciers on Greenland and Antarctica will determine the extent of the rise in sea level. Under warming conditions, the great majority of this water is expected to thaw from the Northern Hemisphere. "Contraction of the Greenland ice sheet is projected to continue to contribute to sea level rise after 2100" (IPCC 2007a: 17). If this rate were sustained for millennia, the Greenland ice sheet would vanish, and sea levels would rise by about seven meters. Such a scenario would create a very different physical world. Antarctic ice seems less affected by climate change, compared to the North Pole, and may in fact increase with more precipitation.

Precipitation

Unlike temperature, which tends to be diffuse throughout the planet due to air circulation, precipitation patterns related to climate change are much less predictable and more regionally distinct. There will both be winners and losers in terms of precipitation; in some areas precipitation will increase, and others it will decrease. The types of precipitation will change. In terms of general types of precipitation, more will be wet and less will be frozen.



Map 3.1 Regional temperature changes in baseline scenario (A2).

Note
The worldwide scenario would see a rise in temperature of 3.4°C degrees and a sea level rise of 0.32 meters. Comparison of 2090–2100 to 1990–2000. Source: IPCC (2001) *Synthesis Report.* Figure 3–2a. Online. Available at: www.grida.no/publications/other/ipcc_tar/ (accessed 10 December, 2008).

Two related regional patterns of precipitation will ensue. Areas around the poles will become wetter and areas around the Equator will become drier, as rains move from the Equator towards the poles. "Increases in amount of precipitation are very likely in high-latitudes, while decreases are likely in most subtropical land regions" (IPCC 2007a: 16).

The winners will be the high latitudes in the Northern Hemisphere in the Polar Tension Belt. The idea of a winner in this context is a matter of debate. More rain in and of itself is not necessarily a good thing, in that it may lead to flooding and bring more disease to food crops. "From 1900–2025 there has been more precipitation in the eastern parts of the Americas and northern Eurasia" (IPCC 2007a: 8). More intense precipitation will occur in northern extremes. This will be especially the case in Canada, Alaska, Greenland, and Northern Asia.

The losers will be those areas in the Equatorial Tension Belt, which will worsen in terms of water availability. "From 1900–2025 there has been less precipitation in the Sahel, Mediterranean, southern Africa, and portions of South Asia" (IPCC, 2007a: 8). Where more water may be an ambiguous win for the Northern Hemisphere, less water for marginal areas around the Equator is demonstrably bad.

Changes in precipitation will fall on five groups of countries. First, the forecast envisions expanding the Saharan dry zone. The outlying regions of the Sahara Desert will stretch farther north into southern Europe, though it is likely that these societies can adapt. The Sahara Desert will also reach deeper into the Middle East. These societies will be less able to react.

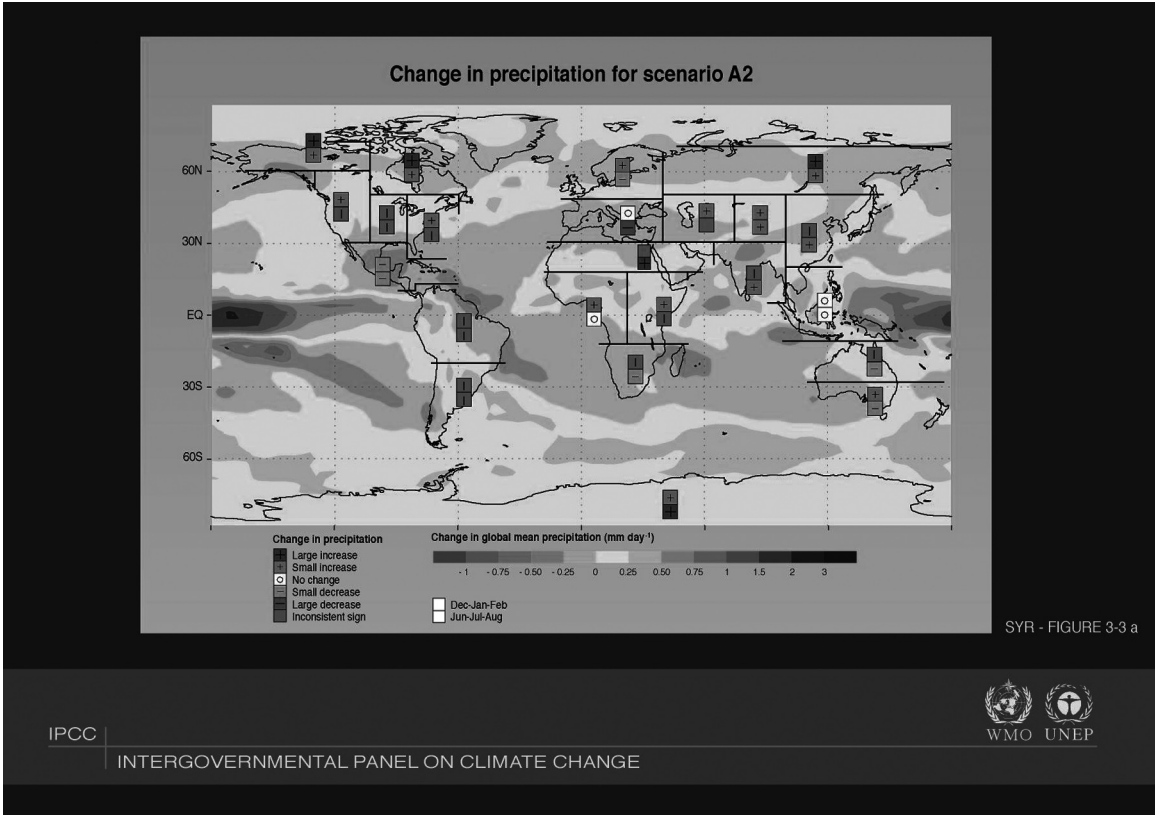
A second significant area of impact will be sub-Saharan Africa, especially southern Africa. A majority of world's failed states are in Africa, where the effects of climate change will lead to a further deterioration in their livelihoods. As the Sahara extends south and establishes new dry areas in southern Africa, these states and the quality of people's lives will deteriorate. A new dry area will cross the continent from roughly Angola to Mozambique.

The warming will affect large populations in countries such as Nigeria and Ethiopia. In the case of Ethiopia and neighbors such as Sudan, the droughts will be much more severe than during the period of major famines in the late twentieth century. Drought may also occur over parts of southern Africa, and may reach the African breadbasket of Zimbabwe, Zambia, and South Africa.

A third area of decreased precipitation is a zone that stretches north to south from Mexico, Central America, and along the east coast of South America from Colombia into central Brazil. These areas have fast-growing populations, which largely depend on subsistence agriculture.

Fourth, there will be areas of less precipitation in Western Australia and into Indonesia and Southeast Asia. Coupled with rapid economic and demographic growth in these areas, climate change will magnify in impact.

Fifth, the greatest areas of decreased precipitation will be in the Atlantic and Indian Oceans, with significant areas that will receive less rain. This trend will have indirect impacts on many parts of land masses through global weather patterns such as El Nino (see Map 3.2).



Map 3.2 Regional precipitation in baseline scenario (A2).

Note
The scenario would see a rise in temperature of 3.4°C degrees and a sea level rise of 0.32 meters. Source: IPCC (2001) *Synthesis Report*. Figure 3–3a. Online. Available at: www.grida.no/publications/other/ipcc_tar/ (accessed 10 December, 2008).

There will be winners to the extent that some areas will receive greater precipitation, which may be both a blessing and a curse. These beneficiaries are mostly developed countries and emerging economies of South and East Asia. The only developed countries expecting less rain are in Southern Europe. Developing countries will constitute the bulk of the precipitation losers.

The temperature and precipitation forecasts allow one to extrapolate into possible impacts on food production. Grain is a mainstay in many diets, and thus a good benchmark. Across central Asia, wheat will suffer and decline with the hotter weather, as will some rice production in East Asia. Maize production will be least impacted, especially with coordinated adaptations.

Some researchers link conflict outbreaks to rainfall patterns (Giles 2007). When rainfall is significantly less than average, then the chance for conflict roughly doubles. One case fitting this general mold was the fighting between Maoists and Royalists in Nepal in 2002, a period that was preceded by drier than normal conditions. Rainfall was, however, only one of many contributing factors that led to this particular conflict situation.

Extreme events

Extreme events are phenomena that vastly exceed normal conditions, often related to precipitation and wind. Rather than averages, event indicators reveal catastrophic situations that unfold during a short-term period. During periods of high climate change, extreme events are more likely measured by human, economic, or ecological cost.

Extreme events have an obvious human perspective. An extreme cold event that killed many moose, for example, would not have the same importance to us as one that killed many people. In the end, however, the health of the moose does have something to do with human health, since it may signal an impending ecological problem.

The Fourth Assessment Report suggests it is likely that climate change will lead to more frequent and more severe extreme events. Greater ranges of meteorological behavior accompany periods of rapid climate change. The IPCC concludes that "It is very likely that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent" (IPCC 2007a: 16). Forecasting such discrete events in the context of long-term climate models is nearly impossible. There are three possible extreme event types.

First, changes in precipitation patterns may become extreme. This means both longer periods of high rain, and drying periods of no rain. "The frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapor" (IPCC 2007a: 8). These extremes of heavy precipitation may occur in areas that generally become drier, with more catastrophic consequences taking place within shorter time periods.

The second change relates to the first condition. Not only will average precipitation decline in areas such as the Sahel; the incidence of extreme short-term

drought conditions will also increase. "More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics" (IPCC 2007a: 8).

The third type of extreme event is high-magnitude, intense cyclone activity. This includes hurricanes, tornadoes, monsoons, typhoons, and similar occurrences. Evidence here is largely anecdotal and regional in focus. "There is observational evidence for an increase of intense tropical cyclone activity in the North Atlantic since about 1970" (IPCC 2007a: 8).

Cyclonic activity often includes conditions of high wind and rain associated with large bodies of waters. This phenomenon is regionalized, with tropical cyclones in South Asia, typhoons in East Asia, and hurricanes and tornadoes in eastern and central North America. Storms normally found in the tropics will move pole-ward. It is not clear whether there will be increases or decreases in the current range of extreme storms.

Two areas where extreme events might intensify could push an already precarious survival over the edge. The first area, the Caribbean Islands, is often subject to extreme events. On islands such as Hispaniola, particularly on the Haitian side, extreme events coupled with massive deforestation and soil loss could produce a mammoth tragedy and incite conflict. This calamity would no doubt spill over the border into the Dominican Republic, and refugees would flood into parts of North America.

A second area for possible extreme weather events is around the Bay of Bengal, especially in Bangladesh. Coupled with overflowing populations and rising seas, an extreme event may put millions at risk.

Could there be a large-scale disruption of the Earth's climate patterns, such as a major disruption in the circulation of the Atlantic Ocean Gulf Stream? This outcome seemed quite unlikely to the IPCC researchers, and no evidence emerged to support that scenario, though nothing explicit in terms of model runs was reported. While the meridonal overturning circulation (MOC) of the Atlantic Ocean will slow down over the twenty-frist century, they conclude that it is very unlikely the planet will undergo any "abrupt transition" (IPCC 2007a: 16).

Evidence for trends in climate change

The three areas of climate change impact (temperature, precipitation, and extreme events) can be categorized on a number of revealing dimensions (see Table 3.2). These impacts are compared on four dimensions: climate trend phenomena, the trend reliability, the extent of human contribution, and the chances that the outcome will be realized. The temperature change is virtually certain, while changes in precipitation will see differing regional distributions. All of the noted phenomena are likely, with some more likely, or virtually certain. The role of humans in these trends is more likely than not. Extreme events appear sporadic and a largely singular behavior.

The three types of climate impact can also be considered in terms of their relation to socio-economic sectors. Agriculture, forestry, and ecosystems will

Table 3.2 Summary of climate trends

Climate change	*Phenomenon and direction of trend*	*Trend reliability**	*Human contribution*	*Outcome likelihood*
Temperature	Fewer cold days and nights	Very likely	Likely	Virtually certain
	More hot days and nights	Very likely	Likely (nights)	Virtually certain
Precipitation	More rain in higher latitudes	Likely	More likely than not	Very likely
	Less rain near Equator	Likely	More likely than not	Very likely
Extreme events	Heat waves and heavy precipitation events	Likely	More likely than not	Very likely
	Drought increases and increased cyclones	Many regions	More likely than not	Likely
	Extreme high sea level	Likely	More likely than not	Likely

Source: Adapted from IPCC (IPCC, 2007a: 9).

Note
* Likelihood that the trend occurred in the late twentieth century (typically post-1980).

see vastly differing outcomes based on their proximity to the Equator or the poles. Water resources will generally suffer, except for short-term snowmelt. Human health will see benefits or costs depending on the indicators of location, industry, settlement type, and social impacts (see Table 3.3). Most economic sectors will suffer from transition costs in adapting to the new climate. The areas likely to suffer are those with little economic reserves, and where the carrying capacity lags behind demographic and industrial growth. This will generally characterize developing countries.

Table 3.3 Summary of climate trends by sector

Climate change	*Agriculture, forestry and ecosystems*	*Water resources*	*Human health*	*Industry, settlement, society*
Temperature	More output in north, less in south Reduced yields in warmer regions	More melt and precipitation More evaporation	Less mortality from cold More mortality from heat	Transport and energy gains Housing shifts
Precipitation	Loss of land or crops Lower yields	Lower water quality Less water	Lower health indices Increased food shortage	Flooding impacts Population migration

Source: Adapted from (IPCC 2007b: 16).

Breaking down the regional data for temperature and precipitation forecasts in the A2 IPCC scenario gives a comparative examination of relative impact. Excluding ocean areas, there are 23 distinct land areas modeled on a regional basis. These 23 regional climate regions are the basis for climate and conflict discussions that follow. Forecast data are converted from interval to ordinal scales based on the degree of temperature change. This produces five general types of impacts compared to a global rate of change: Much Greater Than, Greater Than, Inconclusive, Less Than, and Much Less Than. Keep in mind the average global rate of change is 3–4°C (average of 3.4°C) compared to today.

In five areas, temperature forecasts were inconclusive. In four areas, temperatures will likely increase, but less than the global average. That leaves 14 regions of increase above the mean, half of which will see much greater than average increases.

With respect to precipitation, 17 areas are inconclusive. This pattern suggests the modeling is less precise than in determining temperature trends. Of the remainder, three areas in the far north will increase in precipitation above average, and two will decline compared to the average. Extreme events are mostly limited to the Caribbean and the Bay of Bengal (see Table 3.4).

Forecasts of climate conditions provide the basis for speculation on possible conflict outcomes. Climate change itself may not be the sole reason for conflict, but it may create structural conditions where such an eventuality is more likely given the proper spark. Trends may impose an inextricable momentum to the direction of change that may put countries on a collision course.

The discussion that follows requires some framework of time and expectation. Forecasting possible conflict from climate change 100 years into the future is admittedly an exercise in educated guesswork. Modeling the planet's climate is a daunting task, but building a political conflict model on top of it is even more difficult. It is, however, possible to lay out some general scenarios of probable areas where conflict related to a changing climate is more likely.

When looking into the future it is true that the nearer into the future one looks, the higher the likelihood of reliability. There can be greater precision if one breaks the time horizon into smaller units that have differing weights of probability. One simple distinction would be to divide the 100-year period in two cohorts of 50 years each: conflict from today out to the year 2050, and from 2051 to 2100.

There are three good reasons for thinking about climate change in these two time intervals. First, the climate forecasts from now until 2050 are much more reliable compared to those further in the future. Given the slow movement in trends such as levels of population or greenhouse gas concentrations, and their rates of change, past performances of future trends have a high likelihood of accuracy.

At the same time, the next half-century will see a dramatic change in climate, and this is when the highest rate of temperature increase will occur. After 2050, the concentrations of greenhouse gases will likely start to level off. This is in part a function of an anticipated slowing of population growth rates. Around the

Table 3.4 Regions and climate forecasts compared to global averages

IPCC area	*Forecasts by temperature*	*Forecasts by precipitation*	*Continent*
1. Alaska	MGT	MGT	N. America
2. Hudson	MGT	MGT	N. America
3. West Coast	GT	I	N. America
4. Plains	GT	I	N. America
5. East Coast	GT	I	N. America
6. Cen. Amer./Carib.*	I	LT	N. America
7. North S. Amer.	I	I	S. America
8. South S Amer.	I	I	S. America
9. NW Europe	MGT	I	Europe
10. Mediterranean	MGT	MLT	Europe
11. Sahara	GT	I	Africa
12. West Africa	LT	I	Africa
13. South Africa	LT	LT	Africa
14. East Africa	LT	I	Africa
15. South Asia*	GT	I	Asia
16. Central Asia	MGT	I	Asia
17. N. EurAsia	MGT	I	Asia
18. Tibet	MGT+	GT	Asia
19. E Asia	GT	I	Asia
20. SE Asia	LT	I	Asia
21. N. Australia	I	I	Australia
22. S. Australia	I	I	Australia
23. Polar	GT	I	Antarctic

Notes
Terms: MGT = Much Greater Than, GT = Greater Than, LT = Less Than, I = Inconclusive.
* Possible increased extreme events.

year 2050, global demographic patterns may reach replacement levels. Population increase is a major driver of greenhouse gas growth. There will also be continuing improvements in technology, and less per capita greenhouse gas emissions.

Second, it is possible to look at ongoing conflicts and examine the extent to which climate change may aggravate or improve possible conflict situations in these two periods. This perspective can have some reliability in the short term, but extending this logic more than 50 years into the future can be subjective. New events or circumstances may emerge in the next 50 years that will be drivers of conflict not existing or apparent today.

Third, climate change in the first half of the twenty-first century will not only exacerbate existing cases of conflict, but also generate new ones. By the end of the twenty-first century, these events and the cascading dynamics will create an unpredictable life path. Changes in technology may also affect historical dynamics.

In the next 50 years, it is likely that broad areas of the planet will see more conflict or will encounter new conflict in part due to climate change. This period

may be more dangerous in terms of climate-induced conflict than the second half, from 2050 to 2100. In this time, both the rates of change in climate and population will be at their highest.

Extrapolating conflict trends

The nature of war has been shifting and becoming more dangerous for the civilian. Half a century ago, Quincy Wright wrote that: "the total number of deaths indirectly due to war have been three times as great as direct war deaths in twentieth-century Europe and that the proportion of losses outside Europe and in Europe has been greater" (Wright 1965: 245). The trends that Wright noted then continue today.

Since 1945, the role of civilians in warfare has become more prominent in terms of casualties because countries have come to see conflict in terms of all-out war. Ruth Leger Sivard found that "Wars are now more life-threatening for non-combatants than for the men fighting them" (Sivard 1985: 9). These non-combatants are often casualties of indirect conflict.

Non-combatants or civilians will be on the front lines of conflict in wars related to climate change. The trend towards conflict over environmental issues will likely involve issues of day-to-day concern, especially livelihood wars. In developing countries susceptible to climate change and conflict, the lines between civilians and the military will largely disappear. This conflict may in fact destroy environmental resources in the process, and thus produce a downward spiral. The capacity for environmental destruction is far higher today than ever before.

Conflict trends have seen a general decline over the last half-century. Similar to climate change, these trends show quite different patterns around the world. A 2005 report from the Human Security Center examined conflict trends since 1945 and the end of World War II (Human Security Centre, 2005). Up to 1991, during the Cold War, conflict fluctuated along with bi-polar tensions. Conflict casualties since the end of the Cold War show a further decline, though Africa and the Middle East remain the exceptions.

Conflict trends since 1945 show a general fall-off because the two Super Powers fought wars via proxy that were often quite violent (Korea, Vietnam), especially in the immediate aftermath of World War II. Without the structural pressures from a bi-polar world, many of these conflicts lost their basis for support and receded. The report concludes that the number of armed conflicts has fallen more than 40 percent since 1991, and there have also been fewer cases of secessionist or civil conflict in the period.

The short-term perspective on conflict trends belies a much longer historical record of violent behavior patterns that may be cyclical. Based on long-term trends, there is good reason to believe that the interregnum today in conflict will not be a permanent condition. This breathing space in tension (the post-1991 era) is perhaps a temporary respite, an opportunity to take serious action to prevent levels of conflict from returning. Climate change may contribute to an increase in future conflict.

With an understanding of the likely future climate conditions, it is now possible to lay out some parameters of future conflict. The effort will be to match the climate and conflict trends on a regional basis. There are three dimensions for understanding conflict trends. First, there is the historic conflict intensity in differing parts of the world. Second, there are forecasts of possible future conflict. Third, there is a profile of failed states in the world. These states are likely to witness substantial impact from climate change that may push them into a state of conflict.

A profile of recent conflict

The bases for the IPCC forecasts are climate models built on regional calculations and distinct sets of climate sub-systems. It is useful to start by examining the 23 regions of the planet that underlie the IPCC sub-models. These regions will be the basis for thinking about conflict trends and comparable climate trends. The regions under review are limited to those with continental land areas (see Map 3.3).

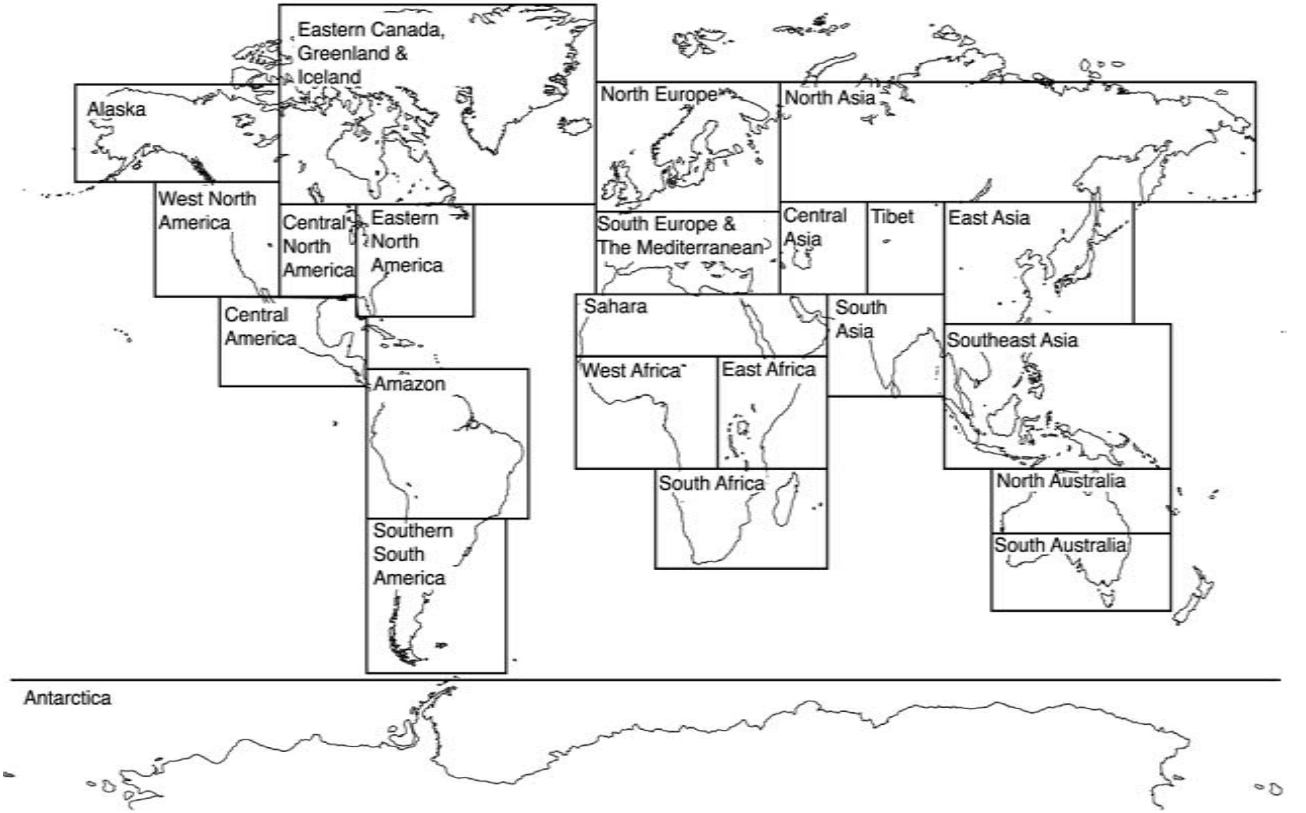
It is useful to compare and contrast the previous temperature or precipitation trends with a similar map based on the intensity of conflict around the world. Conflict intensity can represent a variety of differing outlooks on likelihoods and consequences. It can take on measurable quantities that can be likened to hot and cold periods of tension.

The structure for conflict mapping will use the 23 climate regions in the IPCC report. The historic conflict data will come from the Uppsala Conflict Data Project (UCDP), and cover the period 1946–2005 (Department of Peace and Conflict Research; data updated annually). Two types of conflict are considered: minor and war. The difference intends to highlight occasional skirmishes as opposed to large-scale military actions. Conflict deaths exceeding 25 battle deaths per year are coded as minor. When conflict exceeds 1,000 direct deaths per year, these events are coded as war.

The data provide the exact geographic location of the conflict, so it is possible to match conflicts to the IPCC climate model regions. Country coding locations are based on where the conflict takes place. This location allows the matching of countries to climate regions.

To compare with the temperature and precipitation maps on climate, the conflict data are converted to a temperature-like scale. For each region, there is an assigned level of intensity to the conflict. Intensity is measured using the country as the unit of analysis with two components: the severity of the conflict, and the nation-years at war. Calculating the severity of conflict is relatively straightforward. One year of "minor" conflict equals one unit of conflict intensity, and a "war" constitutes two units.

Each year at war is another dimension of counting. Countries may have more than one conflict going on in any particular year. For example, Sudan was in civil conflict at one point in both the south of the country, against the Sudanese People's Liberation Army, and in the west in Darfur against the Fur and other tribes. Thus, the number of conflicts per country can exceed one per year.



Map 3.3 Climate model regions.

One issue with the data that needs to be reconciled is the countries and their boundaries, since in some cases they have changed over the period. Since 1946, some countries have unified (South and North Vietnam; East and West Germany) and some have split apart (the Czech and Slovak Republics; Ethiopia and Eritrea). Some states have expired (Yugoslavia), while others have been created anew (Croatia, Serbia). Countries of today constitute successor areas of sovereignty, and are used as the basis for defining states in the dataset.

The summary indicator measures the conflict temperature, based on country years at war, adjusted by intensity (minor or war) and number of distinct conflicts per year. Country intensity, by year, is aggregated up to the regional level, to equate with the general areas of regional coverage in the climate models.

For most countries, this is a straightforward process of matching countries to the larger regional groupings. Large countries, however, may overlap into several climate regions. This led to a second area of data reconciliation. For these countries, determinations of conflict region are decided on an individual case-by-case basis and the exact location of the conflict. This was the situation with the United States, Canada, Russia, China, and Brazil.

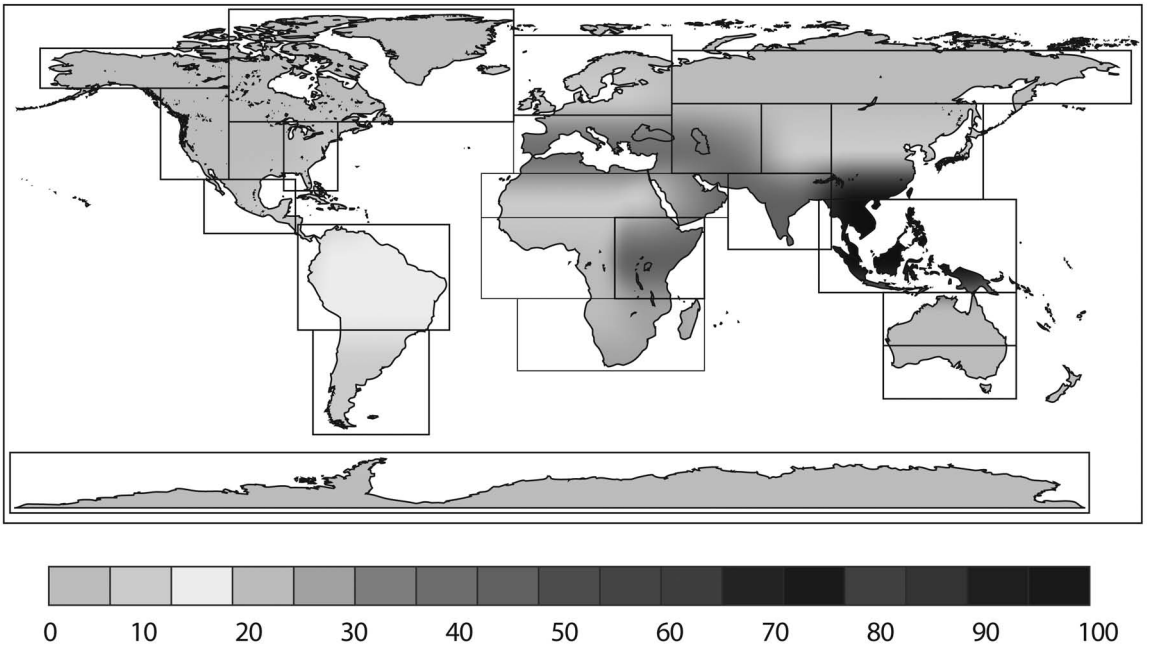
The totals reflect a general atmosphere of conflict or a background for global social behavior. The units represent degrees of conflict temperatures that are scalable. Since the end of World War II, Southeast Asia experienced has 649 units of conflict intensity, and East Africa has experienced 314 conflict intensity units. Canada, on the other hand, has had none.

The regions of overall high conflict intensity are often in the Equatorial Tension Belt. There are some significant differences between the Equatorial Tension Belt and the historic indicators related to conflict. To allow comparison with the earlier maps of temperature trends and distributions, conflict data are portrayed on similar dimensions to show hot and cold areas in terms of conflict.

First, while Southeast Asia has the highest conflict temperature for the recent past, there is no forecast of substantial impact from climate change. Neither temperature nor precipitation will substantially change. Rather, climate change may affect the area through altering water resources that arrive from other climate regions, especially Tibet. However, high rates of economic development may also hasten the rate of climate change in the region. Habitat change rather than greenhouse gases may be the largest single contributor to climate change in the region.

Second, far Northern and Southern latitudes show little conflict, since few people live there. These areas, however, are thought to have the greatest potential for climate change, and may increase their propensity for conflict. Canada and Russia, possibly Antarctica, might be included here. This situation exemplifies low conflict areas where climate change might be high.

The conflict temperature map is built to resemble the climate temperature map. As in the earlier case, the darker the color, the greater the degree of conflict. The patterns resemble and diverge from patterns in the climate maps (see Map 3.4).



Map 3.4 Conflicts by region, 1946 to present (source: Uppsala Conflict Data Base, www.pcr.uu.se/database/index.php).

Future conflict forecasts

The US Department of Defense uses a system, called ACTOR (Analyzing Complex Threats for Operations and Readiness) to forecast conflict. ACTOR uses data-mining tools and pattern classification algorithms to forecast conflict based on "key structural factors that influence country instability" (Center for Army Analysis, 2000: v).

The purpose of ACTOR is to provide a statistically based estimate on the likelihood of conflict occurring in a country for the period 2000–2015. The forecasting of these cases of stability, or instability, can offer a sense of where US national interest may be at stake, and the requirements needed to serve those interests. Moreover, it suggests where preventative actions may make a difference in the occurrence of conflict or its severity.

The structural factors in the ACT model intend to reflect economic, political, public health, and socio-cultural conditions in a society. The indicators were chosen for their suitability (reflecting potential instability) and accuracy (the consistency and coverage of data). Countries having populations of more than 500,000 are included. The independent variables are from a variety of available sources (World Bank, United Nations, Freedom House, etc.).

The dependent variable, conflict, comes from Conflict Data Project produced by the Peace and Conflict Institute, Uppsala University. Cases of conflict are included when they produce at least 25 battle deaths in a given year and one of the parties is a government (thus differentiating inter-state and intra-state conflict).

The result is a set of country forecasts indicating areas that may be somewhat unstable and prone to conflict ("amber") and those that may be very unstable with higher conflict intensity levels ("red"). These levels of instability reflect conflict casualties. Therefore, it is possible to equate an "amber" forecast in ACTOR to a "minor" war in the Uppsala Conflict Data Base, and a "red" forecast equal to "intermediate" and "high" conflicts. Country forecasts are set to specific periods. Country instability, similar to the approach of the UCDP, is defined as "armed conflicts involving at least 25 battle deaths" (O'Brien 2001: 2).

The forecast horizon is set at 15 years, to 2015, and uses a historical database for the period 1960–1999. Twelve structural indicators serve as independent variables to explain instability and its level (see Table 3.5). (In the map, the darker colors represent the highest levels of conflict intensity, or the "red" countries.)

Table 3.5 Independent variables in the ACTOR model

Independent or causal variables	
1. Percent of history in armed conflict	7. Life expectancy
2. Infant mortality rate	8. Civil liberties index
3. Youth bulge	9. Trade openness
4. Caloric intake	10. Democracy
5. GDP per capita	11. Religious diversity
6. Political rights index	12. Ethnic diversity

The 12 causal variables are political, economic, and demographic in nature. Fatality estimates are short term, and will necessarily underestimate total human mortality. As noted earlier, the nature of modern warfare tilts towards greater civilian deaths.

The ACTOR forecasts can be represented on a map in terms of conflict intensity. Countries are aggregated up to regional levels that correspond to IPCC climate regions. Scores are given for countries with higher and lower intensities, producing an overall absolute total for each region. Based on the highest region, then other scores are relatively scored. There are 22 countries forecast across the red zone and 36 in the amber zone.

East Africa is projected as the region with the most intense conflict indicators in ACTOR, and thus on a scaled basis its conflict intensity is set to the highest value (100 percent). On a relative basis, Southern Europe and the Mediterranean (72 percent) are next highest, and Southeast Asia (56 percent) follows regarding leading conflict intensity scores for regions (see Map 3.5).

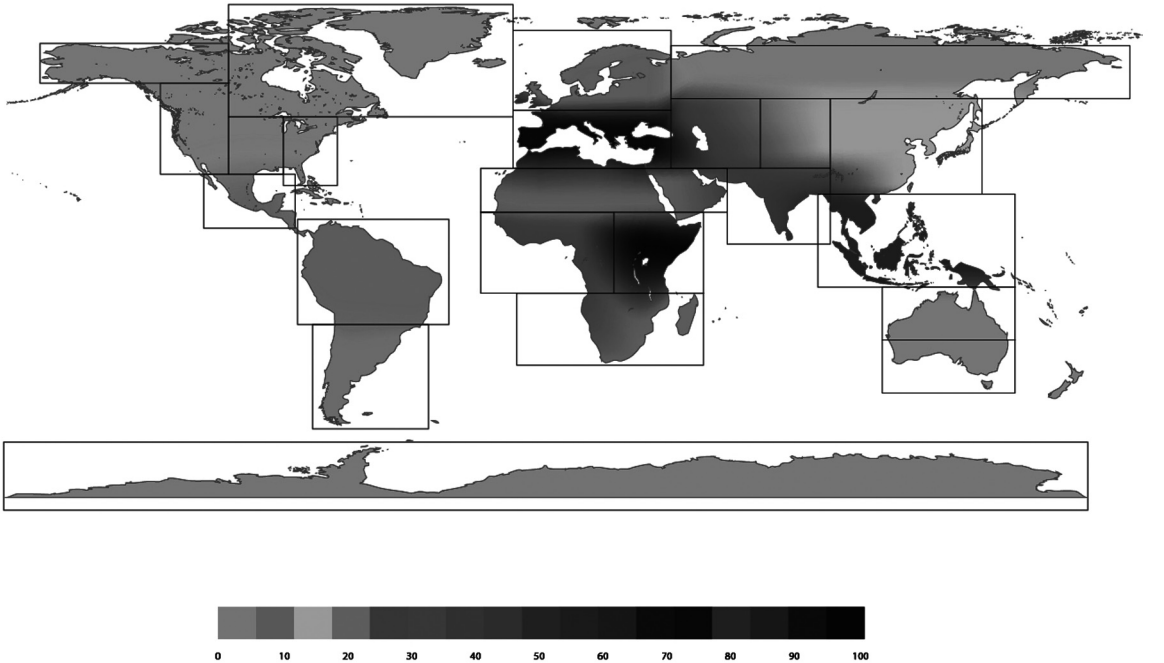
It is also possible to juxtapose conflict forecasts with climate forecasts. The red and amber country forecasts are shown alongside forecasts of high, intermediate, and low climate change. For the red forecasts, there is one country in the high climate change category, there are four in the intermediate category, and 13 in the low category (78 percent). These high conflict countries are especially located in the African central basin, and have been participants in the war that has continued for some years. Of these more intense conflicts, 11 out of the 18 are found in Africa. Some portions of these countries are in much higher zones of climate change, such as Sudan and Ethiopia (see Table 3.6). The Middle Eastern countries account for one-half of the African total. For these areas of high conflict, changes in climate will be a minor worry because of basic survival concerns, but one that has additional significance.

Table 3.6 Red forecasts and conflict likelihoods by 2015 (percent)

*High climate change**		*Low climate change*	
Afghanistan	80–90	Angola	75–92
Intermediate climate change		Sierra Leone	53–75
India	65–80	Somalia	59–99
Iraq	75–82	South Africa	76–81
Pakistan	74–83	Sudan	77–82
Yugoslavia	51–68	Uganda	85–92
Low climate change		Angola	75–92
Peru	67–80	Burma	80–91
Philippines	82–100	Burundi	60–100
Rwanda	55–69	Cambodia	70–75
Senegal	78–83	Congo-Kinshasa	71–95
		Ethiopia	73–88
		Indonesia	75–83
		Laos	77–82

Note

* High, Intermediate, and Low climate change forecasts based on temperature.



Map 3.5 ACTOR forecasts of future conflict.

The distribution of the cases for the amber forecasts, the minor wars, shifts somewhat from those in the red forecasts (see Table 3.7). The red forecasts are overwhelmingly located in Africa and there is a low relative impact from climate change compared to most countries. African countries account for ten of the 23 in the amber category, and most are countries that are part of the Sahel. Countries with near-desert conditions account for 13 of the 23 cases. Included are seven countries in Europe, though these conflicts are often tied to secessionist causes and terrorism (for example, France and Corsica; Russia and Chechnya; and the United Kingdom and the Irish Republican Army).

In areas of high climate change, including parts of Russia and Tajikistan, breakaway inclinations will be amplified. Other emerging geopolitical powers are Mexico and China. The consequence of minor conflict in powerful countries is more dangerous than that of major conflict in weak countries.

For compatibility with the country-based ACTOR forecasts, the IPCC regions are used for comparison. The regions are categorized as high, medium, and low in terms of expected climate change measured by temperature. Of the 22 "red" countries in the ACTOR forecasts, only Afghanistan falls into the high area of climate change. Most climate change will take place at extreme latitudes and in Central Asia, where the current levels of conflict are relatively low.

Five red ACTOR countries are in areas of medium climate change that are part of the existing Equatorial Tension Belt, or near to it. Sixteen red ACTOR countries are in areas with an expected low impact from climate change. Most of these countries are from sub-Saharan Africa and Southeast Asia. By far most of

Table 3.7 Amber forecasts and conflict likelihoods by 2015 (percent)

*High climate change**	
Russia	72–79
Tajikistan	99–100
Intermediate climate change	
Albania	67–71, 2007–2015
Algeria	69–76
Armenia	86–98
China	84–91
Colombia	75–78
Egypt	74–76, 2011–2015
Georgia	68–78
Iran	69–85
Israel	68–85, red 2000–02
Lebanon	79–85, red 2000–07
Libya	91–96
North Korea	66–80, some years
Mali	63–75
Syria	91–99
Morocco	92–96
Turkey	69–81
Low climate change	
Liberia	70–74
Mexico	66–68, 2002–9/15
Nigeria	82–84
Oman	70–82
Portugal	69–70, 2004–06
Sri Lanka	67–81
Tanzania	67–71
United Kingdom	99–100
Argentina	67–70, 2008–2015
Bangladesh	87–98
Comoros	77–79
Kenya	86–88
France	76–78
Guatemala	72–92, red 2002
Haiti	67–74

Note

* High, Intermediate, and Low climate change forecasts based on temperature.

the red countries are in areas where climate change is expected to exceed global averages.

The 36 amber country forecasts from ACTOR are also aggregated by region, so they are comparable to the IPCC climate forecasts. Two amber forecasts show up in an area of high climate change (Russia and Tajikistan). Nineteen amber forecasts show up in areas of medium climate change, most of them in areas nearby the Equatorial Tension Belt. Fifteen of the amber countries appear in areas of low climate change.

Failed states

The 2002 US National Security Strategy, on the heels of September 11, 2001, heralds the danger of weak states: "America is now threatened less by conquering states than we are by failing ones" (Bush 2002: 1). Failed states tend to multiply and create other failed states that challenge the stability of the international system. They can act as cauldrons for extreme acts of warfare, including terror.

Failed states lead to conflict in three ways. First, failed states are often associated with military interventions by neighbors and tend to create conditions for regional conflict, thus spreading conflict like a disease. Second, failed states are lawless, which means that criminal and terror activities are more likely to spawn there. Third, failed states also symbolize failed livelihoods, and thus large-scale migrations of people. Death rates spike during such events, and so too does the need for humanitarian assistance (Esty *et al*. 1998).

Failed states are political and geographic entities that possess territory, but lack a coherent central government. This lack of sovereign control in turn diminishes the ability of the state to physically police its own territory, influence its economy, or improve the quality of life of its citizens. A failed state will not be able to cope with climate change.

The Fund for Peace, a non-government organization, creates a yearly index to indicate failed states based on 12 criteria: population pressure, refugees, history of grievances, large migrations, differential economic distribution, economic decline, corruption, declining public services, human rights violations, inability to control physical space, factions of powers, and inability to prevent interventions by other states (Fund for Peace 2007). These 12 criteria originate in four areas: social, economic, political, and military.

The failed-states scoring in the Fund for Peace relies on the ranking system of the Conflict Assessment System Tool (CAST). An event-based system, the CAST records positive and negative reports related to these categories by countries. Experts review the totals and make inductive adjustments in scorings relevant to determining failed states.

Out of 177 states in the index, 32 states failed for the year 2007 (based on late 2006 data). Scores for all 12 categories are added, and for individual country scores are calculated on a scale of 1 to 10. Higher scores are greater indicators of failure. Scores above 90 are regarded as failed states. The top three failed states

are well-known examples: Sudan, Iraq, and Somalia. In all three instances, there is a high degree of internationalization of conflict. The failed states do lie in an area that shows the outlines of the Equatorial Tension Belt. The next tier of failed states ("in danger") illuminates the belt even more. Countries do enter and leave the failed state list. Zimbabwe has relatively recently joined, and Bosnia has recently departed from the critical group.

The failed states cluster in Africa, and form a triangle that stretches across the continent. Africa accounts for almost 60 percent of the countries regarded as failed states. These countries are mostly found in west and east Africa. Asia accounts for about one-third of the total. About one-half of these countries are from South Asia; most other cases are isolated or special instances, as are the cases in North America (Haiti) and Australia (Solomon Islands).

Some obvious characteristics of these African countries, and why they are conflict-prone, are apparent. First, these are some of the last countries to have gained independence after long periods of exploitative colonialism – patterns that still echo today. Second, these are among the world's poorest peoples, with real average incomes lower now in some places than 50 years ago, when they achieved independence. Third, a legacy of incessant conflict has internal and external manifestations. The slow-moving Great Lakes of Africa war, which has killed millions, has roots in land disputes, population growth, and economic systems. In these failed states, livelihood and ethnicity has created a crisis that climate change may well push over the edge. Of the 32 countries, 18 are in Africa and 11 in Asia (see Table 3.8).

The distribution of the failed states corresponds to the conflict forecasts in ACTOR. African states and those in South and Southeast Asia are most likely to be failed states, just as they are those most likely to be involved in conflict.

Evidence for trends in conflict

Evidence from conflict trends since World War II, forecasts out to the year 2015, and the likelihood of failed states, all point to many similar patterns. Places in conflict are likely to be exacerbated by even subtle changes in climate. On the other hand, places with little or no conflict may increase as much greater changes in climate act to create conflict conditions. Africa will be a place of high conflict, and with climate change the human tragedy there will likely continue.

The conflicts in the post World War II era clearly show the preponderance of conflict undertaken in places far away from the major powers and occurring in client states. Significant conflict has occurred in Korea and North East Asia, Southeast Asia, the Middle East, sub-Saharan Africa, and the Indian subcontinent, related to Great Power rivalries. Over time, some conflict stabilization has occurred in Asia.

The near-term forecasts out to the year 2015 indicate that the majority of conflict will be in Africa and the Middle East. Some conflict will occur in Southeast and South Asia, although on a more limited basis. Many areas of Asian conflict may subside during this period, in part due to rising levels of development. In

Table 3.8 Distribution of failed states

Continent	*Region*	*Countries*	*Totals*
Africa			18
	West	Chad, Ivory Coast, Guinea, Central African Republic, Niger, Nigeria, Sierra Leone, Liberia	8
	East	Uganda, Burundi, Malawi, Kenya, Sudan, Somalia, Ethiopia	7
	South	Congo (Kinshasa), Congo (Brazzaville), Zimbabwe	3
Asia			11
	South	Sri Lanka, Nepal, Afghanistan, Pakistan, Bangladesh	5
	Central and West	Iraq, Uzbekistan, Yemen	3
	East	N. Korea, Timor, Burma	3
Europe			1
	SEM*	Lebanon	1
N America			1
	C. America and Caribbean	Haiti	1
Australia			1
	N. Australia.	Solomon Islands	1
Total			32

Source: Fund for Peace, 2007.

Note
* Southern Europe and Mediterranean countries.

terms of persistence and virulence, East Africa remains an ongoing place of conflict spreading across national borders throughout the region.

The failed states reflect trends both from the past and from the near-term future. They are dominant in Africa, with only the far south immune. Other pockets of failed states occur in the Middle East, as well as Central, South, and South Asia. These states will have the least resistance to climate change.

The failed states have conflict levels so high and persistent that even baseline changes forecast by the IPCC are likely to worsen livelihood conditions. The trends suggest more of a social or tribal breakdown than wars between nations. Climate trends will also ignore borders, and failed states prone to conflict will spread like a disease.

The next section examines each IPCC region via the likely convergence of climate change and conflict, and lessons from them. The effort intends to show regions in the two Tension Belts where logical groupings of conflict factors will occur.

Regions for future climate change and conflict

This section uses the regional IPCC models to compare areas of climate change to existing or new conflict. The approach employs a mapping process based on a temperature-like gauge to assess how changing climates and trends in conflict may interact on a regional basis.

Various indicators of climate change and conflict can be collapsed into a single context with comparable scales. The forecasts on temperature and precipitation (climate change impact) draw from the earlier noted IPCC reports. Conflict trends use material from the Uppsala Conflict Data Base, the ACTOR forecasts, and the Failed States index. The future conflict is an extrapolation of trends in temperature and precipitation (see Table 3.9).

Table 3.9 also includes the type of climate threat. These are qualitative approximations of the convergence of future conflict and climate change impacts. The regions are organized according to the IPCC climate regions. For each region, the climate and conflict impacts are shown, as well as the climate threat and the conflict types.

Table 3.9 Regions and impacts

IPCC area	*Climate trends*	*Conflict trends*[a]	*Climate threat*	*Future conflict types*
1. Alaska	High	Low	Habitat change	International
2. ECGI[b]	High	Low	Habitat change	International
3. West Coast	Medium	Low		
4. Plains	Medium	Low		
5. East Coast	Medium	Low		
6. C. America and Caribbean	Unclear	Medium	Drying	Civil
7. Northern S. America	Unclear	Medium	Drying	Civil
8. Southern S America	Unclear	Low		
9. NW Europe	High	Low	Habitat change	
10. Mediterranean	High	High	Drying	
11. Sahara	Medium	High	Drying	International
12. West Africa	Low	High		Civil
13. South Africa	Low	High		Civil
14. East Africa	Low	High		Civil
15. South Asia	Medium	Medium		
16. Central Asia	High	Medium	Habitat change	International
17. N Eurasia	High	Low	Habitat change	International
18. Himalaya	High	Low	Habitat change	International
19. NE Asia	Medium	Low		
20. SE Asia	Low	Medium		
21. N. Australia	Unclear	Low	Sea level	
22. S. Australia	Unclear	Low		
23. Antarctic/Arctic	Medium	Low		International

Notes

a Sources: Uppsala Conflict Data Base, www.pcr.uu.se/database/index.php.

b ECGI includes Eastern Canada, Greenland, and Iceland.

The next section examines the 23 regions by way of climate change forecasts and the types of future conflict that might ensue. The analyses are organized by continent in describing the future of regional climate change and conflict patterns. The continental breakdowns show North America, Central and South America, Europe and Mediterranean, Africa, Asia, Australia, and Antarctica.

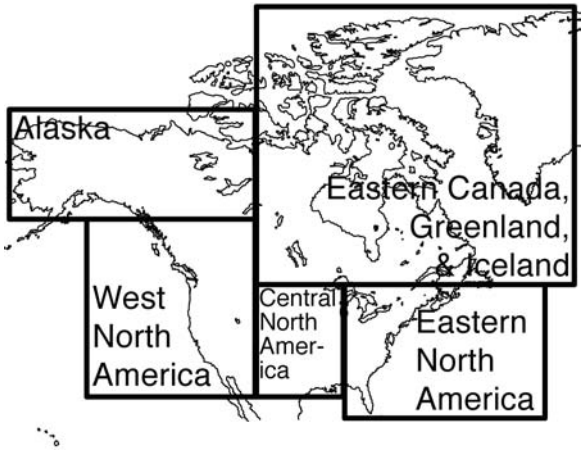
North America

North America includes only non-tropical areas, and thus only Canada and the United States. There are three temperate regions and two cool regions in North America. The North American regions see profound climate change (see Map 3.6). With temperatures expected to rise by more than average, considerable warming and habitat change is likely. In the far north, there will be much more precipitation as well. Extreme terra-forming will take place.

Agricultural yields in North America may increase in the early decades of the century by 5–20 percent. In fact, most of North America will benefit from climate change. There will be a longer growing season, and warmer winters will save on energy costs. The Southwest United States will see continued drying conditions coupled with growing populations that will stress water resources. There will be a corresponding reduction in western water supplies (IPCC 2007b: 12).

Alaska

The Alaska region covers the United States region of Alaska, and inland parts of the Canadian Yukon that are closer to the Pacific than the Atlantic Ocean. Although there is little ongoing conflict in the area, warming will be extremely high. With expected consequent inward migration, there will be some greater chance for conflict on domestic dimensions. There are, however, three other areas where conflict will be more likely.



Map 3.6 North American regions.

First, as noted earlier there will be navigation rights issues regarding Arctic Sea waters. Canada and the United States already disagree on ownership of these waters, and these positions will evolve with climate change and sea-level rises. Several differing routes are possible, so the result may arrive in a piecemeal manner.

Second, melting may expose or emphasize the importance of an island or rock-crop that may be a source of conflict. Countries may claim these islands largely to gain access to the Exclusive Economic Zone around them. This tactic would allow countries to claim and exploit continental shelves. The competition over Arctic land areas is already underway, as all polar countries are now attempting to establish claims.

Third, development of resource extraction industries will act as a major source of economic development that will attract migrants. This process may overwhelm the capacity for stable progress. It may be that these chaotic regions are the new gold rushes, the new frontiers to make a livelihood. Such situations are prone to organized criminal activity that weakens state institutions.

The Alaska region is likely to undergo substantial terra-forming with climate change. This change in habitat will echo a lesson learned from past conflicts that are similar (Neanderthals, Vikings) in that they invite a variety of disparate peoples and their interests into the region. This influx will lead primarily to intra-state conflict for a variety of differing economic reasons.

Eastern Canada, Greenland, and Iceland

The Eastern Canada, Greenland, and Iceland region includes Canadian lands that encircle the Hudson Bay. Much like the Alaska region, the Hudson region has little ongoing conflict, but warming will be extremely high in this region. Three facets of the changing climate will have potential conflict consequences for the area.

First, this region will become a critical area of focus on rights of navigation through Arctic Sea waters. There are more contentious navigable waterway issues in this area than in the Alaska area. Conflict will arise over the control of and access to the emerging Northwest Passage in Northern Canada. These claims have long been dormant. Climate change will make them red-hot.

Second, the expectation is for development of ports along the Hudson Bay to facilitate trade along the Northwest Passage. This development will engender significant economic and demographic growth as part of this new corridor that may be accompanied by violence, drug use, prostitution, and other illegal activities.

Third, the melting may bring to light other territorial conflicts. This Arctic area abuts claims of other countries, such as Denmark (Hans Island for example). Conflict may also occur with Russia and Norway on possible claims related to continental shelves.

The area will warm perhaps even more than Alaska. Like Alaska and Siberia, this will also open more land to natural resource exploitation, including oil, gas, diamond, and water resources.

The Hudson region is also likely to undergo substantial terra-forming with climate change. The terra-forming in this region centers on Hudson Bay, and will have significant impact on access to both land and sea resources. On the whole, there is only a small chance for climate-induced conflict. The situation in this region will somewhat proximate the Viking attempts to colonize North America. This means multiple peoples migrating to the region for resources and land, and conflicts over them.

Western North America

Western North America will see some higher temperatures and less precipitation over the time horizon. These drying conditions have already appeared in some locales. There is no recent history or expectation of conflict on a large scale. Drying and warming to the south will continue to attract migrants.

The border between the United States and Mexico will continue to serve as a dramatic zone where conditions on either side of the line will remain extraordinarily unequal. Drying will force more farmers off lands in Mexico and, along with globalization and mechanization, will add to the flow of refugees northward. Populations in this area will continue to surge, as will economic activity between North America Free Trade Agreement (NAFTA) trade partners.

Water will become scarcer, absent human interventions, with less precipitation and hotter temperatures. That scarcity may in turn act to dampen economic activity in the face of surging populations. The border may become a spark for conflict as inequalities on each side grow greater.

Plains North America

Plains North America will have some higher temperatures and less precipitation over the time horizon. It is likely that ecosystems will gradually creep northward. Some areas in the south that are now semi-arid may become arid. There is little recent history or expectation of conflict.

Drying conditions and continued expansion of agricultural production will cause a significant drawdown on fixed underground water resources such as the Oglala Aquifer. Named after a place in Oklahoma, the Oglala is one of the world's largest aquifers. It underlies eight states in the Great Plains, and ranges, north to south, from South Dakota to Texas. There is very little recharge of the water, and wide-scale use of it for irrigation has been underway since the 1930s.

Most of the water is thus fossil or paleo-water that has largely finite limitations. In parts of Texas, the aquifer is mostly exhausted. Climate change and increased food production (especially for producing energy sources such as ethanol) may drain the Oglala Aquifer and return the region to the dust-bowl days of the 1930s. This event will not lead to starvation in the United States but, as the US is the world's largest agricultural exporter, it may exacerbate food supply conditions elsewhere.

The region will see little conflict, and will not significantly suffer under climate change. There may be some desertification of some southern Plains areas. There do not appear to be major climate change and conflict issues looming.

Eastern North America

In Eastern North America, temperatures will be more moderate and there will be some increases in precipitation. The area will be a winner in the sense that winters will be less costly in terms of energy use. Moreover, additional precipitation would likely have a positive impact on agricultural production. There is no recent history of or expectation for future conflict.

Some extreme events that may strike the Caribbean and Central America may also make their way to Eastern North America. Some civil unrest may occur in situations resembling Hurricane Katrina of 2005, one of the most severe Atlantic hurricanes on record. A rise in sea level will force a slow movement of people away from the heavily populated coastline.

The region will see little conflict, and will not suffer under climate change. With milder winters and more rain, the region may in fact benefit from climate change. These benefits, however, may be outweighed by costs related to changes in agricultural production types and invasive species. Little interaction between climate change and conflict is expected in the region.

Central and South America

Latin America, or the sub-tropical Western hemisphere, is broken into three regions; one that focuses on Central America and the Caribbean (tropical North America), the second on the Amazon River delta and the tropical forest around it, and the third on the temperate zone in southern South America (see Map 3.7). Impacts from climate change will not be limited to land areas, and there will also be changes offshore. The result will be "shifts in the location of south-east Pacific fish stocks" (IPCC 2007b: 12).

The area temperature is in general indeterminate in the climate model. In Central America, less precipitation is forecast. This trend will have consequences in a fast-growing region whose population is falling behind in economic growth.

Central America and Caribbean

The Central America and Caribbean Sea region has an existing record of persistent internal conflict. Deadly and violent civil wars have raged in Guatemala, El Salvador, and Nicaragua. There is an expectation of some temperature increase and some decline in precipitation. These two trends may promote conflict tendencies.

First, the region expects less rain, and this, combined with human-induced habitat changes, will result in substantial deforestation throughout the area. This

Map 3.7 Central and South American regions.

climatic factor will tend to exacerbate existing civil conflicts that are widespread from Mexico City to Lima.

Second, there is some likelihood that extreme events will occur in areas within or adjacent to the Caribbean Sea. These events may not be frequent, but their possibility on islands such as Haiti, already a failed state, could exacerbate severe environmental conditions. People with extremely low standards of living lack the resources to adjust to these changes. In the Caribbean and the Pacific, by mid-century, water resources from rainfall will not meet demand. These regions will be especially vulnerable to climate change (IPCC 2007b: 12).

Carrying capacity conflicts resulting from climate change will strike this region. Limited land area, a rapidly growing population, a drying environment, and large-scale deforestation will limit opportunities for people and incite tension. The region is already a large exporter of population, and will become even more reliant on remittances from abroad for economic viability. This condition in many ways parallels the historic case of the Mayans, except they had nowhere to go.

Northern South America

Northern South America now experiences persistent internal conflict. Political conflict driven by illegal narcotics trade has spilled from Colombia into Ecuador, Peru, Venezuela, and Brazil. The conflict in Colombia is particularly brutal, and has been ongoing since 1949. The drying and warming trends may force many

peasants off lands and drive them either into the cities or deeper into the jungles of the Amazon region. This cascade of events will lead to more conflict and to more deforestation, which will speed up the warming process.

The region includes most of the Amazon River delta, and promises to be the epicenter of a large-scale migratory assault on this largely unpopulated area. This dynamic of human intrusion, where forestlands are burnt for ranching or agriculture, will hasten climate change by adding more carbon to the atmosphere. At the same time, "slash and burn" agricultural practices will remove the trees that are vital to sequestering carbon.

On top of the domestic conflict that may occur with large migrations, there may also be an international element to disputes. The exact boundaries between these countries in the Amazon are not precisely marked, and some claims overlap. These disputes have never amounted to much, because it was hard to survey the land and the need to do so was so small. In the future, these conditions will change, with an influx of refugees from overcrowded urban centers.

By 2050, most of eastern Amazonia will convert from tropical forest to savanna. Semi-arid lands will be replaced by arid lands (IPCC 2007b: 12). The combination of human settlement and industry, along with higher temperatures and decreased rainfall in northeast South America (Brazil, the Guyanas, and Venezuela), will lead to large-scale changes in environment and demography that will cross country lines.

Carrying-capacity conflicts will occur in northern South America for the same reasons as in Central America. Rather than migrating outside the region, however, large populations that now cluster around the coasts will push inland to the Amazon basin. This intra-migration is already occurring in countries such as Venezuela, Colombia, Peru, Ecuador, and Brazil.

Southern South America

Southern South America will see little impact from climate change, in part because it is surrounded by a large mass of water that will tend to ameliorate temperature rise. The area will see some warming, particularly the farther south one goes. Although the region does not have an extensive recent history of conflict, there are instances such as the Falkland Islands war. Argentina invaded the Falklands Islands and fought a war over them with the United Kingdom in 1982. The British tied their Falklands and Antarctic claims together.

There are border disputes between Argentina and Chile, particularly in the extreme southern parts of the continent and on some offshore islands. With warming, this competition over claims will likely extend into Antarctica. Dwindling fish stocks may prompt these countries, as with Canada in the north, to extend the EEZ areas to capture offshore resources and maintain fish stocks.

The region will not see much impact from warming or resulting conflict. With only some minor border disputes, there are probably few points of convergence between climate change and conflict.

Europe and the Mediterranean

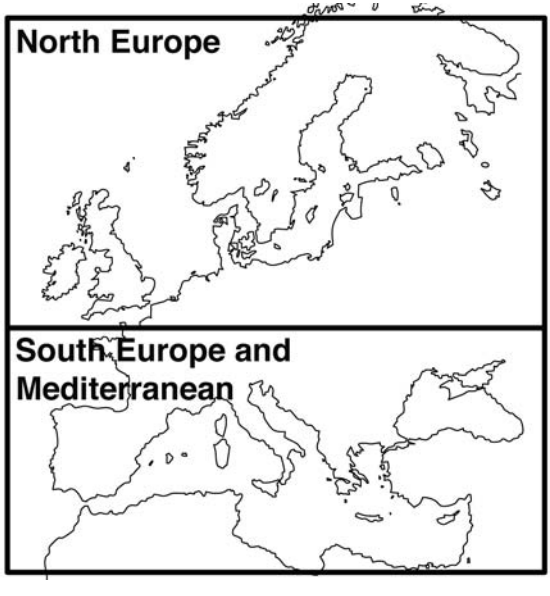
Both regions in north and south Europe will see significantly higher temperature levels that will create warmer habitats throughout the area. While precipitation outlook in the north is indeterminate, in the south it is expected to decline (see Map 3.8).

Nearly all parts of Europe will see both positive and negative effects of climate change. One negative trend is that glacier retreats are expected (IPCC 2007b: 11). Warming will likely move ecosystems north, with the south turning drier and hotter, and the far north becoming more temperate. There are two major regions in Europe: northern Europe, and a Mediterranean zone that also includes parts of North Africa, Turkey, and the Levant.

Northern Europe

North Europe will see a significantly warming temperature and greater precipitation in the form of rain. These favorable conditions will attract migrants from areas where climate change will have a negative impact. Given past trends and proximity, these migrants will come from Africa, the Middle East, and South Asia. There are currently low levels of conflict in Northern Europe, and any international violent conflict is unlikely. The lands most affected by temperature rise will be in Norway, Sweden, Finland, and Russia.

The opening of the Northeast Corridor in the Arctic because of declining ice will initiate a second new transportation corridor. The opening will bring front



Map 3.8 European regions.

and center navigation rights issues that will involve at least Russia and Norway. These areas will encounter some of the same problems noted with the Northwest Passage and Canada, related to navigation rights and territorial claims.

Rising sea levels will inundate some parts of the Netherlands and the Rhine River delta area absent preparatory measures. The rising seas will be augmented by melting glaciers. Alpine glaciers that feed the waters of these rivers will decline and probably vanish within the next half decade, and many fields are already in full retreat. This trend will affect summer agricultural irrigation and Europe's ability to act as a major food exporter. Crop planting types and zones will creep northwards.

Initial benefits of warmer temperature in Northern Europe may be also be tempered by negative impacts, such as flooding and ecosystem damage. Warming will be most pronounced in areas near the Eurasian Heartland. The extremely cold conditions now found in Northern Scandinavia and Northeast Russia near Finland will see the greatest increase in temperature, and will be very attractive to migrants. North Europe will experience warming especially in the extreme latitudes of the continent. The area has little recent history of conflict.

Southern Europe and the Mediterranean

The area around the Mediterranean Sea will see some warming and some drying of the climate over the next century. Population growth on the north side of the sea will be at replacement level, while growth on the south side will be high. This human dynamic will produce very differing conflict outcomes on the two sides of the sea.

The south side has seen significant civil conflict in the past 50 years, including wars in Morocco, Algeria, and Egypt. There has also been some conflict between Morocco and Libya over the Spanish Sahara, and Egypt and Libya over their border. Conflicts may arise regarding huge underground aquifers that underlie Egypt and Libya and other countries. These deep resources could also become flashpoints for conflict as surface and near-to-surface water resources become scarce. Rising populations in a time of declining natural resources will be a pathway to conflict. Egypt's population, which clusters mostly near the Mediterranean Sea side of the country, will grow more dependent on Nile River water. Egypt has threatened Sudan and Ethiopia over attempts to draw from the river water through dams or canals.

There is ongoing conflict between Israel and Arab states, with flashpoints for reasons of both land and water. Overall land productivity may fall and water resources decline. Given the already precarious situation in Gaza and the West Bank, deterioration in the most basic livelihood measure, growing one's own food, may portend catastrophe. There may be serious dispute about the areas around the headwaters of the Jordan River and the tributaries that feed it. One of the roots of the 1967 Arab–Israeli War was the diversion of Jordan River water.

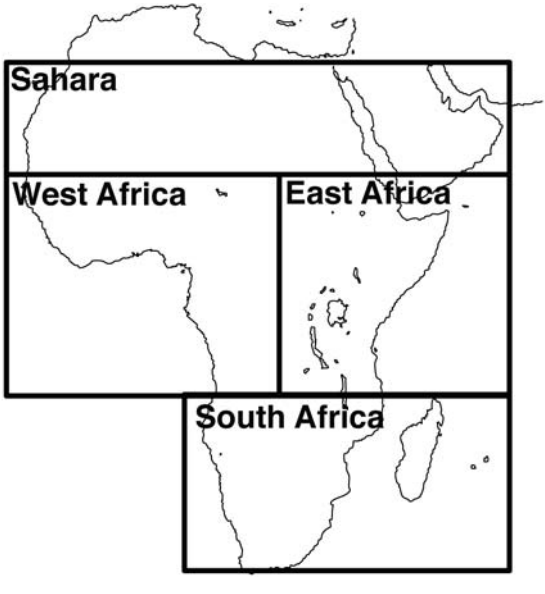
The northern side of the Mediterranean Sea, in Europe will start from a dif-

ferent structural point than the south. Water and biological resources are much richer, and the population is stabilizing. The reality of south to north immigration is now becoming a matter of low level conflict in Europe regarding Muslim communities. Further immigration may provoke a xenophobic reaction. Europeans are not immune from such a reaction. The recent and continuing conflict in the Balkans is ample evidence of that.

Southern Europe will see drier conditions (IPCC 2007b: 12). Temperatures will not increase as sharply as in other places to the north, as the Mediterranean Sea will temper warming trends. There will be a substantial decrease in overall precipitation and a rise in episodic behavior, such as long droughts or periods of rain. This will have an impact on lifestyle and livelihood. Most populations, however, cluster along the coast, and the impact on conflict will be less. It is more inland areas that will suffer. European societies should be able to withstand these challenges due to greater adaptive capacity and more stored resources.

Africa

The climate model for Africa contains four major sub-sectors: Sahara, West, East, and South Africa. The impacts are especially prominent in the Sahara, which will grow hotter, and Southern Africa, which will have less rain. Both of these consequences could be catastrophic when coupled with other trends. Africa is one of the places most vulnerable to climate change (IPCC 2007b: 10). For people already living on the edge in Africa, climate change will be a disaster (see Map 3.9).



Map 3.9 African regions.

Climate change will fall heavily on sub-Saharan Africa in a one–two punch. First, the Sahara and the Sahel will continue to creep south into the northern Sahel, and push marginal lands into desert. Second, a new widespread area of dryness will extend across parts of Southern Africa in a belt stretching roughly from Angola to Mozambique.

The drying will descend on Africa with deadly consequences: "By 2020, between 75 and 250 million people are projected to be exposed to an increase of water stress due to climate change. If coupled with increased demand this will adversely affect livelihoods and exacerbate water-related problems" (IPCC 2007b: 10).

Africa remains a region where livelihoods remain extremely reliant on agriculture as a source of income and of survival. Future agricultural production will be extremely compromised (IPCC, 2007b: 10). These conditions will breed instability, and may lead to failed states.

Sahara

The world's largest desert will grow in size, it will become hotter and drier, and more people will live in it. This swathe of largely empty land spans from the Atlantic Ocean to the Indian Ocean, crossing the continents of Africa and the Saudi Arabian peninsula in Asia. It is one of the most prominent features on the planet, along with other natural landmarks such as the Himalayan Mountains and the Amazon River.

Both warming and drying will occur in this already water-stressed area. This phenomenon will continue the historical trend of desertification in the interior of northern Africa.

The need for resources will push peoples and governments to seek resources in new places. There are resources available deep underground – both oil and water, for example – that can be exploited, given greater demands or newer technologies. Fossilized water sits in a large lake bed underneath parts of the Sahara and Arabian Deserts.

Two areas seem ripe for unrest based on these trends. First, Egypt in the upper and middle Nile River valley will be a focus for possible strife. These upstream civilizations rely on agriculture for people's livelihoods. Second, Yemen will grow in population and decline in arability. Such conditions are often breeding grounds for radical, violent activity. This area will witness a decline in sustainability.

West Africa

West Africa is already a region with substantial civil conflict that has international dimensions. Conflict is often over specific environmental resources, such as diamonds and oil. The region will see warming, but perhaps less than in the Sahara region. Precipitation impacts are not clear.

With an existing record of conflict, high population growth, and moderately declining resources, the situation in West Africa will be one of decline. The

ultimate indicator of quality of life is life span, which in Africa has fallen since 1960. Sahara desertification will probably creep southward into heavily populated West Africa. Human land use will amplify this trend.

Over the last century, the Sahara has moved about 200 kilometers south into the Sahel and more tropical sub-humid areas. It is a marginal existence. Rates of food production trail population growth. Food is grown on marginal lands or fertile lands without proper fallowing periods. "The decreasing rainfall has also pushed northern pastoralists to migrate southward into lands occupied by sedentary farmers, causing conflicts and the widespread destruction of farmlands and cattle, with adverse implications for the region's food and human security" (Nyong 2006–2007: 36–7). This persistent conflict between pastoralists and farmers was explored in the historic Fulani and Zarma case.

The line of the Sahara and the Sahel will move south, and this will push up against the line of religious orientation that divides West Africa between a Muslim North and a Christian or Animist south. Muslim populations will tend to move south with these trends, and it is likely that conflict will follow.

In addition to marking a transition from pastoralist to farming livelihood systems, the Sahel is also a zone of cultural transition, where the Islamic culture from the north mingles with the traditional cultures of the south. The region's large number of ethnic groups – as well as immigration of several new ones – creates potential for conflict (Nyong 2006–2007: 7).

Sea-level rise will also impact poor African populations living on the coast. "Towards the end of the twenty-first century, projected sea-level rise will affect low-lying coastal areas with large populations" (IPCC, 2007b: 10). Sea-level rise will cost African countries 5–10 percent of the national output. "Mangroves and coral reefs are projected to be further degraded, with additional negative consequences for fisheries and tourism industries" (IPCC, 2007b: 10).

West Africa will also see livelihood conflicts resulting from climate change. The Sahara Desert, expanding southwards, will encroach on currently habitable lands. Population pressures and a number of failed states will add to general instability.

South Africa

South Africa will see more drying and warming than the rest of sub-Saharan Africa. Some forecasts warn of deep drops in agricultural production juxtaposed against rapidly growing populations. The impact of growing demand and significantly limited output from the area known as Africa's breadbasket, the country of Zimbabwe and its neighbors, will spread beyond the region's borders. The region will go from a traditional exporter to an importer of foods.

The potential for conflict is much stronger in this area rather than farther south in South Africa and Namibia. The combined impact from climate change and disease, especially HIV, may take a great toll on Africa in the first half of the twenty-first century. Climate change will be one of many maladies striking people.

There is good reason to expect a breakdown in the nature and definition of states in Africa during this period. How bad could this get? Access to food may become a critical factor. "In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020" (IPCC, 2007b: 10). Africa could become the continent that cannot support itself.

This region will see minor climate change impacts and an existing record of low-level conflict. Droughts may add to instability. Though persistent, conflict may not rise to a significant level.

East Africa

The picture in East Africa is much like in West Africa, where moderate rises in temperature and drops in precipitation may spell possible disaster over the long term. State governance in these areas is weak, and failed or near-failed states dominate the region.

The future for this region may include mass starvations that are regular events in Ethiopia and Somalia. With rapidly growing populations, the casualties may be much higher (Faris 2007). The drying trends are spreading to places like Darfur in Sudan and the Omori tribe lands in southern Ethiopia (they are Somali people) and inciting further conflict. These crises of failed states will overflow national boundaries and dip farther south into countries like Kenya and Uganda.

Rising water temperatures in large lakes will reduce fish resources, and human pressures will exacerbate this problem. The decline in biodiversity will be especially prominent in the Great Lakes region in Africa (IPCC, 2007b: 10). This region has encountered livelihood conflict for some time, with the genocide in Rwanda only one example.

The line of climate change will also match the religious line in this region. Muslims are dominant in the dry land areas, and Christians and animists dominate in the more southern areas that are tropical and temperate. As was the case in East Africa, conditions will push people southward. These people will be largely Muslim. This would be an impetus for conflict, as large migrations of Muslims into Ethiopia or Kenya would probably meet some resistance if expanding into traditional Christian or animist zones. These failed states will not be able to care for refugees adequately, so religious institutions and non-government institutions will see more involvement and overlap.

Livelihood conflict will affect East Africa. Similar to West Africa, encroaching desertification, development, and population growth will contribute to tensions. The looming state failures in the region will set off large-scale social conflict between and within states. The enduring conflict around the Great Lakes region will continue and expand.

Asia

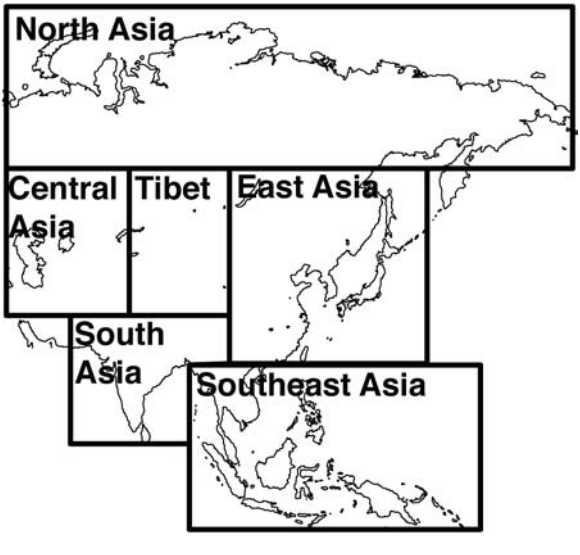
Asia is by far the planet's largest continent, so it is no surprise that it will see the widest gamut of impacts. There are six distinct regional climates in Asia (see

Map 3.10), and differing parts of Asia will see differing outcomes. In general, the north will gain and the south will lose to climate change. With continued economic growth and development, a growing middle class will embrace another billion people from China and India alone. Asia will be a place of great environmental transition. The temptation will be for the heavily populated corridor along the coast to retreat north and inland into the continent. "Climate change is projected to impinge on sustainable development of most developing countries of Asia as it compounds the pressures on natural resources and the environment associated with rapid urbanization, industrialization, and economic development" (IPCC 2007b: 10).

For the next two or three decades, river flow from the Himalayas will increase with global warming. Once the glaciers are largely spent, the river flows will decline and become much more seasonal. Fresh-water availability in large river basins, along with population and demand increases, could affect a billion people around mid-century (IPCC 2007b: 10). The risk of hunger will be high in some countries. South and Southeast Asia will see the least warming. The interior and north will see the most change. Precipitation patterns are not clear.

South Asia

The forecasts for South Asia show a greater than average rise in temperature, and an indeterminate impact on precipitation patterns. India, in this period, will pass China in population size, and both countries will experience a growing middle class. This lifestyle change may add to the pace of climate change and resource use that goes beyond the baseline of the climate forecasts. A higher



Map 3.10 Asian regions.

than expected population growth may exacerbate greenhouse gas emissions through the burning of forests.

South Asia has a history of conflict with international implications. These conflicts have flashpoints in upland areas such as Kashmir, where Indian forces and Pakistani militants fought a recent war among glaciers and snowy mountains. There will be further conflict regarding the ownership of waters in the Ganges or Brahmaputra Rivers, which originate in China and form one of the largest fresh-water outflows in the world.

Waters from the Himalayas will be of consequence in future relations. One outcome of warming will be the melting of Himalayan glaciers, whose waters feed great rivers such as the Ganges, Brahmaputra, Indus, Amu Darya, Sri Darya, Yangtze, Mekong, and others. In the short term, there will be seasonal surpluses. In the long term, however, there will be substantial regional deficits. The headwaters and sources for most of these water resources are under Chinese control.

Chinese control of the headwaters of major rivers in Asia will be a key environmental security aspect of the upcoming century. As the water from melting glaciers eventually declines, these waters will become more precious, particularly during the summer months. China can cite the precedent examples of Turkey (Tigris River) and the United States (Colorado River) as countries that claim up-river rights to control water resources. There is no doubt that China will divert more water each year from flowing out of their country.

Another climate change impact in this part of the world is the extreme event. In 1991, Bangladeshi floods killed 130,000 and may have had origins in climate change (Page, 2006: 39). Hurricane Katrina displaced perhaps 1 million people, and thousands died. Conflict was an intrinsic part of this chaos. Now multiply this by 100 in the case of a future extreme event in Bangladesh. Extreme events will have cascading impacts into areas not directly affected by the situation (IPCC 2007b: 9). For example, Bangladeshis who are fleeing rising waters might be forced to cross the border into India or Myanmar. This may cause conflict.

In South Asia, there will be some impacts from climate change – particularly in the west, where substantial drying may occur. People's lives will be precarious, and there is a good likelihood that extreme events may push the region into conflict. Monsoons and other extreme events, coupled with a rising sea level, may threaten many communities in the Bay of Bengal.

Central Asia

Warming will be substantial in Central Asia, in part as a consequence of continental properties of heat retention. Human activities and land-use change will promote the warming. Both a significant rise in temperature and a decline in precipitation will be a consequence. For the last half-century, ideology repressed nascent conflict in Central Asian countries in the former Soviet Union. With the demise of the Soviet Union, traditional rivalries are re-emerging at the same time as substantial changes in climate are underway. Fast-growing populations and

petrodollars may produce misaligned growth patterns among ethnic or tribal groups, and stir civil unrest.

Warming trends will put stress on water supplies. The Amur Darya and Sri Darya Rivers will become points of international competition and possible conflict in Central Asia. These river resources are already stretched to the maximum, and failing in many places. The dying Aral Sea is ample evidence of the decline in fresh-water resource flows.

Kyrgyzstan will emerge as a key player in these water wars, since some of the headwaters for Central Asian rivers originate or pass through the country. The Sri Darya River originates there. The headwaters of the Amur Darya, the largest river in Central Asia, originate in Afghanistan and Turkmenistan. Afghanistan uses relatively little of the water, compared to downstream countries.

Central Asia will become an ecotone area and a divergent zone that straddles desert and cold weather areas. Demands on its resources come from two differing economic types and thus invite conflict.

Northern Asia

Northern Eurasia will see a temperature increase that is greater than the average. Precipitation patterns are indeterminate. These trends will lead to longer growing seasons and a more moderate climate. Coupled with high immigration and significantly increased economic production, this area will see enormous changes. The driver of this change, however, will be human rather than natural factors. Northern Asia is already undergoing rapid economic development, and will likely see considerable deforestation over the course of the century.

Northern Eurasia consists mostly of Siberia, a place that has been associated with abandonment and isolation in history. In this region, warming will be substantial and will fundamentally change a climate that never emerged from the Ice Age. Permafrost will end in large parts of Siberia, and thus make it much more habitable. There is a high likelihood of immigration from other countries to fill this welcoming situation, because Russian population is falling.

Where will these people come from? To the south, millions of Chinese are ready to cross the border to live and work in Russia. Environmental refugees from other areas of the world are likely candidates. This long border will be impossible to control.

The Northeast Passage will also have a substantial impact on North Asia. The opening up of this waterway, the counterpart of the Northwest Passage, will allow year-round access, perhaps within as little as 20 years. The receding glaciers in the Arctic Sea above Russia will allow alternative transportation to the pipelines now used for energy supplies. Tankers may be a cheaper alternative, especially in terms of getting to non-Eurasian markets. East Asian exporters will use these routes for transport to Europe. This may reduce trade flows through the Panama or Suez canals.

The region will be a key transit point for the Northeast Passage, and Vladivostok in Russia will serve as a key port. New cities of considerable size will

emerge along these new northern passageways. Offshore Arctic fish stocks will become expensive commodities. Russia will seek to protect these waters and resources.

The whole image of Siberia will change. Whereas Stalin exiled Russians to Siberia as punishment, the new reality will draw willing European Russians to migrate to its Asian side. This is not unlike the shift in the United States, with populations moving from the east to the west coast in the twentieth century.

The warming may also allow easier export of other resources constrained by the costs of extraction in a cold climate where there is a lack of adequate transportation alternatives. This means precious metals, gems, timber, furs, and other products, such as Siberian woolly mammoth ivory. These transport routes will develop their own issues of control, crime, and sovereignty.

Northern Asia will see substantial warming and higher precipitation. The warming trend will allow exploitation of vast resources that are now largely locked away due to cold conditions. Energy resources, timber, and gems will become much more available, and act as sources for both immigration and economic power.

Tibet

The Himalayan Mountains account for 10 percent of the world's land mass, and are the "roof of the world". The mountains trap more water than any other range. Drainage from the Himalayas flows out in every direction: south, north, east, and west. Climate change will improve the habitability of the mountain range in China, India, Pakistan, Nepal, Afghanistan, Kyrgyzstan, and Kazakhstan, by making these areas warmer. This warming may make some downstream areas less habitable by depriving them of river water.

The Himalayan region will undergo tremendous changes in habitat. The temperature rise will be much greater than average, and precipitation will probably increase, though more as rain and less as snow. The physical terrain will change substantially as glaciers recede.

Technology and rising populations in the warmer Tibetan climate will be sure attractions for migration. Governments may subsidize domestic migration in order to fortify these regions with national populations. The Chinese are now promoting Han migration into Tibet, and have completed a railway to Lhasa in order to accelerate that process. Some day there will also be a high-speed railway to Xinjiang province to speed migration.

Populations in this area have traditionally been low, but the warming trend and the proximity to several billion people nearby in Asia will make this entire area a magnet for migration. The demographic make-up of this region will change dramatically. Native Tibetans and Uyghurs will become minorities, probably to Han Chinese.

Demarcation of borders in this area is a matter of dispute. India and China fought a border war in 1962 over their Himalayan border (China won). There is a dispute over the Siachin Glacier between China, India, and Pakistan. Pakistan

and India have fought mountain wars over part of the uplands in Kashmir. The Nepali civil war between the Maoists and the Royalists is spilling out unto India and Bhutan.

Control of the physical land mass will probably be important, and this includes occupying militarily significant highland areas. Conflict will also occur over the claims of downstream water users. These water flows will actually rise for perhaps 20 years, due to the melting of the glaciers, but after that flows will become less, and seasonal.

Tibet's warming will make resources more available for exploitation. There are some mineral and energy resources. The most important resource will be water.

East Asia

East Asia will also see higher temperatures and more precipitation. The sparsely populated areas to the north will become an inviting habitat, rich with natural resources. The area will become a natural strategic resource hub to supply energy, forestry, and perhaps even food products (at least) to Korea, Japan, and China. The region will see a tremendous amount of change and economic development.

The growing economic links belie other divergent political dispositions. China and Japan both claim parts of territory now owned by Russia. The claims differ greatly: China once owned a great part of Siberia, while Japan claims a few islands that the Soviet Union (now Russia) seized at the end of World War II. Two key unknowns in the area are the states of North Korea and Mongolia. Both lie along the fault lines between these more powerful states and may become areas of contention regarding differing spheres of influence. North Korea has been a failed state for some time – and one with nuclear weapons.

Warming temperatures will make northern lands more habitable. At the same time, growing populations will increase deforestation pressures. Rapid economic development will increase the need for nearby resources.

Southeast Asia

Southeast Asia will not suffer much from climate change, compared to others, and this is probably due to the moderating impacts of the Pacific and Indian Oceans. Warming will not be significant, and rainfall patterns will remain somewhat constant. The region will experience some change as part of a worldwide warming pattern. Probably, more climate change will ensue due to human-created land-use changes. Rapid economic development may aggravate conditions for greater warming. Deforestation and the burning of the forests for conversion to agricultural production will reduce carbon sinks while at the same time increasing carbon release.

The area does have a history of instability. The US war in Vietnam in the 1960s and 1970s spilled over into Laos and Cambodia. China attacked Vietnam

in 1979 in part because Vietnam had attacked Cambodia, a Chinese ally. Ethnic and political conflict has spilled over the borders of Thailand, Cambodia, and Myanmar. Myanmar is engaged in a border dispute with Bangladesh. There is no reason to believe the bases for these conflicts will disappear with economic development or climate change. Competition over resources may in fact incite further conflict.

Reliance on Himalayan waters such as the Mekong or Irrawaddy Rivers (and others) will grow in national security interest for the countries of Southeast Asia. China controls these upland resources, and has, for example, an ambitious program underway to build a series of dams on the Mekong River. Just as Russia uses energy dependence to achieve political objectives in Europe, China will use water to achieve its objectives in Southeast Asia. Will China simply take as much water as possible before it passes out of its territory? At a minimum, it will ration the water out.

Will China's action lead to a chain reaction in water-users downstream? Consider the Mekong River. It comes out of China and forms the border between Burma and Laos. It meanders south to form the border between Laos and Thailand. It then flows into Cambodia, where it seasonally creates the Tongle Sap mega-lake, before entering Vietnam and exiting into the South China Sea. What would happen if the Mekong River flowed to Vietnam only during certain months of the year? What if each country took as much as it could? The lowest flows would likely be in the summer, and might result in reduced agricultural production and substantial land-use changes.

On the populated Indonesian islands, the number of people already exceeds the region's carrying capacity in some places. As the process continues, there will be substantial conversion of forest to farmland on the islands of Borneo and Sumatra. This added conversion, and the fires that usually accompany the transition, will add to the pace of climate change locally and worldwide. Loss of livelihood and overcrowding have already caused migrations of Javanese to Borneo, Papua New Guinea, and other islands, causing conflict.

Sea-level rise will exacerbate climate change for island nations. For instance, Indonesia, a collection of many islands, will see its borders reduced. In general, countries with the largest coast lines vis-à-vis their total size will lose the most territory from a rise in sea level.

The rise may imperil the livelihood of some small island states, to the point where such islands will need to be abandoned or fortified. The latter option might persist in order to maintain sovereignty and claim the resources of the Exclusive Economic Zone around an island. If sea levels rise, then land areas will shrink. This means the areas of continental shelves associated with national rights will grow. Thus, countries do not actually lose any territory; only some of it that was once above water.

The island of New Guinea will see similar conditions, where local and global factors will hasten climate change. The global climate change impact will be average, but human acceleration of that process may be significant, in a situation resembling that of Hispaniola, divided between Haiti and the Dominican Repub-

lic. The division of the island between Indonesians and Papuans will perhaps lead to conflict, as Indonesia's huge and growing population begins to push into Papuan territory.

Southeast Asia will see moderate climate change, but population growth and economic development will hasten these trends. These pressures will spur deforestation and habitat change, and heighten climate change. In sum, the climate impact will be marginal, but, given the conflict history, it may be sufficient to cause tension.

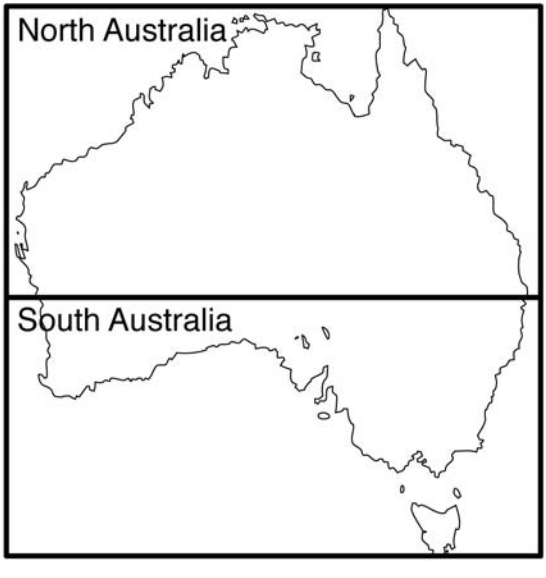
Australia and New Zealand

Australia and New Zealand will not see as much climate change as Southeast Asia, and these societies possess better than average adaptive ability (IPCC 2007c: 11). There may be an increase in some storms and flooding, by 2050, in areas that are aggravated by climate change (see Map 3.11).

Northern Australia

The impact of climate change in Northern Australia is inconclusive and probably not significant. The region will suffer some from the worldwide warming trend, but precipitation patterns are much more uncertain. "Significant loss of biodiversity is expected to occur by 2020 in some ecologically-rich sites, including the Great Barrier Reef and the Queensland Wet Tropics" (IPCC 2007b: 11).

There is low conflict for the area in recent history. There may be high levels of migration to Australia from other parts of Southeast Asia. This situation may



Map 3.11 Australian regions.

resemble the US immigration issues and trends. The country will attract migrants from the Equatorial Tension Belt.

Given its low population density, Northern Australia may well be a destination for environmental refugees. Some refugees will be from other parts of Southeast Asia where populations will exceed carrying capacities. Other refugees may come from nearby islands inundated by sea-level rises.

There is little history of conflict and there is no forecast of large-scale climate change in Northern Australia. It will be a likely home for migrants from small island states and places in the Equatorial Tension Belt.

Southern Australia

Unlike New Zealand, which may observe some agricultural output benefits overall from climate change through greater precipitation, Australia will surely not. Australia is already suffering dry conditions that will get worse. "Water security problems are expected to intensify by 2030", especially around heavily populated southeast Australia (IPCC 2007b: 11).

The impact of climate change on South Australia is inconclusive, though warming will occur. Short-term weather climate trends suggest drier conditions that may be unrelated to climate change. Near to this region are many Pacific Ocean islands that could be submerged or crippled by a rise in sea level. A long-term extreme event might impact the entire region, and hasten the exodus from the islands.

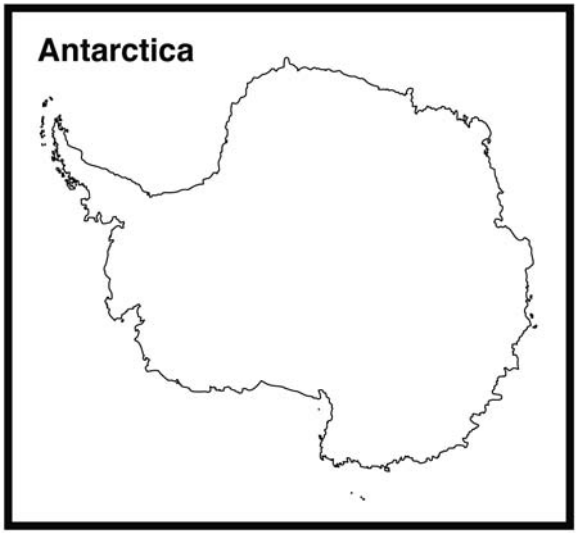
Antarctica

In both Polar regions, where temperatures will increase the most, humans and other species will invade and plant themselves (IPCC 2007b: 12). This section focuses on Antarctica, and the role of climate change and conflict in it (see Map 3.12).

Antarctic warming will change the dynamic of habitation, and make year-round living by humans a much more realizable phenomenon. There does not seem any short-term rush to press claims in Antarctica. At some point in the future, this will change.

The claims for Argentina and Chile in South America extend down into Antarctica in a straight line. Both countries argue for the extension of contiguous land mass based on longitude. Other countries will argue for sovereign claims based on rights due to exploration or proximity. Does Chile have a greater claim in Antarctica due to its proximity, compared to Norway?

It will be many years before this issue takes hold. First, it will be a long time before there are substantial changes in habitat. Second, the current treaty on access to Antarctic resources runs out in the year 2048 (Scientific Committee on Antarctic Research). As the deadline approaches, countries will want to know more about the areas they claim. This will also occur about the time these resources may become more easily exploitable.



Map 3.12 Antarctica.

Several inter-related treaties pertain to Antarctica. Most of them are environmental agreements. Military activities are forbidden, but military personnel are not. Countries can ask for inspection of environmental conditions at other camps, and many countries have done so. Most of the US inspection requests were directed at Soviet Union facilities.

Antarctica will see enormous changes due to terra-forming that will create opportunities for economic exploitation. With many sovereignty claims in the region, there is a chance that conflict will be the outcome.

Climate change, conflict regions, and lessons

From the contexts for climate change and armed conflict, it is possible to construct a set of causal factors. First, there are recurring dimensions for engagement between climate change and conflict. There are both direct links, such as drivers, types, and durations, and indirect indicators, such as related migration, development, and resource use.

According to these dimensions, attributes for Hot and Cold Wars can be juxtaposed to illustrate the differing nature and context for climate change and conflict. Hot Wars are driven by patterns in precipitation, and where there is a contraction of internal state control. The duration is long term, with push migration factors, lower levels of development, and a general impact on resources. Conflict drivers are livelihood-based.

Cold Wars, on the other hand, are driven by temperature increases and expansion of state control and external conflict. These conflicts are often short term,

where a pull factor exists. In these places, there are high levels of development, conflict drives opportunities, and resource types are more specific.

The ability to adapt to climate change in the two conflict dimensions differs substantially, and this differentiation is key to the types of conflict that subsequently emerge. "Cold War" countries, which are largely developed, will face few adaptation issues. In fact, livelihoods may be easier in some areas due to a warming temperature. Some adaptations may be required, but these countries have sufficient stored resources to allow them to respond.

The situation is quite different in Hot War countries. Here, climate change through loss of precipitation will cause livelihoods to deteriorate. This area consists largely of developing countries that lack many stored resources. The result is that where more adaptability is needed, less ability to adapt exists. The greater the adaptability gap, the greater the chance for conflict. This relationship may not be linear. Conflict may be more likely as the gap becomes more apparent, rather than at its widest point. Then, simple survival may be paramount.

The comparisons reveal, starting with the drivers, two entirely different types of systems and behavior. Precipitation and temperature changes drive the differing contexts. The relation to conflict is the process of adjusting to declining and increasing resources.

The next chapter brings together these lessons of climate change and conflict, and forms them into discrete scenarios. These climate change and conflict scenarios reveal a variety of perspectives. One perspective is long term, with centuries required to understand this problem. Another view is from the decision-maker who will need to incorporate these factors into a coherent national strategy. A third concern is the international dimension, and instruments that can work to address climate change and conflict. Finally, there is the reality that climate change will occur. The climate in the next half-century is set.

4 Scenarios of climate change and conflict

Climate change that induces conflict in the twenty-first century may turn out to be quite dangerous or quite benign. The profile can easily change, depending on the actions of people. It may be that people make good choices and minimize the dangers of conflict. It is nonetheless prudent, and indeed necessary, to prepare for a more dangerous world.

This section crystallizes the cases, lessons, and trends into six future scenarios. These scenarios epitomize past conflicts and speculate on future ones, particularly the structural conditions that may reveal areas for potential conflict.

Scenarios of climate change and conflict

This section focuses on key areas of direct and indirect conflict resulting from future climate change. These conflicts are not specific predictions; they are, rather, general parameters for the conditions and possible scenarios of climate change as it interacts with future social stability.

The six future scenarios cumulate the cases, lessons, and forecasts in two ways. First, the future cases embody specific regions within the two tension belts. There are four cases from the Equatorial Tension Belt and two from the Polar Tension Belt. The number of cases from each does not reflect anything of more or less importance. The portion of the planet around the Equator is simply much larger than that around the poles.

Second, each conflict area reflects a differing lesson from the earlier historic cases. As climate change conditions vary, so do the structural and demographic situations in differing parts of the world. In this way, climate change can lead to several differing types of conflicts, though not necessarily the only ones (see Table 4.1).

It is also important to note that these conflicts will not occur in vacuums. There will be feedback between conflicts in differing regions. Part of the reason is that one impact, like emigration for example, may affect another area through immigration. Another reason is more holistic and attributable to the global connections that have become so powerful. These strong global linkages stand in stark contrast to the poor health of the planet.

Table 4.1 Summary of future case regions and associated lessons

Future case	*Tension area*	*IPCC regions*	*Historic lesson*
The end of Ice Age	Polar	Alaska, Hudson, ECGI	Terra-forming
Where have the tropical forests gone?	Equatorial	Central America and Caribbean, Northern South America	Carrying capacity
The Great World Desert and water wars	Equatorial	Sahara, Central Asia	Ecotones
The protein and livelihood deficits in Africa	Equatorial	West Africa, East Africa	Livelihood
Central Asia is heating up	Polar	North Eurasia, Tibet	Resources
Rising tides don't lift all ships	Equatorial	South Asia (and Pacific Ocean Islands)	Extreme events

> The statistics that document nature's diminished capacities are astonishing given the short period during which the changes have occurred: more than 59 percent of the world's accessible land is degraded, half the world's available fresh water now co-opted for human use, half the world's wetlands drained or destroyed, one-fifth of the world's coral reefs destroyed and one-half damaged, and on and on.
>
> (Linden 2006: 256)

Human development has seriously eroded the natural carrying capacity and the planet's ability to sustain renewable resources. Like a patient weakened through bad eating habits, obesity, and lack of exercise, the emergence of a serious virus that attacks the body becomes much more dangerous. Where the person or planet would at one point have been able to recover from the illness, the sapping of the system's vital stores of healthy vitality could well be fatal.

The forecast scenarios are just that: projections of unhealthy convergences between climate change and conflict. They are based on historical records as well as anticipations of future trends. The scenarios are not guaranteed, as modern human society can adapt and respond, but whether we will is another matter. These two outcomes guide the beliefs of the optimists and the pessimists.

> Still, no modern industrial society has been tested by the protracted climate chaos that destroyed the Akkadians, the Mayans, or even the Norse in Greenland. Nor has the global system of markets and food distribution, which has largely eliminated death by starvation except in Africa.
>
> (Linden 2006: 251–2)

The end of the Ice Age

Large-scale changes in climate create conditions for conflict. Such global climate impacts are part of a phenomenon known as terra-forming. The transformation of habitats during these times unsettles existing social structures. The "end of the last Ice Age", which began perhaps 50,000 years ago, may finally come to a conclusion within the next century. This finality, the vanishing of large-scale areas of stored, frozen precipitation, will have geopolitical consequence.

There have been four major ice ages in the last billion years. The first was the late Proterozoic Ice Age, between 800 and 600 million years ago. The latest Ice Age began 40 million years ago, with the growth of the ice sheet in Antarctica. Since then, inter-glacial periods have alternately increased and decreased the extent of permanent ice on the planet. Today's glaciers are the last remnants of this 40-million-year-old cycle. It is possible that human-induced warming will end the current Ice Age, though the time horizon for eliminating the last bits of the world's permanent ice will probably extend beyond the year 2100.

The poles will be a major source of conflict in the twenty-first century, though the issues at the north and south poles will be quite different. In the north, there are existing territorial claims that are long established. Fitting these claims to the new realities will be an issue. In the south, the issue will be determination of sovereignty in areas where ownership remains in stasis.

The end of the Ice Age will open a "new world", comparable in some ways to the voyage of Columbus. There will be claims to lands, populations will move on a large scale, and there will be a rush to exploit resources. Just as the "discovery" of the New World brought European powers into conflict, so too will global warming open up new northern and southern lands and incite violence. Two issues will dominate the future discussion related to Polar areas: sovereignty of lands and of seas. Due to the differing situations at the North and South Poles, conflict will emerge sooner in the north than in the south.

Northern polar areas will become habitable from an economic standpoint for reasons of both arability and resource availability (as discussed earlier in the Northwest Passage case study). The region will include Canada and the United States in North America, several northern European countries (Scandinavia and Russia), and large parts of Siberia. In Europe, the country of largest geographic impact will be Denmark, who owns Greenland as well as the Faroe Islands.

In the northern polar areas, the issue concerns extraterritorial claims, since all of the unclaimed area is under water. The United Nations Convention on the Law of the Sea (UNCLOS) allows countries to extend their Exclusive Economic Zone beyond the 200-mile limit in certain circumstances. One permissible instance is when the Extended Continental Shelf (ECS) goes beyond that point. These rights are for the shelf, which is thought to contain energy and mineral resources, but not the sea above it. Controlling these ECS areas will be one of the largest land grabs in history, even if they are underwater.

In this formulation, countries would have sovereign rights to extract energy reserves, mineral finds, and organisms that live on the seabed. The rights would

not apply to the fish or other organisms that live in the waters above the seabed, with some exceptions. The Law of the Sea Treaty gives the owning country the sole right to conduct scientific research and to control pollution originating in the ECS. Thus, a ship improperly disposing of waste would fall under the a country's jurisdiction; maritime control would be subject to that country's laws. The reason these rights are important is that countries near the North Pole are already in competition over ECS claims.

Denmark is one claimant, and announced in 2004 that it was undertaking scientific investigations to prove that the "seabed beneath the North Pole was a natural continuation of Greenland" (BBC News, 2004). Claiming the seabed as part of Greenland's continental shelf would allow Denmark access to an enormous area, since the northern tip of the island is 450 miles south of the North Pole. Danish research teams explored the underwater Lomonosov Ridge.

A Russian sea expedition to the North Pole in August 2007 sought to provide data that showed that the Lomonosov Ridge is actually a geologic extension of Siberia, and thus Russian territory (CNN 2007). As part of their mission, two mini-submarines dived 13,200 feet to the sea floor and planted a Russian flag. While the Russians compared it to planting a flag on the moon, the Danes and Canadians saw the move as simply a symbolic gesture. In 2001, the Russians filed a claim with the United Nations, under UNCLOS, to 460,000 square miles of extended continental shelf, with perhaps 10 billion tons of oil and gas reserves.

The United States and Canada are also possible claimants to sea beds around the North Pole (BBC News 2004). As they advance their claims, they are also working on enhancing enforcement ability. The United States is building two new icebreakers, and Canada eight new Arctic patrol ships. Part of the reason is security related, but part is also to regulate fishing. Russia, though, is well ahead in having ships that can traverse polar areas.

In January 2009, as one of its last official acts, the Bush Administration announced the *National Security Presidential Directive and Homeland Security Presidential Directive: Arctic Region Policy*. The directive points to three major US security interests in the Arctic: missile defense and early warning, deployment issues related to strategic deterrence and maritime security, and ensuring freedom of navigation, particularly on the seas. It also aims to ensure protection of the environment and native peoples.

Preventing terrorism in the Arctic is also a major goal of the policy, though at the moment there is little evidence of any nascent threat. The United States, as part of the directive, is to increase its military capabilities and presence in the Arctic to protect air, land, and sea borders. At the same time, it wants to foster a peaceful means to resolve disputes, and encourages expansion of the existing Arctic Council understanding and structure. The document explicitly points to geopolitical circumstances of the Arctic as fundamentally different from those in Antarctica. There is mention of disputes with Canada over the Beaufort Sea and with Russia over the Bering Sea.

Fishing patterns will move farther northward in a warming climate, and there will be more stress on coldwater fish stocks. There will also be adverse effects

for aquaculture and fisheries due to regional climate changes in fish species' distribution (BBC News 2004). Warming will contribute to problems with both food resources and jobs in a time of transition. Pressure will mount on countries to expand their claims for exclusive economic zones. Canada is has already suggested doubling the limit from 200 to 400 miles.

Sovereignty claims related to extending EEZs will cause tension in this new ecological and political climate, just as the extension from three to 200 miles did. In 1972, Iceland unilaterally extended its EEZ and came into dispute with the United Kingdom. There was militarized confrontation between Canada and Spain over fishing during the expansion to 200-mile claims. Morocco and Spain also entered into dispute, as well as other African countries. Countries that are large fish importers – i.e., traditionally East Asia and Europe – will continue to push for access to fish stocks. These efforts will likely target stocks found off South America, Africa, and Antarctica. With some likely northward drift of fish populations under warming conditions, fleets will follow them to the Arctic Sea.

Which countries are most likely to be participants and perhaps winners in the Polar land rush? In the north, these include the United States, Russia, Canada, Denmark, and Norway, the latter of which has claims at both poles. Countries nearest Antarctica, mainly Australia, New Zealand, South Africa, Chile, and Argentina, have also made geographic claims. France and the United Kingdom have Antarctic claims based on explorations.

As terra-forming proceeds, there will be conflict over sovereignty. The key question is whether this will be managed or anarchic conflict. Those countries within NATO have some means for conflict resolution. Russia will be a key competitor to all.

Four types of disputes are already occurring, and will escalate. First, there are issues concerning offshore territorial claims and exclusive economic zones. Three of these countries claim and dispute seabed beneath or nearby the North Pole related to extension of continental domains, with four other disputes on territorial claims.

Second, there are issues of navigation rights in waters that may become passable. Canada claims transit rights through its territory, although this position is opposed by other countries both within and outside of the northern countries. The United States has refuted this claim this for over 40 years. The current policy is "don't ask, don't tell", where resolution of status will be forced by situation.

Third, insignificant islands will become more valuable when they are ice-free and have important rights to an Exclusive Economic Zone (EEZ). This is the case in disputes involving Russia–Norway and Canada–Denmark, but also islands in the Antarctic Sea. In addition, some countries may see intra-state instability due to large migrations: Russia, Canada, and Denmark/Greenland (see Table 4.2).

Fourth, the lands of Antarctica are of key importance to some countries. As the Antarctic Treaty expires, it is reasonable to expect some militarization of claims. This may include stationing military assets there. It may also promote

Table 4.2 Country conflicts in the Polar Tension Belts

Party A	*Party B*	*Dispute*	*Where disputed*
United States	Canada	Navigation and off shore claims	Northwest Passage and Beaufort Sea
Denmark	Canada	Island claim	Hans Island
Russia	Canada	Offshore claims	North Pole
Russia	Denmark	Offshore claims	North Pole
Denmark	Canada	Offshore claims	North Pole
Norway	Russia	Offshore claims	Barents Sea
United States	Russia	Offshore claims	Bering and Chukchi Seas
Iceland	Denmark	Island claim	Arctic Sea
Norway	Denmark	Offshore claims	Arctic Sea
Chile	Argentina	Territorial claims	Antarctica
United Kingdom	Antarctic treaty members	Off shore claims	Antarctic Sea

the need to create facts on the ground, meaning the settlement of people there on a year-round basis to establish sovereign claims.

There are two general predictions that relate to polar warming. In the north, the key confrontations are regarding continental shelf disputes and transportation rights. There will probably be some armed conflict, or threats of it. There will be an arms race in terms of Cold Water military capabilities. Russia will want to control transit through the Northeast Passage, and Canada to control transit through the Northwest.

Second, there may be international conflict over increasing habitable or exploitable lands near the South Pole. Up to now, competition has been frozen by the Antarctic Treaty, but that legal position may thaw perhaps in the year 2048. In 1998, countries agreed to a 50-year ban on mining and economic development. The need for resources in 2048, along with a more welcoming climate, might be a powerful impetus for countries to make formal claims. The treaty counts more than 40 members, and essentially demilitarizes the land mass and de-economizes it as well. The timing of the treaty end and the peaking of global warming growth rates may serve as invitations to tension.

The Antarctic Treaty does not address the claims of countries to Antarctica made prior to 1945. The first claim was made by Great Britain in 1908. Other claimants to territory, based on exploration and presence, are France, Norway, Chile, Argentina, Australia, and New Zealand. There is also an unclaimed area. Antarctica's future can serve as a bellwether, depending on outcome, as a place either where countries compete for control or where they agree on something like a peace park. Most of the treaty members do not claim lands, as of now.

There is a history of aggressive attempts at colonization of Antarctica. Nazi Germany laid claim to parts of Antarctica in 1939, in an area overlapping the claims of Norway. Shortly thereafter, Germany invaded Norway and extended its claim over Norway's Antarctic lands. The Germans called this combined territory "New Swabia", and planned to build a whaling station. This was intended

to develop alternative fuel sources, one based on whale oil, in anticipation of war and a cut off in petroleum supplies. The idea seems foolhardy from a resource standpoint. Germany would run out of whales rapidly. The real value in the waters today is probably not the whales, but the krill they live on.

Some of the Antarctic Treaty members include China, India, South and North Korea, and Japan. Given global demands for resources and living space, there is good reason that many of these countries will support the current treaty but would favor resource development with a multilateral component.

Drawing a straight line south is also the basis for the claims of Australia, New Zealand, Chile, and Argentina. Papua New Guinea is an observer, because some of its islands lie due north of Antarctica. Chile, Argentina, and Australia also include the EEZ adjacent to their territory claims. In 2008, the United Kingdom claimed its offshore sea beds.

The year 2048 will be nearly 150 years after the United Kingdom made its original claim, and claimant countries may think it is time to finalize sovereignty. This process of establishing sovereignty will come in stages – a sort of creeping sovereignty. One country going ahead with its claim would undermine the whole system.

The Antarctic outcomes may embrace national sovereignty, international jurisdiction, or perhaps formulations somewhere in between. At a minimum, there need to be some interim decisions regarding the existing treaty. For example, two areas of key economic activity, tourism and fishing, will grow. How will this industry be regulated between now and the year 2048?

China is expanding its Antarctic presence. It now has two operating stations, and a third station due to open around 2010. Called Dome-A, the third station will be built 4,093 meters above sea level – the highest point on the continent. China is also deploying two robots at the Antarctic locations, one of which will operate on land and the other in the air in order to collect data (Antarctic Treaty Secretariat). Some analysts suggest this is also practice for robotic explorers that may be used in space missions to the Moon and Mars.

There is also reason to believe that Chile and Argentina will take their claims more seriously, since they are closest to Antarctica. If Argentina thought it necessary in 1982 to invade the Malvinas/Falkland Islands to reclaim historic territory, then Argentina may also invade Antarctica to enforce its claims.

In the southern polar areas, the issue is sovereignty. There are many claims on lands in the Southern Hemisphere that will need amelioration. This includes both islands, as well as the continental territory of Antarctica. Justification for sovereignty may well fall into two types: explorer and proximity claims.

Norway and the United Kingdom clearly place their claims on explorers. Roald Amundsen and Ernest Shackleton, among others, were the respective first explorers of Antarctica, and they were from those two countries. These explorers provided the basis for sovereign claims over these territories that will have consequence over time. After all, Norway and the United Kingdom are on the other side of the world. The proximity claims of Australia, New Zealand, Argentina, Chile, and Brazil, may be much more salient arguments in a modern world.

It is possible that member countries would decide to divide the region between the claimants after 2048. Adding these territories would greatly increase the geographic size of the claimant countries. Argentina, the world's eighth largest country, would grow by 35 percent; France by 68 percent; and Australia, the world's sixth largest country, by 77 percent, to become the second largest country in the world. New Zealand and Chile would grow by 165 percent, and Norway and the United Kingdom by over seven times their current size. In comparison, however, is the possible habitation of Greenland, since it is 50 times the size of Denmark.

The outcome of sovereignty claims may in fact resemble a combination of the commons and territorial approaches. Russia and the United States have always reserved the right to make claims. The presence of so many Antarctic research stations from these two countries suggests that they might make a claim at some point.

There is an aspect to claims from Antarctica that magnifies the importance of offshore claims in a way that the North Pole does not. In the north, there is no land mass at the pole, but rather largely south of it in Canada and Russia, so claims will radiate northward. The area claimed decreases as the line goes toward the North Pole, due to the curvature of the planet.

Antarctica, however, is a land mass that sits at the South Pole. EEZ claims will radiate in a straight line northwards. The size of that zone will increase as the distance from the shore grows, again due to the curvature of the planet. The more the EEZ extends in the south, the more area one controls.

At some point, indigenous communities will develop in Antarctica. These may be freewheeling and libertarian people, as have usually existed on frontiers. They may not want to have any part with these colonizer countries, or international institutions, and prefer their independence. Perhaps a mix of independent countries, colonies, and multilateral zones will be an alternative future for Antarctica.

Where have the tropical forests gone?

Climate change will stress people and forests. Hotter temperatures will cause forest types to move gradually pole-ward to more optimal ecological niches. There will be transitional losses in the ability of the habitat to maintain carrying capacity. Climate change and human intrusion will accelerate the disappearance of tropical forests. This loss will have significant human consequences.

Carrying capacity is not immutable and varies with time, especially in relation to humans and their activities. Environments with too many people taking too many renewable resources will see their carrying capacity reduced. Reduction in carrying capacity will occur when waters are too polluted to drink, soil arability is exhausted, or forests vanish.

Differences in carrying capacity may be a cause for conflict. There may also be spill-over. Two regions side by side may show very different loadings in terms of carrying capacity per capita ratio. Part of this ratio includes population

density per area, but an overall calculation would require including resource replenishment weightings, climate characteristics, economic levels and types, and trade profiles, to name a few factors. Where these loadings show sharp differences, and population densities are a good initial indicator, people will tend to migrate to those places with the most available resources per person. These resources are probably already claimed by someone else.

Carrying capacity can be diminished by climate change, and there is a high likelihood of this. In some tropical forests, the area will warm and rainfall will decline, although by just a small amount each year. However, a small rainfall deficit over nearly a century compounds to cause significant changes in forest health.

The socio-economic stress on forests, coupled with climatic stresses, will be intense (see Map 4.1). Other areas of significant forest loss will include Central America, Central Africa, and Southeast Asia. Some pressures on forest health will come from warmer temperatures around the Equator, though precipitation may actually increase in some places, such as Central Africa. The majority impact will come from growing populations that are extremely reliant on livelihood farming for survival. The combination of these two factors makes South America a special case.

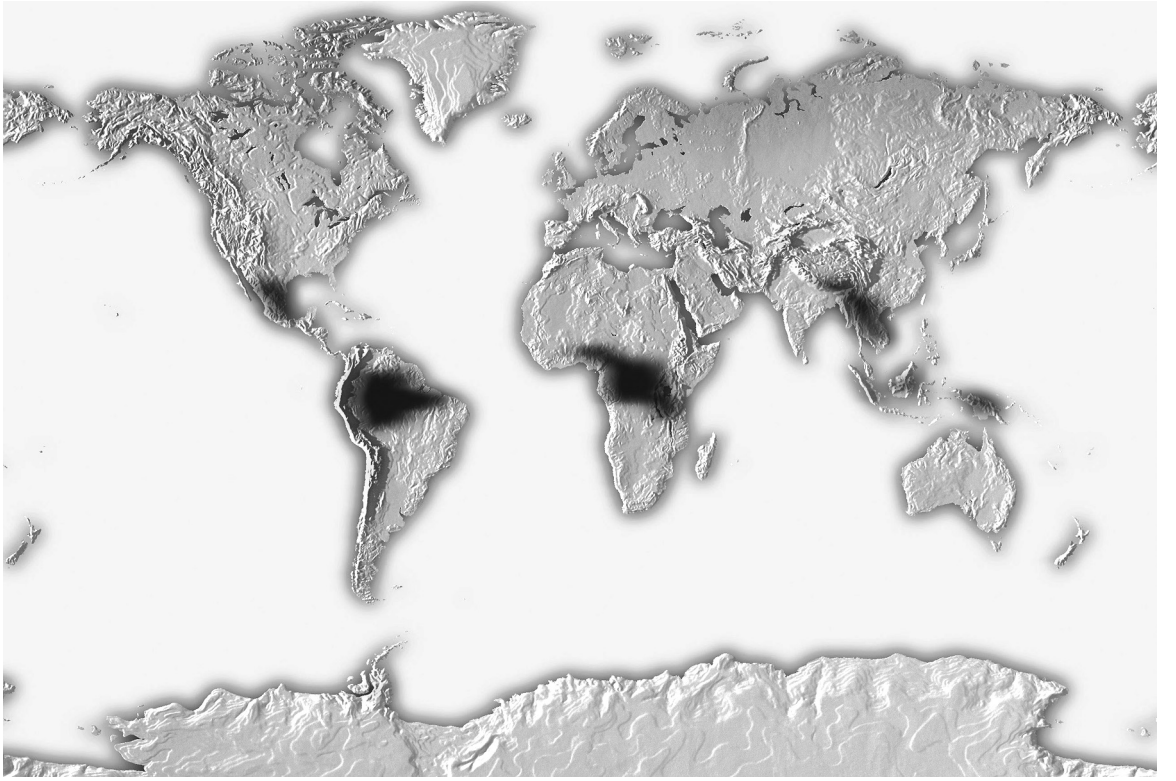
One particular area likely to see a substantial impact from climate change and human factors is the Amazon. Within that expanse, some parts are more at risk than others and some are already being exploited. There is a population density hole in northeast South America, in the Amazon area, that will entice people and national interests in the upcoming century. It is an area with small populations near to areas that are extremely overcrowded. As people and industry move into the area, large-scale changes in habitat will take place. This change will hasten an even higher rate of climate change.

Populating the demographic hole in northeast South America will also amplify border disputes. These are not just disputes over where lines on a map are drawn, but claims to a substantial area of land within another country.

Forests will serve as a key counterweight to climate change. Forests will be under threat from conversion to agricultural lands to feed expanding populations. The wood itself will have value as a one-time instrument of income for people, yet the soil for farming purposes is rather poor. Besides climate and demographic stresses that harm ecosystems, forest fires (both intentional and otherwise) will add to further deforestation and accelerate climate change by spewing more carbon into the atmosphere.

In Central America and the northern part of South America, demographic pressures will push people deeper into the inland forests. As carrying capacity is exceeded, migrating peoples will be in great flux and a source of internal conflict. Poor demarcations of national boundaries may also lead to inter-state conflict.

The IPCC generally forecasts reduced precipitation and higher temperatures in Central America and northern South America. Temperatures are expected to rise by 2–3°C, and precipitation to drop by 10 to 20 percent. Drying will be especially pronounced during summer months.



Map 4.1 Areas for potential forest cover loss by 2100.

Temperature and precipitation changes, alongside growing populations and incomes, will place enormous pressures on the environment. The need to save these forests in order to forestall or reverse climate change will encounter the growing need to cut them down for livelihood reasons.

The Amazon River region will be a new world ready for exploitation. The push of population and the pull of new lands now more habitable due to climate change will be a tremendous lure for migrants. A warmer climate with less rain might be better for growing crops. Exploding population levels in Latin America's metropolitan areas along the coasts will lead to migrants trickling into the region and then flooding it. In the Northeast Quadrant, these trends will affect the countries of Venezuela, Surinam, Guyana, French Guiana, and Brazil.

Population growth will be instrumental to the future of this area. The three small countries will not appreciably change their demographic profile. According to the United Nations, populations in Surinam, Guyana, and French Guiana will remain rather limited out to the year 2050. None of the three has a population exceeding one million. The population of French Guiana will nearly double in this period, while that of Guyana will fall by half.

These three countries currently have the lowest population density in South America, with only two to three persons per square kilometer. Populations are clustered largely along the coast. Even this sparseness belies the intense concentration of current populations. In Guyana, two of its smallest regions account for almost half of the total population, but only about 3 percent of the country's land area. The largest region, Demerara-Mahaica, has a density of 82.6 people per square kilometer.

The demographic future is quite different in Venezuela and Brazil. Venezuela's population in 2005 was 26.7 million, with a density of 27 people per square kilometre – the third highest in South America. Most of Venezuela's population lives in northern, urban areas, and within 100 kilometers (or 62 miles) of the coastline. Almost half of Venezuela's land area lies south of the Orinoco River, but only 5 percent of Venezuelans live there. By 2050, Venezuela's population will rise by 57 percent to 42 million.

Brazil's population in 2005 was 186.8 million, with a density of 21 people per square kilometre – the fourth highest in South America. By 2050, that population will rise by 36 percent to 254 million. The northern region has the smallest population level, while 30 percent of the country resides in the northeast near the coast. Together, Brazil and Venezuela will add 83 million people by the year 2050.

Settlers, ranchers, and prospectors of various sorts will drive deep into tropical forests of the Amazon. Indigenous peoples will acquire more sophisticated weapons to defend their lands and their lifestyles. There is no shortage of warfare tools in this part of the world, in part due to the regionalization of the Colombian civil war and narco-trafficking linked to it. Conflict is a likely result that will have both inter- and intra-state dimensions.

Brazil's relationship to Guyana, Surinam, and French Guiana, is somewhat like Russia's relationship to the small Baltic states of Lithuania, Latvia, and Estonia. There are four ways in which these relationships are comparable.

First, the geographic relationship on a map looks very similar. The three small countries are clustered together along a coast in both cases, adjoining a larger neighbor. Second, the ratio of relative populations is in both cases equally lopsided. In either instance, the large country has a population of 150–200 million, while the total population of the other is around ten million. Third, the three countries are in many ways economically reliant on their bigger neighbor. This reliance is a form of political dependence, as well. Fourth, these small countries are also sought after areas of influence and domination. Germany, Sweden, and Poland, for example, have competed with Russia throughout history for sway in the three Baltic countries.

Venezuela will vie with Brazil for influence in the Guyanas. Venezuela has a number of outstanding border disputes with the three small countries, while Brazil has resolved its border disputes with them (Dominguez *et al.* no date). It will also characterize inevitable clashes between the dominance of Portuguese or Spanish cultures.

Indigenous peoples there may develop their own sovereign ideas. The Brazilian military warns that Native American tribes in the northeast of the country may one day want independence from Brazil. They fear that the result may be a Kosovo-like situation.

Disputes do exist within the small countries. Guyana and French Guiana have differences over borders. Surinam claims land east of the Corentyne River in southeastern Guyana. Brazilian migrants have already moved into Guyana, whose government lacks the resources to expel them.

Venezuela claims land west of the Essequibo River as part of Guayana Esequiba. The dispute has roots in post-independence and agreement between Venezuela and Guyana as a British colony. Venezuela also has a border dispute with Colombia. In 2008, when Colombia launched an attack on FARC guerrillas in Ecuador, Venezuela sent troops to the border. Border disputes persist because demarcations of boundaries are not always clear or permanent, as in the case of shifting rivers.

> Nevertheless, some disputes do linger from the nineteenth century, exhibiting path-dependent features common to boundary disputes worldwide. Several factors explain such endurance. One is geography. Tropical rainforests in South and Central America long made it physically difficult and logistically complex and costly to demarcate boundaries. Inaccurate maps have been part of the story of conflict reappearance, notably between Ecuador and Peru.
>
> (Dominguez *et al*. no date)

In some instances, the forest may also disappear because it will be a resource for waging war. The sale of forest resources funded conflict in the case of the Khmer Rouge in the 1980s and 1990s.

Conflict over the Amazonian Northeast Quadrant has three dimensions where the potential for militarized disputes over territorial integrity might occur. There

will always be sparks that set off conflict events, but the structural conditions ("the kindling") will be in place. There are three types of potential conflicts that can be expected.

First, there is likely to be internal conflict in the three small countries. Each carries a legacy of colonization by European countries, and importing of labor from other colonies. These countries have identity issues to begin with. In Guyana, most of the population in this former British colony is from South Asia, followed by those of African descent, Native Americans, and Europeans. With and influx of migrants that will likely become a majority due to the relative size of populations in Brazil and Venezuela, the already fragile states might begin to crumble.

Second, the three countries have unresolved issues regarding territorial integrity, and these are sources of external conflict. This inter-state aspect of the conflict will tend to add to conflict likelihood. These disputes are often are long-standing and relate back to colonial arrangements. As these states are under pressure to decompose or redistribute, they will do so in tandem. Venezuela and Brazil might back different groups in the struggle, or seek solutions in the way that Germany and Russia divided Poland.

Third, Brazil will have native peoples who at some point may want to secede from Brazil. The Yanomami tribe lives in remote areas in both Venezuela and Brazil. This is clearly the case in Russia with Chechnya and special areas in the Russian Far East. In Brazil, native populations in favor of independence may also support differing sides in conflict within the small countries.

The Great World Desert and water wars

Within uninhabitable dry regions, there are special areas – oases – where human populations thrive. Oases are isolated ecotones that are very fragile environments and susceptible to climate change. There are a number of fresh-water oases that are struggling to support burgeoning human populations. Great river systems within deserts are types of expanded oases. For many people, the water situation in these river oases is quite dire and will get quite worse. "By 2025, an estimated 2.8 billion of us will live in areas with increasingly scarce water resources" (Fagan 2008: 233). This water shortage will lead governments to take drastic measures to secure this resource, including conflict.

A re-distribution of precipitation patterns will be a major feature of the new climate. In terms of fresh-water resources, developed countries in the northern hemisphere will benefit from climate change and countries nearer the Equator will lose:

> By mid-century, annual average river runoff and water availability [is expected] to increase by 10–40% at high latitudes and in some wet tropical areas, and decrease by 10–30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water stressed areas.
>
> (IPCC 2007a: 7)

The warming of the planet will have considerable impact on the Great World Desert. The Great World Desert is a collection of nearly continuous arid regions that stretches from the Atlantic Ocean in Africa to the Pacific Ocean in Asia. Climate change will cause these deserts to expand and link up. This group of deserts includes some of the largest and harshest on the planet, including the Sahara, the Somali-Chalbi in the Horn of Africa, the Arabian, the Lut in eastern Iran, the Thar that sits along the India-Pakistan border, the Kara-Kum in Central Asia, and the Talkimakan and Gobi that stretch through China and into Mongolia.

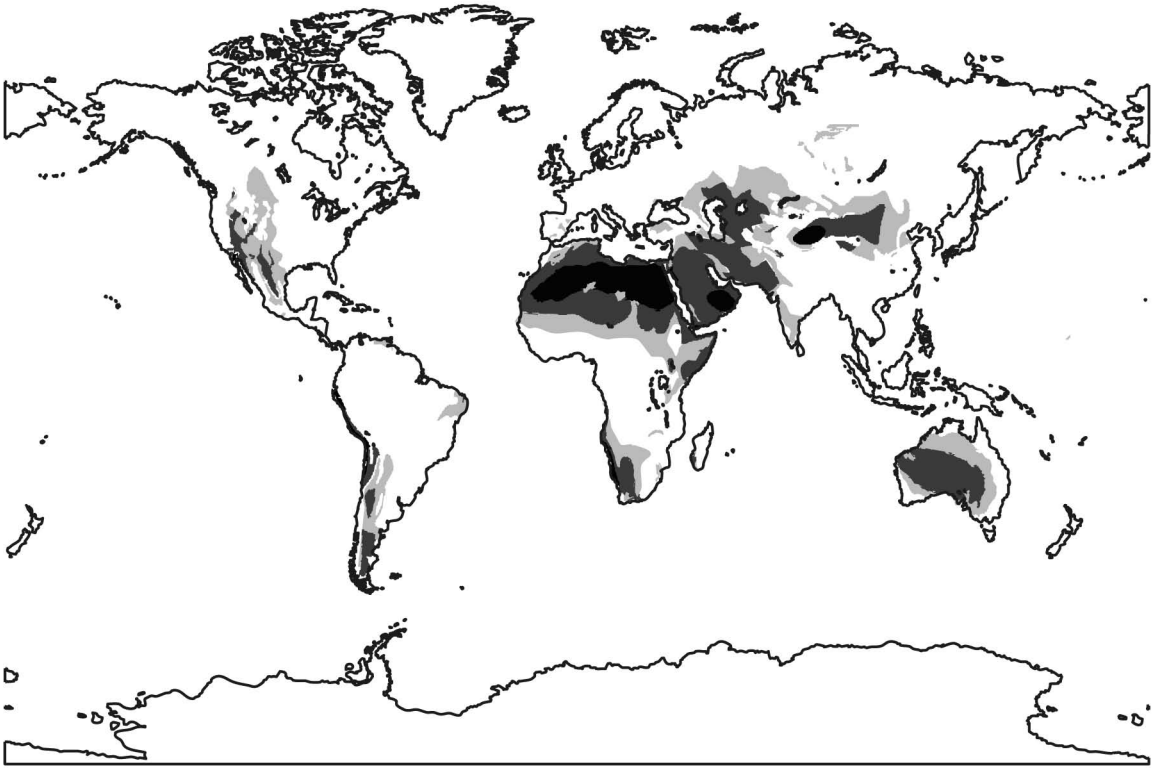
The current area in the Great World Desert covers differing types of deserts, based on the relative scarcity of water. Deserts can be extremely arid, arid, or semi-arid. Based on the system designed by geographer Peveril Meigs, deserts are differentiated into three types based on rainfall. In extremely arid areas rainfall can be absent for an entire year period, as in the Sahara Desert. In arid areas there is less than 250 millimeters annually, as in the Sahel. In semiarid areas there is precipitation of between 250 and 500 millimeters annually, as in Syria.

It is reasonable to believe that a cascading affect will occur with climate change in the Equatorial Tension Belt as precipitation becomes scarcer for each of these desert types. Extremely arid areas such as the Sahara are virtually lifeless now, so climate change cannot make conditions much worse. On the other hand, less precipitation will cause arid areas to become extremely arid, and semiarid places to become arid. New semi-arid regions will emerge.

Enhanced aridity will expand the Sahel deeper south in Africa, north into southern Europe, and further eastward into the heartland of central Asia. With these shifts in climate, and thus ability to sustain human population and economy, new ecotones will develop between differing types of habitat and related economic subsistence zones (see Map 4.2). There will be expanding deserts in western South and North America, southern Africa, and large parts of Australia.

Extremes of precipitation will also occur more frequently in the Great World Desert. “Drought-affected areas will likely increase in extent. Heavy precipitation events, which are very likely to increase in frequency, will augment flood risk” (IPCC 2007c: 7). It is impossible to say exactly where these extreme events are more likely to occur. Places with too little water, such as in the Sahel, would seem most vulnerable. Extreme events also can produce quick degradation of arable land conditions. There will be greater seasonality to river flows in the Great World Desert, especially those that rely on melting snow in summer months. During this century, “Water supplies stored in glaciers and snow covers are projected to decline, reducing water availability in regions supplied by melt water from major mountain ranges, where more than one-sixth of the world population currently lives” (IPCC 2007a: 7).

Melt waters from the glaciers contribute to water in the Nile, Sri Darya, Ganges, Mekong, and Brahmaputra Rivers, to name just a few. While water becomes scarcer, needs will rise. Many people living on the fringes of the Great



Map 4.2 The Great World Desert and other dry areas (source: Based on Meigs (1953) and U.S. Geological Service. Online. Available at: http://pubs.usgs.gov/gip/deserts/what/world.html (accessed 17 December 17, 2008)).

World Desert will be incorporated into it. This will impact four areas in particular, and frame future conflict conditions.

In northeast Africa, populations will rise in areas already experiencing water deficits. Between 2005 and 2050, according to the United Nations, Egypt's population will rise from 73 to 121 million, Sudan's from 37 to 73 million, and Ethiopia's from 79 to 183 million. Population for these three countries, heavily reliant on the Nile River, will grow from 189 to 477 million, or an increase of over 100 percent (United Nations Population Division 2007).

In the Middle East, the population will surge even more. Between 2005 and 2050, Iraq's population will grow from 28 to 62 million, Saudi Arabia's from 23.6 to 45 million, Israel's from seven to 11 million, Jordan's from six to ten million, and Syria's from 19 to 35 million. The total population of Saudi Arabia, Jordan, and Syria will increase by over 100 percent.

In West Africa, populations will see the highest growth in the world, and of people with low income levels. Mali's population will rise from 12 to 34 million; Mauritania's from three to six million; Niger's from 13 to 53 million; and Nigeria's from 141 to 288 million. For upland river countries, like Mali and Niger, population totals will increase by 200 percent.

Central and South Asia will also see large increases in population. Between 2005 and 2050, Pakistan's population will nearly double. Turkmenistan's will grow from five to seven million, Uzbekistan's from 27 to 38 million, and Iran's from 69 to 101 million. These population increases are more modest compared to other regions, but still quite high on a worldwide basis.

The IPCC paints a bleak picture of access to fresh water in the future for these regions. There are currently about 1 billion people who do not have access to fresh water. By 2050 that number will rise to two billion, and in 2080 to 3.2 billion.

Forced to make changes, societies will certainly adapt. Temporary and marginal attempts to add to water-storage capacity will help, but in the end these strategies cannot withstand a drought of decades or longer. Adaptations will need to focus on the agricultural sector, by far the largest user of fresh water. Reducing fresh-water use for irrigation is a key factor in restoring ecosystems.

Populations and economic growth in and around the Great World Desert will substantially rise. There is an obvious collision course ahead. The need for fresh water will go far beyond the supply, and in some places peoples will be subjected to desperate levels of water insecurity.

Clashes will develop over control of the waters in rivers in this area. International water-sharing efforts have been a rather rare point of conflict-resolution over resources. There is no guarantee that this amelioration will continue as water scarcity conditions worsen and become critical.

Over time, conflict will spread to control of every drop of water in a region. Conflict may erupt over water resources not previously considered in conflict terms. This means water deep underground (fossilized water obtained by drilling) or water in the air (precipitation obtained by rainmaking). These under-and above-ground resources will be sources of conflict. One is a finite resource, the other infinite.

The changes in precipitation will decrease fresh-water availability in the Great World Desert. The International Water Management Institute (IWMI, a part of the UN system) believes that North Africa and the Middle East already experience water scarcity. By 2025, they "will be joined by Pakistan, South Africa, and large parts of India and China" (IWMI 2008). Areas experiencing water stress areas will grow in scope from now into the future (see Map 4.3).

Five rivers will be major sources of confrontation in the Great World Desert. As the Great World Desert becomes more expansive and hotter, rivers that flow through it will become that much more precious. Declining water resources will be both human- and climate-induced. The five river systems of focus include the Niger, Nile, Jordan, Tigris-Euphrates, and Sri and Amu Darya Rivers (see Map 4.4).

First, the Niger River in West Africa will be a major source of strife. The river starts in Guinea, only 150 miles from the ocean. From there, it flows inland and continues through Mali and Niger, where populations out to 2050 are expected to triple. At the city of Timbuktu in Mali, it turns right and heads south. It follows the border between Mali and Niger, passes into Nigeria, and forms the border with Benin. Flowing through Nigeria, the Benue River (the main tributary) joins the Niger River, and then flows into the Gulf of Guinea.

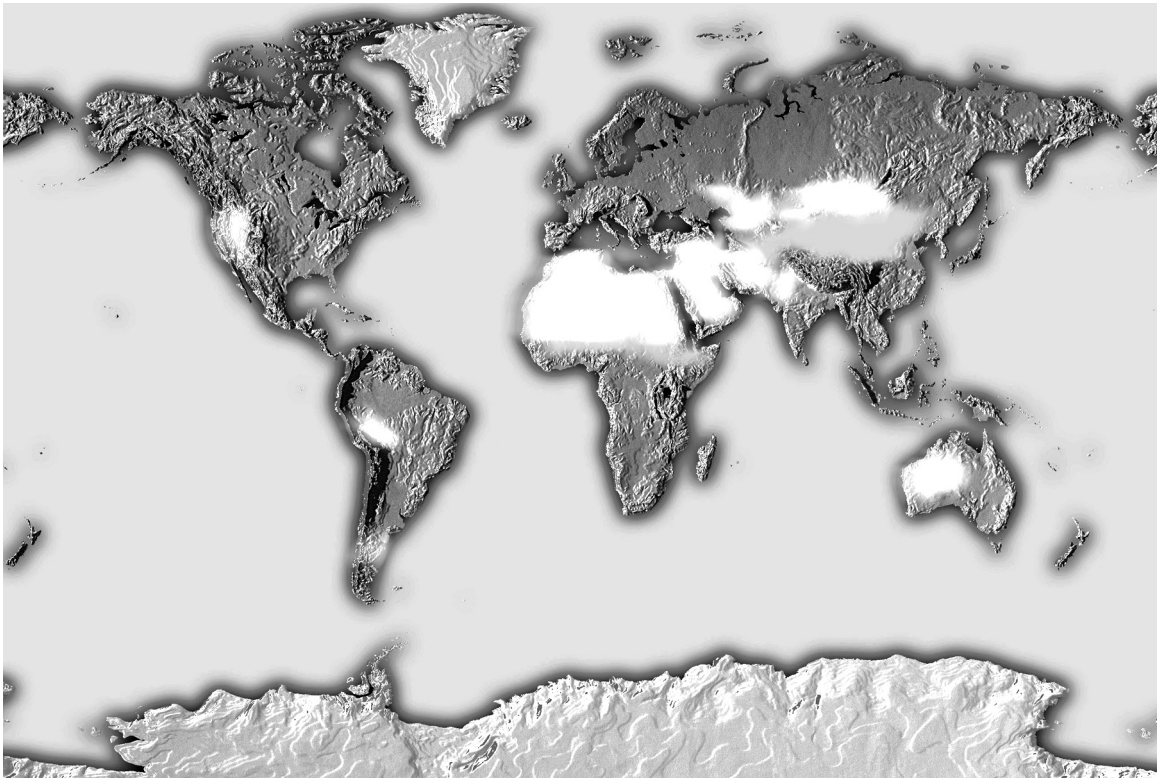
Some geographers believe the odd river course is the result of climate change. The upper half of the river at one time continued inland past Timbuktu and into today's Sahara Desert, where it emptied into a vast inland lake. The lower half of the current Niger River began south of Timbuktu, and flowed directly into Gulf of Guinea. As the Sahara grew with the ending of the current Ice Age, the lake dried, and the two rivers met up and formed a single waterway.

There will be great temptations for Mali, Niger, and Benin to siphon off Niger River water for irrigation and other uses. These withdrawals will increase over time as populations grow and the climate becomes drier. These upland countries may be competitors with downstream users for the waters.

Second, the Nile River is vital to the health of several countries. There appears to be an inevitable collision between Egypt's need for water, as a downstream user, and rising needs upstream to satisfy growing populations in Sudan and Ethiopia. There is simply not enough water to go around.

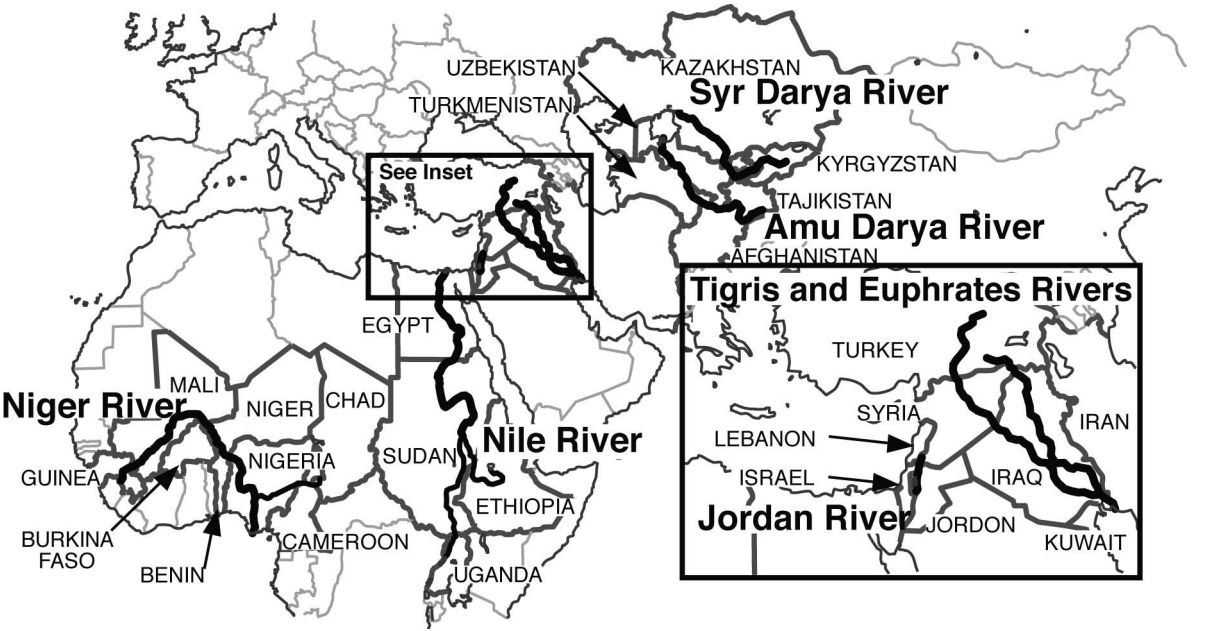
There are differing issues with the two sources of the river, the White and Blue Nile. The rivers meet in Khartoum, Sudan. The White Nile begins far south, with the most distant point in Rwanda. From there, it passes through Lake Victoria, Uganda, and Sudan. Precipitation may increase in Central Africa, but water needs will also rise due to population growth.

The Blue Nile begins in Lake Tana in Ethiopia. Enduring droughts in Ethiopia will force the population to use more of the Blue Nile River water over time through dams and canals. Countries with impending thirst will not refrain from using the waters. In especially lean years, these conditions have already led to mass starvations in these two countries. The day will come when Egypt will use military force in Sudan or Ethiopia to guarantee its Nile River water.



Map 4.3 Water crisis areas now and in the year 2100.

Note
Current areas of drought are shaded and new ones darkened.



Map 4.4 Five great river systems in the Great World Desert.

Egypt uses a variety of military (threats of aggression) and diplomatic tools (blocking loans at the World Bank) to prevent dam and canal projects that would remove large amounts of Nile River water. They consider the matter among the highest order of national interest issues. There simply will not be enough water as the population grows and agricultural production increases in response. Egypt will need to consider other sources of fresh water, whether from the sea (using desalinization techniques) or from underground water sources.

Third, the Jordan River will be a flashpoint for conflict because of declining sources, increasing demands, and politics. Water will only be one reason out of many to fight in the Middle East. The struggle is not only over the Jordan River resources, but also over the aquifer that lies beneath the Palestinian-controlled West Bank, Israel, Jordan, Syria, and Lebanon. Populations will increase in this region, and the growing populations will need more water than these rivers can provide.

Near the border between Jordan and Saudi Arabia lies a huge aquifer of fossilized water. As water resources become increasingly scarce, the economics of extracting this water will become more favorable. Iraq justified its invasion of Kuwait, in part, because the Kuwaitis were allegedly taking an exorbitant amount of a common oil deposit that straddled the borders of the two countries. Could this serve a similar context for underground water that crosses national boundaries?

Fourth, the Euphrates and Tigris Rivers could be major sources of contention as Turkey retains more water through dam and canal systems, and Syria and Iraq receive less over time. Climatic conditions will become drier in this region. The Turkish dams are intended to support livelihood for the southeast part of the country, which has a large and restive Kurdish population. The project's purpose is to raise incomes for poor Kurds, to counter their civil war against the Turkish government. Syria has provided political support to the Kurds in Turkey, and this policy is in part payback for Turkey's taking of large amounts of "their" river water. The loss of water resources especially affects Iraq, as a downstream user of the waters. Iraq nearly rivals Egypt in terms of countries dependent on foreign fresh-water sources.

There is no doubt that Iraq's major source of fresh water, the Tigris-Euphrates River, will decline in the future. This decline will have an adverse impact on the country's economic health. Current efforts to restore historic estuaries and long-standing marsh communities will suffer. Iran is also a small player, since some of its rivers flow into the Tigris. Control of the Shatt-al-Arab has been a major source of contention between Iran and Iraq for some time, and this waterway was a significant factor in the Iran–Iraq war of the 1980s. Until there is a water-sharing agreement, the temptation will be to support civil unrest in upstream areas, notably Turkey.

Fifth, the Sri Darya River (along with the Amu Darya) will also diminish in flow, and this will have consequences. Growing populations and economies in Central Asia will soak up more waters and deprive the Aral Sea of sustenance.

The two rivers flow into the Aral Sea, but not much water now reaches it. The sea is slowly dying, and the salts and minerals from the lakebed, picked up by

winds, now pollute the air. The majority of river water goes to agricultural production, particularly growing cotton, a legacy of centralized Soviet policies created under Joseph Stalin in the 1930s.

The Amu Darya River begins near the Afghanistan and Turkmenistan border, and is the longest river in Central Asia. Climate change will melt off the glaciers. While melting will initially increase the rate of summer river flow, this will gradually diminish as glaciers disappear.

Conflict is very possible on the Amu Darya River, because many countries already rely heavily on its waters. The river begins in Afghanistan, very near to Pakistan and China. It forms most of the border between Afghanistan and Tajikistan, and between Afghanistan and Uzbekistan. The Amu Darya River then turns slightly into Turkmenistan, and emerges to form the border with Uzbekistan. From there, it flows through Uzbekistan and empties into the Aral Sea. The river will have strategic value not only due to its hydrological resources, but also because it forms the border between so many countries.

The Sri Darya, to the north of the Amu Darya, begins in Kyrgyzstan, and flows out to form part of the Tajikistan, Uzbekistan, and Kazakhstan borders. The headwaters of both rivers are very close to Chinese territory. Most of the length of the river resides in Kazakhstan, where it feeds a large cotton-growing district. With drastic reduction in summer flows, the water needed for irrigation will not be enough to support current production levels.

Each of the five river systems is already heavily contested, because depletion of these waters is well underway. The Jordan River no longer feeds into the Dead Sea to any considerable extent, and the Amu Darya does not reach the Aral Sea. Will this also be the fate for these other great fresh-water river systems?

Regional politics will play a key role. In each region, there is one major power that demands control of water resources: Nigeria, Egypt, Israel, Turkey, and Kazakhstan. These five countries, which are both upstream and downstream users, will view themselves as the regional power-broker regarding allocation of water. As a result, they are likely to be involved in any conflict.

Countries may embark on grand schemes to move water to where the people live. In the 1950s, there were Soviet plans to reverse Siberian river waters (the Ob or the Lena, for example) and send them to Central Asia to irrigate cotton. Similar ideas will emerge in the future.

China's great water deficits in the northern part of the country may draw attention to its surplus in the southwest, in Tibet. Chinese planners will no doubt entertain proposals to move water on a large scale, evident in the building of the world's largest dam, Three Gorges, on the Yangtze River. This is consistent with China's long history of altering the environment – a long tradition dating back to the construction of the Great Wall.

More precipitation will fall in the northern parts of the North American and Eurasian continents. Coupled with a longer growing season due to warming temperatures, this trend should open up vast areas for agricultural use. The water surplus will also revive ideas about water pipelines or canals to send water south

to the Plains of North America or to Central Asia. With respect to these five important river systems, there will be no winners, only losers.

The protein and livelihood deficits in Africa

The poor in many countries will suffer disproportionately from climate change, some more than others. Africa especially will encounter declining climatic fortunes, increasing demographic needs, lagging economic opportunities, and a growing resort to violence to solve problems of livelihood wars. Meteorological studies of climate change in the United States and the United Kingdom suggests that, by 2050, "larger farmers in Asia and medium and large farmers in Latin America might benefit, as a result of rising prices, while poor farmers and all farmers in Africa would suffer. Urban dwellers would also suffer with poorer people standing to lose more than the urban rich" (Miall 2007: 148).

The quality of life in Africa will deteriorate on many dimensions in the twenty-first century. This trend has and will continue a decline in "quality of life" indicators since the 1960s, where average life spans in some countries today are below earlier levels. "The IPCC sees Africa as being highly vulnerable to climate change, particularly due to decreased water availability, enhanced food insecurity, impacts on human health, and increased desertification" (Barnet 2001: 7).

A warming and drying climate juxtaposed against rapidly increasing populations will create structural conditions for conflict in Africa, given the right spark. One of Africa's great problems will be in the loss of the most essential and basic livelihood occupation: farming. At the same time, the need to import greater amounts of food will, ironically, worsen the occupational plight of people, thus decreasing the viability of even meager agricultural livelihoods.

For producers of farming and agricultural goods (i.e., food, fiber, or forest products), there are winners and losers from climate change that generally correspond to the changes in temperature and precipitation that are forecast. For northern African countries, this means "Crop productivity is expected to increase slightly at mid to high temperatures" (IPCC 2007c: 8). For countries near the Equator, especially those in already stressed regions, productivity will decline. Crop production in lower latitudes will decrease with a rise in temperature, increasing the risk of famine (IPCC, 2007a: 8).

Climate impacts generally fall into three bands across Africa. First, there is the Sahel band, a dry area that will creep southward and become extremely arid. Second, there is the Central band, a tropical area that may warm and see increased precipitation. Third, in the Southern band, a temperate region, drying conditions are expected.

Sahel rainfall declined sharply in the late twentieth century, with droughts responsible for several million deaths. "Between 1950 and 1999, there has been about a 20% decline in summer rainfall over southern Africa" (Black 2005). Computer models of the global climate show the Sahel region and southern Africa drying substantially over recent history. "If we compare it against the

drought in the 1970s and 80s, the late twenty-first Century looks even drier – a 30% reduction in rainfall from the average for the last century" (Black 2005). This trend continues today.

Africa's growing season will shrink in many areas during the twenty-first century. In the Sahel, there will be a large drop in precipitation of possibly up to 20 fewer days of rainfall. In some areas, the rainfall decline may be quite severe. IPCC "modelling indicates much more substantial ongoing drying, with the epicentre for drought in Africa effectively moving further south" (Black 2005). Drying will affect flows of waters into the Nile River. Perhaps some cities will see the same fate as Mohenjo-Daro.

In the west, a region focused on Liberia, Sierra Leone, and Guinea will see dramatically shortened growing seasons (50–113 fewer days). Between 2000 and 2050, severe reductions in the length of the agricultural growing period "are predicted for areas of West Africa, southern Sudan, Uganda and some areas of Ethiopia, and increases are indicated in southeastern Kenya, northeastern Tanzania, southern Cameroon and other areas of Ethiopia" (Thornton *et al*. 2002). In East Africa, where the countries of Sudan, Ethiopia, Kenya, and Uganda join, there will also be a shorter growing season.

In the Central African Belt, growing seasons may actually increase in a continental swathe spanning from Congo (Kinshasha) to Tanzania. Kenya, like other countries in East Africa, will see both a major decrease in growing season inland, and an increase along the coast. Gabon and Tanzania will also see longer growing seasons. The human impacts via habitat change will probably well exceed the climate change impact.

The South African Belt has two distinct mini-belts. In the most southern part, South Africa and Botswana, moderating ocean impacts will limit increases in temperature and produce no significant changes in precipitation. The area north of this, in Zambia, Zimbabwe, and Angola, will be less fortunate. In addition to some temperature increase, decreases in rainfall are expected. Some locales may witness a drop of 20–50 fewer growing days.

One commodity that may become more abundant is water. Could excess water in some fortunate countries become a major commodity export? These countries (mostly Africa) have few options for competing in the global market, outside of natural resources. Water is simply the next resource in line. Current rules on international trade do not include provisions related to bulk water transfers. These rules will change as water becomes increasingly scarce.

As African food production declines, other regions in the Northern Hemisphere will probably see greater outputs that can make up for the difference in a global food supply equation. In the end, starvation and hunger are less food-production problems than they are issues of distribution and economy. For many Africans reliant on subsistence agriculture, new crop lands will be needed. These new lands will come from cutting down tropical forests. Cropland expansion will occur especially in South America and sub-Saharan Africa (Bruinsma 2003).

There will be a contest for survival in Africa. Increasing productivity and increasing populations will be in a race in the twenty-first century. There are no

doubt maximum yield levels for crops, so as agricultural productivity increases level off, it will be necessary for population growth to do the same.

If conditions do substantially deteriorate, some states will cease to function, and tribes or city-states will emerge as the only viable levels of political organization. In the case of the Mayas, this gradual decentralization of institutions corresponded to the decline in resource levels and livelihoods. Social collapse and conflict were the result.

Collapse of states is quite likely in sub-Saharan Africa. Such a collapse indicates a level of anarchy below the level of a failed state. Major loss of life can be expected, without substantial changes in trajectory. These trigger events could be horrendous droughts, as in Ethiopia in the 1980s, or political assassination, as in the ongoing ethnic conflict in the Great Lakes region of east Africa.

Climate change may push some people into wars over livelihood. As more livelihood wars accumulate, they can cause countries to fall into the category of failed states. One or two failed states may lead to a cascade of failures, and create failed regions.

Africans will increasingly become caught up in livelihood wars, which will pose a threat to the territorial integrity of countries. Countries under threat by climate trends may disintegrate and revert to pre-colonial boundaries that are more tribally based, rather than the existing ones built on colonial guidelines. These entities would be more like European nation states.

The Sahel African Band will be a zone of intermittent chaos, with declining control over state sovereignty. The internationalized conflict in Darfur (Sudan) that has spread into Chad and elsewhere is a sign of things to come. There are also border disputes, such as the one between Libya and Chad over the Aozou Strip, where uranium is the resource of interest.

In the eastern portion of the band, the results of further droughts in Ethiopia are almost unimaginable given its recent history and likely large increases in population. The drying will also tend to worsen conditions in the failed state of Somalia. In 2006, Ethiopia invaded Somalia and toppled an Islamist government, taking power.

The Central African Band will likely see conflict exacerbated by climate change. Conflict will occur across borders, and involve disputes over scarce resources (arable land or forest resources) or abundant ones (valuable minerals or stones). Reasserting ethnic loyalties in an era of climate change will lead to regional conflict.

Climate-induced conflict can spread throughout the region and spur instability. The habitat change in Central Africa has been a factor in the African World War of 1998 to today, where several million have perished. Eight nations have sent troops into the Congo (Kinshasa) as part of the conflict. The war had roots in the Rwanda genocide. Climate change may tip the scale towards even greater instability.

Central Asia is heating up

Resources have always been vital to national security interests. Both finite and renewable resources will be points of focus. Climate change will spur exploitation of finite minerals and energy. It will also inflate the importance of renewable resources such as water. These water resources will be especially central to economic growth and political stability in Central Asia, but not without controversy.

In Asia, the expansion of the Great World Desert and the heating of the continent's interior will lead to a number of policy and strategic dilemmas. Prominent in Asia's topography are a number of great rivers along which early civilizations developed. The rivers support large downstream populations in many countries, but the headwaters and sources of the water are limited to a few points on a map. The countries that control the headwaters will control these strategic resources.

The steppes and highlands of Central Asia that culminate in the Himalayan Mountain range are said to be the roof of the world. The Himalayas include the highest elevations on the planet, and result from the Indian subcontinent colliding with the Eurasian continental plate. The area accounts for 10 percent of the world's land area, and its existence has a major impact on the world's climate and weather patterns.

Due to continental heating factors that will tend to magnify climate change in inland areas, and Eurasia being the world's largest landmass, it is likely that some of the greatest rises in temperature will occur around the Himalayan Plateau. By circumstance, northern Eurasia may also receive more precipitation. These warming trends will have a significant impact on access to resources.

The vacuum of human beings in this part of the world will not last long, since several billion people live on the edges of the Himalayan highlands of Central Asia, especially in South Asia and China. This is similar to the population hole noted in tropical areas of northeastern South America. People on the fringes of these demographic sinks will see an increase in migrants from differing places. This is similar to the Viking and Beothuk migrations that brought them to the same place and into conflict in North America.

China has begun a large relocation program that aims to move millions of Han Chinese into Tibet and Xinjiang provinces. The building of the high-speed railroad line from Beijing to Lhasa exemplifies this goal. It is possible that 100 million Chinese could move into these two provinces over 100 years. Jobs will pull migrants, while social and environmental pollution will push them. Of course, 100 million is less than 10 percent of the total Chinese population.

Russia may see significant economic immigrants. Economic opportunities from climate change will also cause a relocation of the Russian population away from Europe and into Siberia. This migration will be encouraged by the existence of untapped natural resources.

Change in climate will also have significant impact on countries such as Tajikistan and Kyrgyzstan, as well as other countries in Central Asia. Populations will tend to move east on the western side of the Himalayas, and west on

the eastern side. These countries have relatively high population growth rates. Coupled with climate-induced impacts, their strategic importance will grow.

The impact on the water flows from the Himalaya Mountains to these great rivers will have two stages. Overall, the Himalayan region will see a small increase in precipitation in general over the forecast time period. These flows will, over time, become much more seasonal. The first stage will occur when rising temperatures melt glaciers and provide run-off above today's levels during summer months, and act to increase river flows. The second stage will be after the majority of glaciers have melted. This source of summer water will decrease run-off from today's levels.

Central Asia will rise in importance in world affairs with climate change. Control of these resources will re-ignite the "Great Game" of nineteenth century central Asian politics, played out especially between Britain and Russia. This time, the focus of the Great Game will be on controlling the area's water resources. China will be central to this new game, and the key to the game will be fresh water.

Ten Asian rivers extend over 1,000 miles in length – one indication that these are among the most important water sources on the continent. Out of the ten, eight originate in China in some way. Six rivers originate in Tibet, and these rivers are the lifeblood of river civilizations along the Mekong, Yangtze, and Indus Rivers, among others. In two rivers (the Irtysh and the Argun), waters originating in other parts of China are major contributors to overall water flow for the top ten rivers. Out of the top ten Asian rivers, five originate in Tibet (see Table 4.3).

China's ability to control these waters and use them internally will be a central geopolitical issue. Rather than allowing these resources to "leak" to downstream users, holding them in dams will be a way to increase power and

Table 4.3 Top ten Asian rivers (by length in miles)

River	*Length (miles)*	*Source country*	*Downstream country*
1. Yangtze	3,900	China, Tibet	China
2. Yellow	3,395	China, Tibet	China
3. Ob	3,362	China, Xinjiang, and Russia[a]	Russia
4. Amur	2,761	China, Manchuria, and Russia[b]	China, Russia, North Korea
5. Lena	2,700	Russia, Siberia	Russia
6. Mekong	2,600	China,Tibet	Thailand, Laos, Cambodia, Vietnam
7. Yenisei	2,543	Mongolia	Russia
8. Indus	1,800	China, Tibet	India, Pakistan
9. Brahmaputra	1,770	China, Tibet	India, Bangladesh
10. Salween	1,750	China, Tibet	Myanmar

Notes

a The Irtysh, the main tributary of Ob, originates in Xinjiang province in China.

b The southern tributary, the Argun, originates on the western slopes of Great Khingan Mountains in Northeast China.

security. The result will be fewer water resources in South and Southeast Asia, and an increasing commodification of water supplies.

China's role in the control of water resources will place it at odds with downstream users which are also powerful countries: India, Russia, Vietnam, and Pakistan. These countries will consider violent means to ensure water supplies.

Border disputes are rife in this area. Conflicting claims to the Himalayan Plateau exist between India, China, and Pakistan. India and Pakistan have a major dispute over control of Kashmir, and the Kargil War in 1999 highlighted how these conflicts continue to move to higher altitudes. Waters from the Siachen glacier in Kashmir flow into the Indus River, and Siachen is the largest non-polar glacier in the world.

Both sides maintain considerable military personnel at over 20,000 feet – the highest deployment of troops in the world. Pakistan ceded some adjoining lands to China in 1963, but India in turn claims those lands.

East of the Kashmir dispute is simmering conflict regarding border demarcation in the Himalayas. The poorly defined boundaries left behind by the United Kingdom (the McMahon Line) led to a series of disputes. China settled boundary issues with Burma and Nepal over an area known as Aksai Chin. The boundary with India was not as easily solved. Nehru from India and Mao from China disputed claims, though both relied heavily on Soviet arms for their military might. China's military forces were prepared for cold-weather conflict, thanks to experience gained in the Korean War, whereas India's forces were not. In 1962, war broke out. China quickly routed the Indian forces, and just as quickly declared a ceasefire.

Rising tides don't lift all ships

Extreme events will accelerate problems caused by climate change. Climate change, in some cases, will make extreme events more likely. Sea-level rise is an issue where there will be ample time to act on a local basis. Global scale changes are inevitable. The differences in sea level may be a few feet or meters over a century, which to a person may not seem like much, but to a country, over a century, may herald a survival crisis. Early action for these countries is vital for national survival.

Sea-level rise is meaningful because it may affect millions of people. Extreme events can be slow or fast. A rising sea is one example of a slow extreme event; a hurricane is an example of a fast extreme event. Political implications related to extreme events can be broken down in two general categories: impacts on coastal areas, and impacts on small islands.

The first issue is the general encroachment of the sea level in places where billions of people live. For developed countries, this seems an expensive task. For large populations in Asia especially, there will be a significant loss of land mass and economic capital. Sea-level rise will particularly affect East, Southeast, and South Asia. The British government estimates that rising waters may displace as many as 200 million people.

A second concern is the coincidence of fast and slow extreme events. These extreme events can impact island or coastal areas. Coastal systems and low-lying areas will slowly push upland, driven by a rising sea level. This slow stress, along with fast extreme events, may lead to calamities such as Hurricane Katrina. Bangladesh already lies at near sea level. Consider rising seas and. on top of this, a monsoon of historical proportions. A million dead and the evacuation of 50 million people is a possible outcome. What would be the consequences of another year without summer? Catastrophe is the answer.

Some countries may see flooding in the near future, perhaps in low areas such as the Netherlands and Bangladesh. Over the long term, the problem will become widespread. "Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s" (IPCC, 2007a: 9). The coastal river cities of Asia will encounter more water from melting glaciers at the same time that sea levels are rising.

Coastal adaptation will be more difficult in developing countries, given the lack of resources to take on such a large task. "The numbers affected will be largest in the mega-deltas of Asia and Africa, while small islands are especially vulnerable." (IPCC 2007a: 9) This alone may not be a major cause of conflict but, coupled with other factors, will exacerbate conflict situations. Where will these people move to? Perhaps they will migrate to the newly available lands in the Polar Tension Belt.

The third category is the small island country where rising sea levels will make it necessary to evacuate most of the country's population. This eventuality has already entered into future decision-making concerns of some country leaders. This situation raises many questions about the people who live there and the status of their country.

Could people who lose their country to sea-level rise obtain a global passport? Would their government have a standing roughly equal to a government in exile? Would the country retain the rights to the physical territory and the Exclusive Economic Zone around it? Countries will go to extreme efforts to claim or reclaim ocean rights based on title to an obscure rock or island. They could also add man-made structures to claim permanent habitation, and rebuild where necessary to maintain minimum standards related to sovereignty claims.

Two countries whose future is recognizably threatened are the Maldives and Tuvalu, which sit in the Indian and Pacific Oceans respectively. There are 360,000 people living on the Maldives Islands. "Since 80% of its 1,200 islands are no more than 1 m above sea level, within 100 years the Maldives could become uninhabitable" (Bryant 2004). It is understandable that the Maldives were the first country to sign the Kyoto Protocol. Male, the capital, sits behind a 10-foot wall that took 14 years to build and was largely paid for by the Japanese government. Male has the densest population of any city in the world.

The first democratically elected President of the Maldives, Mohamed Nasheed, intends to use the country's tourism revenues to create a sovereign wealth fund. The purpose of the fund is to buy land in other countries. The purchase is pre-emptive, and prepares for the time when sea level rise forces their

people to evacuate portions of the country. Likely targets for migration would be India and Sri Lanka, because of similar cultures and climates, and Australia, because it has so much unused land (Ramesh 2008).

The rise in sea level will not completely cover these islands, but so much will be undersea that existence, as a functioning country, may be unlikely. Three questions related to human and national rights will have conflict dimensions.

First, if large-scale migrations do occur, where will these people go, and under what status? Would citizens go to the nearest major country (in this case, Sri Lanka), or blend into the British Commonwealth system? Would their status resemble governments-in-exile, such as the French or Polish governments that relocated to London during World War II? Would indigenous inhabitants retain those sovereign rights even if their land was undersea? Would they own the submerged cultural artifacts of their society? These are all questions in need of answer as this conversation continues.

Second, could island countries demand compensation from major carbon polluters? Climate change may also increase fast extreme events that are dangerous to island health. Were such a legal claim filed, payment could be made in land rights, dual citizenship opportunities, or some type of financial payment. Some multilateral obligations will probably emerge to deal with this issue across countries.

Third, what happens to the country if it does become completely submerged? Islands will be precious property, because they come with exclusive economic zones of ocean resources. Even if sea-level rise were to inundate and cover an island, does this mean that countries lose claim to that territory forever? If that were the case, countries would naturally build on islands if only to maintain a physical presence that breaks the water surface. This island-making scenario is not speculative. In the United Arab Emirates, islands are being built in the Persian Gulf, including one set resembling a map of the world.

The political power of these island countries may be another matter to consider, especially within the UN system. Small Island Developing States (SIDS) produce a miniscule part of global emissions, but do constitute nearly a quarter of all UN members and associates in the General Assembly (Godoy 2007). In negotiations going forward, would the SIDS countries become opponents of the Organization of Petroleum Exporting Countries (OPEC)? Could repatriations come from OPEC? As these island countries slowly expire, it is not beyond speculation that acts of terror might occur. Could these attacks target supposed perpetrators of their demise?

Of the Small Islands Developing States, 36 are full and four are associate members. Most country members originate in the Indian Ocean, Pacific Ocean, and the Caribbean Sea (72 percent). Included in the Pacific Ocean group is Papua New Guinea, which is one of the largest islands in the world. Cuba or Jamaica, middle-sized islands, are not likely to see a great threat.

Differing levels of income will determine the ability to respond to sea-level rise. Singapore, Malta, and Cyprus are developed countries, and can make adjustments. In Africa, the countries of Cape Verde, Guinea-Bissau, and Sao

Tome and Principe are among the poorest countries in the world, and will not be able to respond on their own (see Table 4.4).

The disappearance of islands will be the most noticeable impact of sea-level rise and extreme events. Less noticeable will be the millions of people in Asia and Africa that will suffer. A collapsing state could be dealt a fatal blow by a combination of a fast and slow extreme events brought on by climate change.

Along with rising seas, there may also be more intensive short-term weather events that will compound adverse conditions and promote social instability. Rising sea levels will interact with other factors emerging from changing climate. Sea-level rise coupled with extreme events may incite cases of conflict. Consider what will happen if more powerful hurricanes or other rain and wind events compound sea-level rises on already stressed societies. For coastal areas in Haiti or Bangladesh, this will be a real threat. For small islands, this may mean the effective end of these societies even before the sea waters rise to inundate them.

Comparing future cases

Future cases can be subjected to the same frameworks as the past cases. Each future case is shown on four comparative dimensions (see Table 4.5). These dimensions give a basis for comparison with past cases. Major themes in the historic cases reverberate through the future scenarios, centering on issues of livelihood, carrying capacity, resources, ecotones, and terra-forming, among others.

Table 4.4 A profile of countries in the Alliance of Small Island States

Ocean or sea	*Member*	*Observer*
Pacific Ocean	Cook Islands (free association with New Zealand), Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Western Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu (12)	American Samoa, Guam (2)
Caribbean Sea	Antigua and Barbuda, Bahamas, Barbados, Belize, Cuba, Dominica, Grenada, Guyana, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, and Trinidad and Tobago (14)	
Atlantic Ocean	Cape Verde, Guinea-Bissau, and Sao Tome and Principe (3)	Netherlands Antilles, US Virgin Islands (2)
Indian Ocean	Comoros, Maldives, Mauritius, and the Seychelles (4)	
Mediterranean Sea	Cyprus, and Malta (2)	
South China Sea	Singapore (1)	
Total	36	4

Table 4.5 Profiles of the future cases

Case	*Type of war*	*Climate change type*	*Development level*	*Conflict type*
End of Ice Age	Cold	Temperature	Developed	Inter-state
Tropical forests	Hot	Temperature	Not developed	Intra-state
World Desert	Hot	Precipitation	Not developed	Inter-state
African livelihood deficits	Hot	Precipitation	Not developed	Intra-state
Central Asia is heating	Cold	Temperature	Not developed	Inter-state
Rising tides	Hot	Extreme event	Not developed	Inter-state

Most of the future scenarios, like past cases, are Hot Wars, though two of the six are Cold Wars. The drivers of the war type and the type of climate impact differ. Temperature rise will be the major factor in three scenarios, and precipitation change in two. Extreme events show up in one case as a contributing factor. Only in one case were major impacts directly aimed at developed countries. Conflict type is mostly between states. The general profile of the cases shows a majority of Hot Wars in the Equatorial Tension Belt, driven by changes in temperature, in developing countries, that will involve international conflict.

The next chapter puts the past, present, and future in context. Given what is known about climate change and conflict, how will key issues emerge? What are the time dimensions of this emergence? What conclusions can decision-makers take away? What are the historical lessons?

5 Climate change, conflict, and political choices

There are three areas for considering the past, present, and future of climate change and conflict. First, climate change will create a series of political and geopolitical choices for countries. Countries will react sometimes in a multilateral manner, and sometimes in their national interest. There will need to be international rules that speak to conduct regarding climate change and the potential to cause conflict. Second, the inevitability of some degree of climate change will require adjustments in world geopolitics. Since some climate change is well underway, what approaches can ameliorate conflict problems and react to the lessons? Third, five conclusions are drawn from the research that provide perspective and point to areas of future actions.

The politics and geopolitics of climate change and conflict

There is little chance that the debate, actions, and consequences of climate change will be an objective enterprise based solely on scientific principles. The process of simply acknowledging that human-induced climate change exists has been extremely contentious. Politics will clearly be part of creating climate change policies. There are at least four ways in which politics will influence behavior and policy choices that countries might follow, with respect to living with climate change. Each of these four ways returns to the basic theoretical orientations noted in Chapter 1, and can be arrayed as points along two dimensions. On one dimension is how one looks at the future (optimists and pessimists); on the other is worldview orientation (realists and idealists).

First, the range of future climate forecasts needs to capture a wider range of possible outcomes. The forecasts should also include an explicit baseline forecast. This wider range of outcomes, either positive or negative, will provide stark pictures of the future, and deepen the difference between policy choices. The interpretations of the forecasts are likely to amplify the perspective of an optimist or pessimist.

Second, there will be strategic considerations by winners and losers in climate change. Some countries may oppose agreement on reducing climate change for reasons having absolutely nothing to do with the correctness or certainty of the

science. Stopping climate change may not be in the national interest if it will provide the country with greater resources. This choice will depend on the worldview viewpoint: one of a realist or an idealist.

Third, climate change itself will alter relative power between countries, based on certain aspects of their national profiles and the way that climate change will unfold. Rival countries that share a common border may encounter differing types of climate change. The change in relative power may provide a context for conflict. The geography of conflict may occur along north–south lines, since more northern areas may benefit from climate change than southern ones. Here, this pessimistic outlook is coupled with a realist orientation.

Fourth, climate change may lead to greater attempts to modify weather, and such practices will become a cause for conflict. Military force may be justified in a situation to stop a human-induced environmental activity from adversely influencing weather and climate in nearby countries. This may be prominent in countries with borders on an east–west basis, since this is the direction of winds on the planet and thus the general pattern for rainfall. An idealist vantage point is framed by technological optimism.

Reliability of climate change forecasts: optimists and pessimists

The IPCC forecasts, as noted, possess an optimistic quality. Representing a relatively linear future trend is a baseline scenario called "Regions". There are also three other fairly optimistic scenarios of differing routes that lead out of the climate change wilderness: the "Market", "Sustainable", and "Green" scenarios. While the levels of population, equality, and income differ in the input mixes for the scenarios, the outputs in fact change very little.

The Regions scenario sees a population of 15 billion in the year 2100. The Green and Market scenarios envision the population level at less than half this, at seven billion. The Sustainable scenario forecasts a population of ten billion. These latter three scenarios all foresee a major shift to demographic transition in developing countries.

It is possible to imagine even more optimistic futures with assumptions regarding breakthroughs in technology that could change the entire premise of the climate debate. What if a widespread alternative to burning fossil fuels is found in the near future? What if there are viable means for carbon sequestration? The entire debate then changes and the role of conflict is re-defined. There are no policy assumptions in the model regarding leaps in technology or in policy.

> The SRES [Special Report on Emissions Scenarios] scenarios do not include additional climate initiatives, which means that no scenarios are included that explicitly assume implementation of the United Nations Framework Convention on Climate Change or the emissions targets of the Kyoto Protocol.
>
> (IPCC 2007c: 13)

On the other hand, pessimistic scenarios, whether moderate or extreme, are largely absent from the IPCC futures. No scenarios envision a future under declining economic and health conditions. What if some tipping point, such as abrupt climate change, is reached that creates a global cataclysm?

Positive assumptions about the future development are built into the basic IPCC model. Energy efficiencies worldwide are expected to increase incrementally, and incomes per capita will continue to rise. The assumption is that as incomes rise, birth rates will fall. The consequence of lower birth rates is that populations will level off in the second half of the twenty-first century. This drop in world population is a key reason the forecasts do not predict even more climate change and an even darker picture.

The IPCC forecast model rests on two assumptions that have nothing to do with climate, but rather the inputs to it. First, it posits a predicted global demographic transition, largely complete about midway through the twenty-first century. For individual countries, this may take much longer. Over a long period, slight annual changes in demographic profiles can lead to large differences in population. What if the transition actually occurs later than thought? This could easily add billions in population.

A second assumption is that incomes will show generally continuous increases, and income gaps will decline. It is assumed that incomes will rise in India and China, and these two countries alone could change the future demographic profile, since they account for 37 percent of the world population. Delaying the transition in India alone would add hundreds of many millions of people. What if a more prosperous China rescinded the "one child" policy?

In both China and India, income levels are very uneven, and looking at country aggregates only tells part of the story. Incomes will likely continue to differ, especially in sub-Saharan Africa. Africa will see the highest rate of population growth, starting from the lowest per capita level of income. Real income levels are falling in Africa, not rising. It is hard to see this transition without a significant infusion of development aid and investment into Africa.

The income-to-birth rate relationship is the key proposition that drives the climate model. This is not a linear relationship, since it initially causes a rise in birth survival rates before it leads to a decrease in births. Life span is also a factor, of course. Together, these complex and dynamic feedback parameters can easily produce incremental change. These small pieces help to shape the puzzle. The models include processes which compound over time, so these small changes in basic model assumptions amplify impacts.

Suppose a series of pessimistic scenarios were introduced? One supposition is a delay in the demographic transition, and thus higher populations than forecast. Hypothetically speaking, what if the human population, rather than falling by half from 15 billion, doubles to 30 billion?

What if a larger population is combined with slower rates of efficiency improvement? Greenhouse gas concentrations due to this small change could be much larger by 2100 compared to the IPCC scenarios.

The IPCC saw little chance for any future where abrupt climate change would

occur. A 2008 report from the Climate Change Science Program of the US Geological Survey (USGS) confirmed the IPCC findings, adding that while the chances were low, the risks were high.

The report went on to say that the 2007 IPCC report underestimated the pace of climate change. The USGS believes that Arctic areas will see more warming and a more rapid loss of sea ice. In the southwest United States, it is likely that a prolonged drought has begun earlier than the IPCC predicted (Climate Change Science Program 2008).

The more rapid onset of climate change will reduce the time for adaptation. Perhaps it is not a problem emerging mid-century, but an issue looming over the next decade or so. Small changes in a complex series of model assumptions can completely recalculate and redefine a scenario.

If climate change comes early and results in substantial economic and agricultural losses, then poor incomes may suffer to the extent that the expected demographic transition among today's developing countries is delayed. The delay in the transition may add more billions in population, and thus create even more greenhouse gas emissions.

At the same time, the models appear rather inelastic in terms of output, measuring by temperature and precipitation. For example, in the scenarios where global population drops from the baseline by 50 percent, the decrease in temperature or the fall in sea level is quite small.

What does a pessimistic forecast mean to the six scenarios on climate change and conflict? The Ice Age will end earlier than thought. Tropical forests will vanish sooner. Deserts in the world will expand even more. The Himalayan water resources will be released earlier. Seas will rise much higher than expected, and most of the smaller islands will disappear earlier.

The more pessimistic outlook makes the probability of abrupt climate change more likely. The more pessimistic the forecast, the greater the probability of abrupt climate change. Eugene Linden believes this to be quite a dangerous situation, because there will be no time to adapt to the new conditions (Linden 2006: 252). One study looked at extreme events in "climate change scenarios that include increases in high temperatures, decreases in extreme low temperatures, and increases in precipitation events" (Committee on Abrupt Climate Change 2002).

One reason abruptness has not received attention is because it is hard to model. Models are best at producing long-term, stable trends. Abrupt changes are more problematic to build into models, since they involve different conditions on which to base behavior. There should, nonetheless, be attempts at simulating abrupt climate change in models. "Relatively little research has addressed the possible costs of abrupt climate change or ways to reduce these costs, both because climatologists have not produced appropriate scenarios and because ecological and economic scientists have not concentrated on abruptness" (Committee on Abrupt Climate Change 2002).

With human population levels so important to climate forecasts, the model assumptions are, in a moral sense, cruel. In terms of greenhouse gases, catastrophes may appear beneficial, and benefits may appear catastrophic. Wars or

diseases could occur and destroy populations and economies, which would have the effect of reducing emissions. A cure for cancer could extend lifetimes by enormous amounts, and result in much higher population totals and thus more greenhouse gas emissions. The case of the optimists and the pessimists can be cloudy when considering the future. Like the Morlock and the Eloi, a sustainable or less impacted future might be a mixed blessing for people and society.

This brings the discussion back to the time horizon which runs until 2100. This does not mean that climate change will stop then. Over a period of centuries, or perhaps millennia, most precipitation stored in glaciers and ice sheets will probably vanish. In all likelihood, the warming in the Northern Hemisphere will melt Greenland faster than Antarctica. The Antarctic melting would add significantly to the total rise in sea level, though perhaps after the year 2100 (IPCC 2007a: 16).

The year 2100 is simply a convenient milestone by which to gauge impact within a familiar timescale. "Both past and future anthropogenic carbon dioxide emissions will contribute to warming and sea level rise for more than a millennium, due to timescales required for removal of this gas from the atmosphere" (IPCC 2007a: 17). The idea that changes underway could influence the Earth's climate for over 1,000 years is sobering. "Anthropogenic warming and sea level rise would continue for centuries, even if greenhouse gas concentrations stabilized" (IPCC 2007a: 17).

Even if remediation measures are undertaken, the dynamic trajectory for tomorrow's climate is already determined. Radiative forcing is the difference between energy coming into the planet versus that which escapes or which we consume. Greenhouse gases from humans can tip this scale so that the amount of energy coming in starts to dominate. "If radiative forcing were to be stabilized in 2100 at B1 or A1B levels [Green and Market scenarios], a further increase in global temperature of about 0.5°C would still be expected, mostly by 2200" (IPCC 2007a: 17). Impacts would stretch well beyond 2200.

> Even if greenhouse gas emissions stabilized in 2100 at A1B levels, thermal expansion alone would lead to 0.3 to 0.8 [meters] of sea level rise by 2300 (relative to 1980–1999). Thermal expansion would continue for many centuries, due to the time required to transport heat to deep in the ocean.
>
> (IPCC 2007a: 17)

As the entire gamut of possible climate futures is revealed, the perspectives of the optimists and pessimists and the realists and idealists become reconfigured and much more complex.

Politics and climate change: realists and idealists

Climate change will most certainly be a political tool. The threat of climate change alone will justify a variety of policies and behaviors. Conflict resolution will need to have both a preventative and a reactive context. It is conceivable

that climate change could justify the use of sanctions and other soft political tools, but also use hard political tools, such as pre-emptive military engagements.

Countries will act in their national interest on climate change, as they will on all issues. Some countries will have differing national priorities based on their level of economic development. The Chinese government has been clear in saying that for the remainder of the twenty-first century, their policy would favor economic development over mitigating climate change. India has indicated the same.

Developing countries argue they did not cause climate change and need not pay for its remedy. Developing countries, who may encounter the more damaging impacts from climate change, ratified the Kyoto accords in great numbers. Many of these economies, especially in sub-Sahara Africa, have little industrialization, and would not need to cut any emissions under some post-Kyoto agreement. They may be beneficiaries of emissions rights trading policies. Their lack of industrialization might be traded to more advanced economies to conserve emissions or forests. Thus, both developed and less developed countries have reason to politicize the climate change debate.

Post-Kyoto agreements on coping with climate change should have four key elements that go beyond current provisions. First, there should be an interim global emissions target. Second, within that global target there ought to be national targets, though these may be on differing trajectories and timelines depending on situation. Third, there will need to be both incentives for participation as well as retributions for countries that do not participate, such as sanctions linked to membership of the World Trade Organization (WTO). Fourth, an agreement will require a mechanism for technology transfer and assistance to developing countries (Walker and King 2008: 168–76).

Even embarking on the task of greenhouse gas regulation is political. Europe, for example, has been at the forefront in recognizing climate change as a reality, and binding commitments as a solution. Because of its geography, northern Europe is likely to experience more climate change compared to most countries. Surely, the climate impact has entered into the European calculus in advocating commitments on limiting greenhouse gas emissions.

Climate change will have substantial impact on the agricultural sector. Protecting agriculture has been a key part of European foreign policy. It is a major public sector expense, and a key source of discord in the World Trade Organization. No doubt, some of the desire to prevent substantial changes in climate is to protect these industries, especially those that claim uniqueness due to geographic location. Climate change would significantly impact these industries and traditional lifestyles.

Some countries might see climate change as an economic opportunity. For Russia and Canada, climate change would open up millions of square miles to development and resource exploitation. Canada's population could increase significantly with warming, since the current population largely huddles across the US border. Warming in Siberia would open up an enormous tract of land for

development, and reduce the costs of natural resource extraction. Could these countries, or some of the people in them, actually welcome climate change? They could.

Argentina or Chile might also welcome a bit of climate change. The two countries will encounter little impact from climate change, but warming might open up Antarctica to realistic economic use around the middle part of the century. Both countries have major claims in Antarctica, near to their home countries. From Moore's perspective, "it would be perfectly rational to speed up climate change so we can enjoy the benefits sooner" (Lacy 2005: 77).

The realist approach to climate change, and a bevy of other environmental issues, is one of techno-optimism. The viewpoint is that problems can be solved through the application of new technologies in a free market system. With the promise of technology to solve climate problems, key decisions can be perpetually delayed because the solution will arrive when it is needed. This realist viewpoint is also quite optimistic.

Geopolitics and climate change: realists and pessimists

Winners and losers from climate change will show a wide variance in impact, but, contrary to Moore's assertion, the overall result may in fact be negative. "Poor communities can be especially vulnerable" (IPCC 2007b: 9). Africa will see the greatest degree of negative impact as populations grow and climate conditions deteriorate. Low adaptive capacity areas will show declining health indicators, starting with increased malnutrition. Parts of South America, especially in the northeast, will see widespread habitat change. China and India have made great headway in development, but there will remain a billion people in poverty in these two countries.

Individual countries will make choices about climate change. Climate change, in turn, will force certain types of policies in countries. There seem to be two climate-related phenomena that will influence relative power relations. First, climate change will alter resource endowments, particularly on a north–south basis. Those countries nearer to the poles will see the most benefit. Second, it will change endowments, depending on whether they are continental places that are inland versus those on the seashore. Those places most inland will see more climate change, and those beside the sea will see less climate change, outside of sea-level rise.

Climate change will disadvantage countries around the Equator that are largely developing, and advantage those in extreme north and south areas. As developed countries attract millions of migrants, this absorption will create difficulties of assimilation. In countries with already large populations, like the United States or Russia, the addition of millions of immigrants will affect the overall society in a relatively small way. The influx of millions of immigrants to Greenland or to Scandinavia above the Arctic Circle will mark a major change in the demographic profile of these societies, since the immigrants will likely come from developing countries.

The other difference in impact concerns countries that are near the ocean and those more inland. The greatest temperature changes outside the north–south dimension are those in the inland portions of the major continents. This is especially the case in Eurasia, where warming will cause large rises in temperature, especially in Tibet and other parts of Siberia and Central Asia. Warming along the coasts of Asia will be much more muted. This trend will draw migrants inland, especially those fleeing rising seas.

In North America, the inland Great Plains will shift further north and open new areas for development, especially in Canada. In South America, the heart of the Amazon will also warm and change the habitat. Tropical forests will shrink dramatically. These trends will affect the two areas differently. In North America, climate change may increase the human carrying capacity of the region. In South America, it may cause the carrying capacity to decline.

The differential impacts of climate change are reminiscent of a geopolitical debate that raged about a century ago. Then, the question was over the best strategy for influencing geopolitical trends and events. Power rested on a structural understanding of the structure of the world's system of geopolitics.

The debate started with Alfred Thayer Mahan. Mahan was an officer in the US Navy, and promoted the use and value of sea power. In 1890, he published *The Influence of Sea Power on History, 1669–1783*. The notion was that the planet's land surface comprised a Heartland (inland continental areas), a Rimland (land along the ocean), and an Ocean Crescent (islands and the shorelines). This was one of several geopolitical theories of world politics advanced around the turn of the twentieth century. Mahan proposed that global domination was rooted in controlling the world's oceans. The oceans were critical to commerce and economic competition. Navies were floating bastions of military power capable of being positioned throughout the world (Mahan 1890). From a geopolitical standpoint, it was most important to control the Rimland.

The English geographer Halford John Mackinder rebuked Mahan's focus on controlling the seas (Mackinder 1919). Mackinder described a planet divided into the World Island (Europe, Asia, and Africa) and Peripheral Islands (the Americas, and islands such as Australia, Japan, or Britain). Mackinder's theory was that power lies in the greatest concentration of land. Most land lies on the Eurasian continent, and thus a logical maxim emerges:

> Who controls Eastern Europe rules the Heartland;
> Who controls the Heartland rules the World Island; and
> Who rules the World Island rules the World.
>
> (Mackinder 1904)

Part of the reason why Mackinder believed the Heartland was so important to power was due to the natural barriers around it that acted as natural fortifications. The highest mountains in the world (the Himalayas) protect the south of the Heartland. To the west in Central Asia, there are the desert steppes. To the north, the cold of the North Pole shields the Heartland.

Climate change will have as much impact on East Europe/Central Asia as anywhere on the planet, save for the poles. The change will act to remove some of the fortifications to the Heartland. Climate change will open the Heartland to penetration from both the south, with the warming of the Himalayan Plateau, and the north, with the melting of the glaciers. It is likely that climate change will boost the relative power and importance of this area, but also make it more vulnerable.

I do not mean to revisit the Mahan and Mackinder debate, because it is such a broad and general construct. Climate change will, however, reorient relative power relationships between countries, based on geography. Seeing the world through such a geopolitical lens is a realist position. It is also pessimistic in accepting the inevitable power aspects of climate change. The result will be relative rebalancing of geopolitical power, as some areas increase in resource endowments, and others decrease.

The climate as war: idealists and optimists

With a changing climate, there will be reactive measures to counteract deteriorating climate events and trends. As sea levels rise, countries will build dikes and other fabricated features to keep out rising waters. As temperatures rise, differing crop types will emerge that can withstand the heat. As precipitation declines, there will be more use of efficient systems of irrigation for crops, the major use of fresh water. Towns and cities will recycle more of their water, and more cisterns will arise to catch rain. In areas that will see greater precipitation both from rainfall and from increased glacial melting, new drainage canals will arise to siphon off overflows for use in dry areas.

Reacting to climate is one response. Changing it is another. Weather modification may be a means of controlling extreme climate events such as hurricanes. It might be possible to deflect an extreme weather event (like a hurricane) away from a major population center, but that only means that it will go somewhere else. Responding to climate change through weather modification will have consequences.

As countries respond to climate change over the long term, there will be the temptation to alter weather patterns to produce a more favorable climatic condition. For such a strategy to succeed, weather alteration would need to become permanent or longstanding.

Weather modification is zero-sum in its impact. If a country is experiencing a long-term drought, inducing rainfall through cloud seeding could provide benefits when planting crops, for example. However, it would also prevent rain that would otherwise have gone to neighboring countries. No country would permit another to control its climate, and such actions would be regarded as a reason for war.

Cloud seeding is one of several ways of rainmaking. Attempts at rainmaking have occurred for centuries, and early attempts involved dancing, religious services, or sacrifices of people and animals. Scientific experimentation began in the

1890s, when the US Department of Agriculture ran a few largely unsuccessful tests. In the 1940s, cloud-seeding technology was demonstrated to be a viable means for making rain. The timing was, of course, not a coincidence; the United States was considering it as a weapon.

The idea behind cloud seeding is to introduce substances into cumulus clouds that cause condensation and precipitation. This is most often done using silver iodide, but dry ice (solid carbon dioxide), propane, and salt are also used. Since the 1940s, at least 20 countries have used cloud seeding, for a variety of purposes ranging from drought prevention to ensuring rain-free days. For the latter reason, the Soviet Union has used it to assure a sunny May Day parade each year, and China allegedly used it during the 2008 Beijing Olympics, both for sunny days and to clean out air pollution prior to the event.

There was widespread use of weather modification techniques during the Vietnam War. Between 1967 and 1972, the United States ran Operation Popeye, a cloud-seeding operation to disrupt transport of supplies along the Ho Chi Minh trail. Operation Popeye covered parts of South and North Vietnam, Laos, and Cambodia. It did produce rain, but North Vietnamese supplies continued to flow down the trail. The operation occurred during the dry season, when it was ordinarily easiest to move men and materials south.

Weather modification is a general weapon of warfare, unlike a precision guided bomb. It is distributed in impact, and indiscriminate. It will often strike civilians harder than nearby military objectives, and it can be regarded as a total war tactic. This was the situation along the Ho Chi Minh Trail. The area of modification was obviously more than just a narrow strip around the north–south road. It is likely that the cloud-seeding program impacted large areas. Since they were out of season, the heavy rains actually damaged agricultural production. Some blamed catastrophic floods in 1971 in North Vietnam on the weather modification program.

In part as a response to Operation Popeye, countries agreed to a Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) in 1977. The treaty applies to the use of environment in hostile circumstances, and supports the use of weather modification for peaceful purposes but not military ones. This aspect of the treaty will no doubt see some reinterpretation as climate change advances, because the line between one country's peaceful move and another's aggressive move is often paper thin. A peaceful action that deprives another country of rain, for example, can be perceived as a hostile or provocative act by another country.

The ENMOD Treaty is a likely basis on which to build a future treaty on climate change and conflict, since it does lay out a rationale for limiting modification for aggressive purposes. Article I of the treaty requires members "not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party" (Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques 1978).

The general intent of the treaty is to limit the use of ecology in a military context. The distinction is clear in separating activities that are weather-related (short-term) from those that are climate-related (long-term). In the "Understanding Relating to Article I", the following definitions are provided.

a widespread: encompassing an area on the scale of several hundred square kilometers.
b long-lasting: duration of months, or approximately a season.
c severe: involving serious or significant disruption or harm to human life, natural and economic resources, or other assets.

The treaty is clear on what it forbids: widespread, long-lasting, and severe environmental modification. It is thus quite revealing to then consider what the treaty allows. First, if the act is undertaken without a military or hostile intent then it is permissible, though no mention really defines who would make such an accusation or who would receive the complaint. Further, a non-hostile action could be carried out by military personnel as long as it was without military intent.

Second, modification by the military with a hostile intent is permitted so long as it is localized, short-term, and produces positive outcomes. It is assumed to be a legitimate agro-economic concern with peaceful intent. The definitions provide a key to understanding the geographic scope of the treaty that defines minimum conditions for acceptable behavior. Areas of impact should be less than 300 square kilometers (or 186.4 miles), so a square of roughly 17.3 kilometers (or 10.7 miles) in length and width. Washington, DC (a partial square city), is 177 square kilometers in comparison, so these are not extremely large areas, but could be home to millions of people.

The second concept is time duration. If one season corresponds to a calendar, then that would be a period of about three months. The chosen months would have differing impacts. If an environmental modification occurred during a planting season, it would mean the loss of an entire year of production.

The third concept is severity of the action, which may be the most difficult to pinpoint. Severity is when there is significant disruption, probably indicated through socio-economic indicators or human health markers. Put another way, actions can be taken as long as they were not severe. Thus, it would be legal to subject Washington, DC, to significant disruption of human and environmental health if it lasted less than three months. This probably sets a risk limit only for health affects that are harmful or fatal. Climate change is but one of a number of environmental phenomena covered by this treaty:

> Earthquakes, tsunamis; an upset in the ecological balance of a region; changes in weather patterns (clouds, precipitation, cyclones of various types and tornadic storms); changes in climate patterns; changes in ocean currents; changes in the state of the ozone layer; and changes in the state of the ionosphere.
>
> (Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques 1978)

The Cold War maxim of mutually assured destruction (MAD) explored differing means for the annihilation of societies. Some researchers considered direct weapons, while others focused on indirect ones. In 1945, the mathematician John von Neumann met with other US scientists to discuss the possibility of modifying weather deliberately as a tool of war (von Neumann 1955). Weather modification was considered a means to destroy Soviet agricultural harvests and harm the economy. There was serious discussion of creating "natural" weapons of mass destruction.

Deepening and expanding the ENMOD Treaty would be necessary to focus more directly on climate change and conflict. The treaty would need universal acceptance to be effective, and not all countries have signed the ENMOD treaty. Notable exceptions include China, France, Nigeria, Indonesia, Spain, Mexico, South Africa, Saudi Arabia, Sudan, and Turkey.

After achieving greater coverage, a revised or updated ENMOD treaty would need to start with a registration of events that alter weather or climate. This would mean members giving advance warming of attempts at cloud seeding and afterwards providing important data related to the event (scope, duration, and severity). Countries might also report the type of chemical used to induce rain, the amount, and the resulting totals of rainfall in the target and adjacent areas.

There might be several types of climate-related activities in need of monitoring. Another reportable event might be practices that change plankton concentrations in the oceans through use of iron-filings and the like. These events are in fact tests for modifying climate on a large scale. Actions to avert extreme weather or wind events would also be catalogued in a manner that makes clear who is doing what, when.

A new treaty would ban countries from using weather modification as a regular, long-term practice that equates with creating new climatic conditions, even if it was not meant with a hostile intent. There would need to be greater limitations on activities that have the potential for cross-border implications, leaving intra-country situations aside.

Exceptions would be needed. There may be some exceptional cases for modification of limited duration, especially when related to humanitarian crises. The exceptions could exist for more localized instances, such as controlling forest fires.

A binding treaty would need instruments for retaliation. There will naturally be dispute about when and how short-term actions differentiate from long-term ones. Dispute settlement would require some type of mediation or arbitration, and the ability to apportion compensation. Perhaps this construct would be similar to the role of the World Bank and dispute settlement in the 1960 Indus River Water Treaty. The treaty apportions resources, and appoints experts to mediate new disputes as they arise. This framework is the basis for discussing the Baglihar Dam in India, which has both climate and conflict implications for Pakistan.

More extreme instruments for retaliation will be necessary. There could be economic sanctions carried out through coordination with the World Trade

Organization (WTO). Countries could estimate economic impacts and remove accordant trade concessions. Under some circumstances, military action may be permissible either proactively or retroactively. A proactive military use might be in preventing another country from causing an extreme event to threaten major population centers by diverting the path of a fierce storm. A retroactive act might be to destroy the fleet of planes used for rainmaking after it had caused an intense drought in a neighboring country.

Climate can also be a weapon of mass destruction. Suppose a rogue country built an energy facility whose emissions were so wasteful and on such a large scale that patterns of short-term weather and long-term climate could be substantially impacted. What if the facility was intentionally built just to release large amounts of CFCs into the atmosphere? This would be a threat to the planet's ozone layer. There may also be some chemical processes capable of greatly accelerating build-up of greenhouse gases.

The idealist approach here is to believe that the international community can and will create rules and norms that will have multilateral utility. There is actually a great danger in leaving environmental modification to realist overtures, which would seem only to add another weapon of mass destruction to military arsenals.

The four issues regarding the politics and geopolitics of climate change provide a map that puts the relevant theoretical contexts in perspective. The confidence in technology under historic and future trends (the optimists and the pessimists) contrasts with the dimension of policy, and the point where it can be most effective (realists and idealists). These categories are not strict boundaries, but generally place the theoretical dimensions into a comparable framework (see Table 5.1).

Learning to live with climate change and conflict

Approaches to climate change can be divided by time. Time horizons for the twenty-first century generally fall into two halves. This division is also important in thinking about problems that can be directed at single generations over the next half-century, or those that are multi-generational in nature and belong in the second half of the twenty-first century.

The differences between the two periods are in many ways continuous, but also quite different. The first half of the century will see the greatest increases in

Table 5.1 Climate change and conflict issues on technology and policy dimensions

Technology/policy	*Realist*	*Idealist*
Optimist	Countries benefit that reduces conflict	Limit environmental modification to reduce chance for conflict
Pessimist	Reorientation of global power may lead to an conflict increase	Climate change will be worse than expected and cause significant conflict

both climate change and the socio-economic factors that contribute to it. This will be a long period of climate change that will require constant adaptation. In the second half of the century, the climate change trends will begin to level off, along with population levels. The rate of change will be less, but the absolute level of change over the long-term will continue to increase. Conditions will be more stable as rates of change slow, but levels will continue to rise.

The next 50 years

Forecasters believe the next 50 years of climate change are inevitable because of actions taken in the last half-century and behavioral trends that will take time to reverse. It is only possible to change projections in the latter half of the twenty-first century by doing something today. "Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts" (IPCC 2007a: 20).

In the end, the climate model forecast is really about human quality of life. Edwin Page looks at climate change and sees health as the ultimate measure. The cumulative impact on human health will be adverse, with direct and indirect health impacts. Indirect impacts will predominate as new vectors for disease transmission open. A warming climate threatens people through extreme temperature, or the proliferation of unhealthy air or water that will probably follow. Direct mortality rates will increase because of extreme events, sudden glacial flooding, or other occurrences (Page 2006).

There is an emerging field of research in the area of climate change and social impacts. More studies on how climate change will impact people and society are needed. For example, a recent study by Nicholas Stern for the United Kingdom posited a world of substantial climate change, and forecast serious problems of food production and water availability. These shortfalls may cause a long period of economic recession and significant losses in incomes around the world. Conflict may be a result as peoples, and nations, seek access to resources. Climate change will unleash a multitude of livelihood conflicts (Stern 2005).

What resources now exist to counteract these inevitable trends? Some capacity exists in the World Bank, in individual government aid groups, and in non-government organizations that specialize in poverty reduction or post-conflict reconstruction. Some resources also reside in military organizations. These humanitarian and military communities will have a lot more in common, and reasons to cooperate.

Military forces worldwide are incorporating climate change into their tactical and strategic planning. It is inevitable that contacts and cooperation with humanitarian and development agencies will continue to evolve and integrate as climate change worsens livelihood conflict around the world. Could there be special UN or other multinational forces trained for cases of climate change and conflict? The answer is yes.

For many parts of the world, climate change may be severe but also somewhat irrelevant in light of other threats to livelihood. African people will have less time to notice climate as they strive to survive day-to-day. Climate change will be just one part of the ongoing livelihood war that will consume them and their neighbors. For Africans, "these stresses arise from, for example, current climate hazards, poverty and unequal access to resources, food insecurity, trends in economic globalization, conflict, and incidence of disease such as HIV/AIDS" (IPCC 2007a: 19). The impact of climate change will be indirect and difficult to isolate as a factor. It will nonetheless make things worse.

The outlook for the least developed countries is pessimistic, but not predetermined. "Studies show that the projected impacts of climate change can vary greatly due to the development pathway assumed" (IPCC 2007a: 19). Livelihoods of people living in poverty will be most vulnerable to climate change, and therefore this area should be a key focus of efforts. It may be that the best response to climate change is to help the very poorest enjoy a lifestyle that is developed, and less reliant on fossil fuels.

As time goes on, climate models will need to evolve to include aspects of social instability. This science will need to progress alongside our understanding of climate change and its implications. The models will need to include a calculus as to how increasing levels of greenhouse gases will affect human behavior and lead to social tension.

Model calibration will also depend on the ability of researchers to establish scientific relations between changes in climate and likelihoods of conflict. The task will inevitably broach the question of the social costs of climate change. This new framework will also need linkages not just to models of climate, but also others that capture a more holistic and global model of people, climate, economy, and society.

The question is whether the goal of good global policy or the goal of national interests will win out in shaping human impacts on future climates. The IPCC scenarios assume there will be a decrease in the global income gap and a relative transfer of economic resources from the richest to the poorest on the planet. This transfer will fund higher incomes that lead to declining birth rates and fewer people to emit gases.

Long-term solutions

What solutions to climate-induced conflicts are possible? The answer depends on the type of link between climate change and conflict. Three types of problems are likely to emerge that can be met via mitigating, preventing, and uncoupling climate and conflict linkages. Each approach has a specific dimension related to the stage of the conflict and the ability of the society to adapt.

First, under a mitigating approach, there would need to be the capacity to contain or reduce violence that has broken out. This would be a joint response, using integrated assets of military and social support groups. The means resolution would be much more limited by situation. Outcomes likely depend on preventative choices already made.

Second, a preventative approach would focus on the structural roots for the conflict. This policy implies forward-looking measures on both fronts – climate change and conflict. If the Middle East is expected to become drier, then policies should begin to examine means to provide more water or to use it more effectively (drip irrigation, for example). The policy would apply to instances of middle-term future duration, and focus on emergent conflicts:

> Emergent conflicts may follow two paths. One path is from an incipient conflict of interest towards an overt conflict, which may become polarized and lead to violence. Another path is towards negotiation and accommodation of the issues in conflict, leading to peaceful change. The dynamics of the conflict process and the context determine which path is taken.
>
> (Miall 2007: 3)

Third, an uncoupling approach would focus on the trigger for conflict that lets loose accumulated structural forces. This line of thinking looks at essential structures, and is long term in focus. The premise would recognize that the potential for climate-induced conflict might occur and mount significant steps to overcome it and the causes for it. This approach might share some common features in either a preventative or mitigating situation.

At the top of the list of general policy thrusts is the need to reduce human contributions to changes in climate. These fall into four areas. First, slowing the overall rate and direction of climate change caused by greenhouse gas emissions is a key starting point. Changing the calculus of change rates is part of a dynamic response. Second, arable land remediation and recovery needs to coincide with agricultural adjustment policies to reduce land use losses. This means avoiding livelihood conflicts. Third, forests need protection from impacts of livelihood and climate. Forests can serve as important carbon sinks and tools for sustainable growth. Fourth, fresh-water resources are under considerable strain and require new strategies for sustainable use. Water conservation strategies will be essential to avoiding conflict in some places.

Scientific research up to this point has begun to lay out a baseline of climate expectations in a physical context. Much more is required to understand the consequences of climate change in the social context, in particular the triggers of climate-induced conflict. Continuing and deepening this research will be essential to mounting a counter-offensive in the Cold and Hot Wars. A necessary step is to build socio-political modules into climate change models and begin incorporating the human element in a dynamic framework.

The six future cases show a wide variety of climate change and conflict types. Each type requires distinct policies to combat problems. Ameliorating or limiting climate change will reduce conflict. What are the lessons from these cases?

Cases of terra-forming are the most general in type. The primary causes for climate change are greenhouse gas emissions and alterations in habitat. Emission limits will have differential impacts on countries and their structures of economy. Quick action on agreement to limit emissions is vital to slowing the inevitable

process, and gives more time for transition and realignment. The speed of change for the near future is simply too fast to adapt to.

Cases of carrying capacity point to policies that reverse trends in deforestation. Tropical forests are more efficient economic resources than farmlands with poor soil. Forests are resources but also hedges against further warming. Living, they sequester carbon. Dying, often burnt, they add to emissions. A strong policy protecting and promoting forests worldwide is needed.

Ecotones need to be expanded. These transition zones are contracting, and at the same time attracting refugees. Special focus is needed to mitigate and push back desertification in the Great World Desert. Lands that now have marginal use cannot fall into an over-exploited category. Continued degradation of these environments will contribute to the problem of failed states.

Livelihood conflict is likely in west and east Africa, without some type of aggressive development programs. Africa continues to fall behind in development. African incomes and life spans are dropping below 1960s levels. Development programs need to keep in mind how the changing climate will alter the trajectory of sustainable livelihoods.

Resource conflicts can be within or between states. Within states, a resource may be totally under the sovereign jurisdiction of a country, but another country might covet these resources. The impulse might be abetted by revanchist claims. Inter-state disputes over resources, such as fresh water, involve power, and claims of upstream versus downstream rights. The problem is that there simply is not enough water in many places. Conflict resolution will be needed – and more so as resource demands increase.

Extreme events will require a quick response rate. A social safety net on a global basis will need to deal coherently with displacement of large numbers of people on a short- and long-term basis. This will require a more specialized, multilateral focus on reaction and conflict prevention.

Climate change is inevitable. It is important to understand that there are no general solutions to climate change problems. Solutions will need to be specific and targeted. Fighting Cold War problems with Hot War solutions will never work, and may be counterproductive. Developing a menu of approaches to climate change and conflict problems is a vital need.

While Hot Wars are usually more prolonged events, approaches to them will require a proactive, short-term approach. Many conflicts are brewing, and severing the link between climate change and conflict will be vital. Severing the link will require large-scale economic, political, and security investments.

Countries could join together in a series of large-scale technology cooperative projects aimed at meeting challenges of climate change. These projects could include developing new types of plants resistant to extreme temperatures, or more efficient systems for salt water desalinization. These investments would counteract warming trends in a Hot War area, around the Equatorial Tension Belt.

Five conclusions

Think about the unfolding of climate change in terms of the financial crisis as it erupted in 2008. The seeds to the crisis were sown many years ago, and the slow rise of market risk began well before 2008. However, once it hit a tipping point the entire system began to unravel. The problem became so widespread that the original source of the problem, risky mortgages, had undermined global systems of credit and put into peril municipal projects, education endeavors, and the entire US auto industry, to name but a few examples.

Would climate change act out in this fashion and produce similar sets of cascading phenomena? Would it start to reduce livelihoods, imperil social safety systems, sap economic productivity, and cause desperate leaders to take even greater risk by resorting to conflict to acquire resources?

> How would increased fire risks and other derivative effects of acute water scarcity [due to climate change] affect the job market or the real estate market? … And what would happen to the banking system if banks become suddenly saddled with a huge increase in unsalable properties possessed through foreclosure? With no cushion and no buyers, foreclosures would quickly propagate back up through the financial system. Because mortgages have been sliced and diced into so many derivatives, the crisis could quickly become systematic as investors fled markets.
>
> (Linden 2006: 254)

This section has five parts that bring together the major findings of the research and implications that arise from them. First, there needs to be a historic perspective on climate change and conflict. Second, there is a clear trajectory that will be difficult to alter which gives the future cases some degree of potential inevitability. Third, there will be very different pathways from climate change to conflict, and thus the modes and types of responses will be dramatically different. Fourth, there is tremendous value in recognizing and advancing scientific understanding of the relationship as a means to cope with or possibly preclude climate-induced conflict. Fifth, this knowledge, rather than politics, should guide actionable policy tools relevant to climate change and conflict issues.

The need for a historic perspective on climate change and conflict

People will need to re-contextualize themselves to understand and respond to the challenge of climate change and conflict. They will need to see themselves not only as supra-biological beings, but also as instinctive creatures in a natural world.

The natural forces behind the end of the Ice Age starting 50,000 years ago brought about the ascendance of human beings. The addition of the human to the climate equation also began a dynamic process where anthropogenic forces intermingled with and ultimately superseded nature in determining the course of

climate's direction. Some of today's warming trends are a continuation of natural processes. Today's great acceleration, however, is driven by human behavior.

The changing climate has always been a factor in the rise and fall of peoples and civilizations. This phenomenon is often accompanied by conflict, insofar as such periods of ascent and descent are inherently unstable as relative power changes. It could also push people to adjust, and develop new technologies or lifestyles that allow for survival and in some way improve humans over the long term. Changing climate pushed humans out of Africa, but it also led to their worldwide spread. It brought people into conflict with other species over food sources, especially other predators, but also other advanced primates.

Conflict is driven in part by a changing climate, as peoples are pushed from and pulled to other habitats. Conflict is often intrinsic to acquiring basic biological needs, and applies to humans and many other species. Climate change and conflict is essentially a socio-biological response that occurs when two species overlap in range.

People today often come into conflict when their "ranges" overlap. The varied interactions between climate change and conflict over time is reflected in cases involving Neanderthals, Aryans, Mayans, Vikings, or Anasazi. It is clear that at times the interaction of natural and human forces was very significant in determining the evolutionary path of peoples, and indeed their very survival. The evidence is that today's and tomorrow's conflict from climate change represents continuity rather than a new phenomenon. Thus, climate change as a cause of conflict is not a revolutionary idea; it is evolutionary.

Believing in the future cases

The future cases are not wild possibilities or attempts at science fiction. They are instances where climate change is highly likely, and conflict emergence a clear possibility. Trends point to geopolitical realignments that are likely to interact, to some degree, with physical realignments. The six future cases are premised on a general trajectory that is unavoidable, where causal factors will intermingle, and where human factors tend to deepen the problem.

1 There will be extreme warming in the world's polar areas and opportunities for resource access in a time coupled with an increasing demand for land and sea resources.
2 The loss of most of the world's great forests and the relation to human livelihoods will be both a cause and a consequence of conflict.
3 The increase of deserts around the Equator, along with the existence of populations that currently exceed water replenishment levels, will aggravate already high levels of tension.
4 Further desertification and deforestation in Africa, coupled with human growth rates and increasing levels of poverty, will push peoples into structural violence.

5 The extreme warming of the Central Asian plateau and its role in providing the headwaters for most major rivers in Asia, on whose waters billions of people depend, will be a fact of geopolitical importance.
6 The inevitable rise of the world's ocean levels due to extreme warming will threaten both island states and billions of people living along coastlines.

How these scenarios unfold will lead to a multitude of paths to conflict or peace. From a global perspective, limiting the conflict to political or diplomatic venues must be preferred to those paths that will emerge as violent, armed conflict.

How the very different pathways from climate change to conflict will emerge

The historic and future cases show continuity in the types of convergences between climate change and conflict. This continuity is especially driven by changes in temperature and its impact on people's livelihoods. Temperature changes in turn impact precipitation patterns and water retention in soil. These general changes in climate, however, translate differently around the planet. The patterns impact developed and developing countries, though in differing mixtures that are both direct and indirect.

There are clearly regional and local microclimates that may react in a variety of ways to climate change. There are two types of habitat that are driven by temperature and precipitation patterns. Cold temperature climates become more habitable and exploitable by humans when temperatures increase. Hot temperature climates become more habitable and exploitable by humans when temperatures decrease. A decline in temperature leads to less evaporation and make habitats more suitable to human habitation.

Cold areas are generally economically developed countries, and hot areas are generally developing countries. Cold and hot economies, along with the differing types of climate impact, produce two very different types of behavior. The paths can lead to wars of expansion and wars of contraction. In some places, those of expansion and contraction will overlap. Conflict among developed countries might lead to concentrated fatalities, while those in developing countries might lead to conflict that is more diffuse.

There are two aspects of modern trends that differ from those of the past. The past cases represent thousands of years of history, within which natural patterns produced periods of extremely slow change. This pace of change is accelerating in two ways.

First, today's rate of climate change is comparable only to the historic end of large-scale glaciations in the Northern Hemisphere roughly 20,000 years ago. No interim period or conflict intersection since the Neanderthal case is even remotely as dramatic in terms of the rate of climate change. Understanding this unique aspect of the context underlines the potential severity.

Second, societies at that time lived in times of great isolation. There was of course trade between early humans, but these were not of bulk items, only

specialty crafts and new technologies (mostly tools). Bulk trade was impossible without domesticated animals. Modern societies are, however, quite economically interdependent.

The difference is that "losers" from climate change will have strong economic linkages to other countries that may be in the middle ground between winning and losing. Their geographic or economic connection to a "loser" may start a chain reaction, where conflict from climate change spreads across national boundaries through natural or human forces in a domino-like effect.

The problem is thus to identify how the onset of armed conflict caused by climate change spreads to other countries, and what the nature of the "infection" is. When conflict is confined to a single country, solutions and approaches are quite different from in cases that involve more than one country. There is also the danger of spread to the entire global system.

Building a scientific understanding of the relationship between climate change and conflict

Social predictions have long been prey to political interests. Over time, however, good science needs to win out in order to make good policy on climate change and conflict. Scientific understanding will need to examine both the macro- (national interests) and the micro-issues (individual and local interests) in the relationship. Rapid climate change is now undeniable.

It is comfortable to believe that lifestyles, which drive national interests, will simply adjust to meet the challenge of climate change and conflict, but that is wishful thinking. The developed countries have stored resources, and can survive economic pressures more easily than a poor family in Africa that lives year to year. Either case can end in armed conflict, with the only difference being how long it takes. There is a need to push the understanding of climate change and conflict to the forefront of scientific investigation. It is inevitable that the two will develop linkages, and possible theories of behavior need to emerge.

Is it possible to incorporate into Global Climate Models data and research assumptions about causal relationships related to conflict? Basic conflict data and models do exist. There would need to be at least three common ground rules for these models in order for them to correspond. First, there is the need for a common unit of analysis. The IPCC approach includes regional climate models, and there needs to be a correspondence table that translates conflict from a national level to a regional one.

The second need is for relevant assumptions on how climate change translates into conflict. Some pathways have been proposed here, but a more definitive model would need the assistance of existing data, theories, and algorithms on the causes of conflict and where climate change fits in. There will need to be further work in order to glean any statistical reliability and appropriate parameters.

A third need is an evolving sense of what the picture looks like in a dynamic fashion. With assumptions built into models, what impact on conflict will likely occur? How will conflict rise and subside over this long time horizon? Could

conflict actually produce some feedback that dynamically adds to climate change? A short-term examination could focus on burning oil wells, as in the Kuwait War, and a long-term examination on the burning of forests for land appropriation and settlement in Kalimantan on Borneo. There, migrants from Java began to arrive in large numbers and needed land for agriculture. The forests are also claimed by the indigenous Dayaks, who are largely hunter-gatherers. Burning the forests meant claiming the land.

The patterns of conflict need to be understood alongside the patterns of climate change. The macro-wars in the twentieth century may give way to micro-wars in the twenty-first century. There are clearly other derivative modes of interaction between macro- and micro-trends in climate, just as there are in conflict.

Making policy tools relevant to climate change and conflict issues

The long historical relationship between climate change and conflict means that policy makers need to embrace long-term commitments to solving the problem. This change in outlook will require the adoption of new thinking about treaties.

The Kyoto Protocol shows the difficulty in getting to the long timeframe required to alter the climate side of the equation. The Protocol was adopted in December 1997, but did not enter into force (needing a minimum quota of signatories) until February 2005. This first commitment period of the Protocol will expire in 2012, meaning that it will be in effect for only seven years. It is obviously only an interim agreement, but one would imagine the commitment periods to increase over time.

Negotiations on a post-Kyoto framework are slowly underway. Will this process be continuous or discontinuous? Will the agreements that follow be essentially new agreements that are negotiated anew each time, or will agreement follow the progressive pattern of the GATT/WTO, where rounds of negotiations amend and broaden the original agreement? The idea behind these agreements is based on the Bicycle Theory: one either keeps going forward or risks falling off the bike.

Treaties covering conflict are unlike climate treaties, and they are long-standing in construct and usually without temporal limitations. Conflict treaties are often very forward-looking. Not long after space exploration began, in 1967 United States and the Soviet Union signed the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. (Most countries signed it then, like Burkina Faso and the Holy See, but only the two Super Powers had any space presence at this time.) The treaty was a preventative, non-armament model, built on principles set out in the 1959 Antarctic Treaty that came into force in 1961. Both treaties stand today. Contrast this record to the very short-term horizon of the Kyoto Treaty.

The need for overlap between the two treaty types is manifest in two ways. The first is the need for timeframes that have greater alignment for stability.

Conflict treaties have long-term stability as a built-in factor. Climate treaties should also have more long-term commitments.

The second area of overlap is that the threat of climate change can be a justification for a preventative war in at least three ways. First, it can be a reason to stop another country from taking harmful environmental actions that impact another, such as pollution that can cross borders. Second, it might be used to prevent countries from depriving others of their fair share of environmental resources (such as water in clouds). Third, some may resort to it in order to acquire basic resources such as food, when state survival or a humanitarian catastrophe looms. It may also turn out that climate change can be a justification for conflict, even if that connection is quite remote. In either case, climate change will be a growing fact in the calculus of conflict.

Even if current forecasts turn out different from the ones shown here, there is a salience to the issue of climate change and conflict. It does not matter whether the climate is warming or cooling, if it is moderate or high, or if humans are responsible. In whatever configuration, climate change has been and will continue to be a source of conflict. Understanding this relationship is more important now, because the degree of warming will be the highest in recorded human history and because the world has become so globalized and interdependent.

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