Chapter 1
Summaries of the Contributions and a Few Considerations

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Cultural, sociological and political factors determine the nature of human societies, but the environment clearly played a dominant role in our early histories and continues to influence society. The objective of this book is to examine this important factor in our history, not only from the standpoint of how the environment influences humanity, but also from the perspective of how we affect the environment. A case history approach is taken with revealing examples chosen to cover prehistoric to recent times. Particular attention is paid to the ways in which societies modified their territories in response to changing conditions—matter of some topicality now.

Meaning of the terms landscape and society are considered in more detail in the next chapter. For present purposes landscape will be taken to mean a geological/geomorphologic/environmental entity within the terrestrial biosphere possessing attributes dependent on climate, hydrology, soils, organisms and historical development. Society is considered to represent a group of people living together within the landscape(s) of a region, and sharing customs, language, laws or institutions. All societies have their complexities, but the ones considered the most complex in terms of institutions and material development are the ones we call civilizations, a word used in this book as a non-judgmental, neutral designation.

Much has already been written on these topics, and the subject is clearly of intrinsic interest, but potentially there is a clear practical value in such studies. It may be that in the give and take between humans and the biosphere in the past, there are lessons to be learned that could serve us well during the current period of global change, for historical purposes as well as for properly planning out present activities and our future. Clearly from ancient times much has changed, particularly with increasingly powerful technologies enabling modifications to the landscape that dwarf most anthropic changes of former times. However, although our sphere of influence has progressed from the village and its immediate environs to McLuhan's Global Village (McLuhan 1962), there remain some basic principles of society/landscape interaction that are brought out in the chapters of this book.

The choice of case-histories is potentially very large. Our selection has been guided by the need to illustrate as concisely as possible, human populations in a wide variety of landscapes over the time period from Neolithic to the present when *Homo sapiens* became the dominant large mammal in the biosphere. We have favored the Mediterranean area because in a relatively small region these requirements of time and space are well satisfied. In addition, much geological, archaeological, and historical information is available.

1.1 The Chapters: Brief Summaries and Considerations[1]

Each chapter analyzes how certain landscapes may have improved or damaged the prospects of a given society at different times, and, conversely, how that

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[1] Edited summaries submitted by authors are in regular fonts, editors' comments are in *Italics*. Any inaccuracy may be due to editing.

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society coped with its landscape and tried to modify it, well or badly, to the society's advantage. The approach is multidisciplinary though each chapter has its own bias and approach depending on the interests of the authors. This results in a variety of points of view regarding the complex two-way interaction between landscape and human beings, to our ultimate benefit in understanding the issue.

In *Chap. 2 (A Semantic Introduction)* Chesworth provides a definition of commonly used terms: landscape society, culture, civilization.

In *Chap. 3 (Womb, Belly and Landscape in the Anthropocene)* Chesworth examines some major effects humans had on the Earth's surface during most of the Holocene. Slightly more than 10,000 years ago agriculture developed, as the new means of food production, which currently dominates the human economy, and indeed, the ecology of the Earth. We have become the dominant large bodied species in the biosphere and have gradually risen to prominence in all biomes. We have taken over the temperate grasslands and much of the temperate forests and converted them to arable farmland. A pristine Mediterranean biome no longer exists in its type locality. Approximately 60% of the world's soils have now been modified by human use, half of that amount, more or less completely. This anthropic makeover of the landscape, justifies the recognition of this latest geological age under the rubric of the Anthropocene (Crutzen 2002). The major question of our time is whether this makeover is so destructive of the biosphere, that the civilization that arose from the practice of farming is not sustainable by farming over the long term.

Human modification of the landscape in a substantial way began when Homo erectus mastered fire. Homo sapiens inherited that mastery and employed it as part of its toolbox in clearing the landscape in the revolutionary new food production system called agriculture. In exploiting soil, water and genetic resources this Neolithic Revolution began a wholesale transformation of the landscapes of the Earth, that provides justification for designating all time since as a distinctive geological era, the Anthropocene. Agricultural sophistication and population numbers increased through time in a punctuated fashion consisting of rapid advances and temporary sharp retreats. By increasing the area of land under cultivation, we were always able, in a general way, to provide food for our growing population. Later, when only marginal land was left to exploit, we avoided collapse by increasing the productivity of the land. Now, as famine beckons again, we hope that the radical technique of genetic engineering will save us. The problem is that population always has the power to outgrow the food supply, as the Reverend Thomas Malthus said over 200 years ago—an insight that has never been falsified.

In *Chap. 4 (Human Responses to Climatically-Driven Landscape Change and Resource Scarcity: Learning from the Past and Planning for the Future)* Brooks examines a number of periods of century-scale rapid climate change (RCC) that have been identified throughout the Holocene period (the past 10,000 years). The best known of these occurred around 8200 and 4200 years before present (BP). However, less well-known, but qualitatively similar events occurred around 5900 and 5200 BP. This chapter reviews the evidence for these events and for large changes in climate and regional environments in the intervening period. The author concludes that the 5900 and 5200 BP events bracketed a period of profound change that represents the last widespread reorganization of the global climate system, and that they played a key role in the termination of the so-called Holocene Climatic Optimum. The chapter goes on to review the evidence for human responses to climatic and environmental change in northern Africa and western Asia during the 6th millennium BP, a crucial period in the development of human civilization. Finally, the chapter discusses what we can learn about human adaptation to RCC by examining the 6th millennium BP, and draws some lessons for the twenty-first century.

The development and collapse of societies are issues too complex for a single explanation. Historical and archaeological information, however, indicate that the collapse of past complex societies is the rule. Although there is no reason to believe that present societies will prove to be exceptions to the rule, past experience may help us to delay the inevitable, or indeed help in any transition to what comes next. Some of the reasons for decline and collapse are: natural disasters (including climatic change), depletion of resources, inability to respond rapidly to environmental or historical changes, including adaptation to a new resource base, influence of neighboring societies and intruders, internal class conflicts, mismanagement of critical issues, social disfunction, religious factors, and economic issues (Karling 2007). Climate change has been the dominant environmental factor to affect humanity during the Holocene, profoundly affecting

the development of cultures and civilizations, and even bringing about their demise. The conventional view is that climatic stability and a benign environment are necessary for the development of stable societies, and that the opposite attributes lead to collapse (Redman 1999; Diamond 2005). Brooks' contrarian view is that sudden variations in climate within the overall Holocene trend (he emphasizes the 5200 BP cold, arid episode) led to a concentration of populations from which complex stratified societies developed.

In *Chap. 5 (Human Communities in a Drying Landscape: Holocene Climate Change and Cultural Response in the Central Sahara)* Cremaschi and Zerboni analyze the effect of mid-Holocene droughts on the landscape and human communities in arid lands of Libya and central Sahara. They consider three different adjoining physiographic units that belong to the same geographic and hydrologic ecosystems: the Tadrart Acacus massif, the dune field of Uan Kasa, and the fluvial valley of the Wadi Tanezzuft. The differing reactions of each physiographic unit to climate change is analyzed from a geoarchaeological perspective. The human groups that settled in the region responded with different adaptations to the drying environment, thus giving rise to specific social dynamics. The termination of the African Humid Period could be considered as the turning point for the environments and settlements in the central Sahara. The onset of aridity corresponds to the abandonment of the Uan Kasa region and to a strong reduction in the occupancy of caves and rockshelters in the Acacus range. On the contrary, along the Wadi Tanezzuft the persistence of surface water reservoirs determined a change in the stream pattern, and an alluvial plain formed. Furthermore, a large oasis came into existence between ca. 4000 and 2000 year BP, to be exploited by Late Pastoral-Neolithic communities, and later by Garamantians. This marked the introduction of soil management and agricultural practices. The Tanezzuft oasis suffered a drastic reduction in size during the first centuries AD, at the time of the abandonment of the Garamantian settlements.

Cremaschi and Zerboni describe and compare the different responses of their three chosen areas and inhabitants to the overall Holocene desertification of the north and central Sahara. In this case availability of water was the dominant factor, but they conclude that reaction of local physical environments and societies differ independently of whether climate change, overgrazing, or other human activities are considered.

In *Chap. 6 (The Desertification of the Egyptian Sahara During the Holocene (the last 10,000years) and Its Influence on the Rise of Egyptian Civilization)* Brookfield examines the overall continent-wide climatic changes of North Africa and the adaptation and evolution of early to middle Holocene societies culminating in the Pharaonic civilization along the Nile River. With the last retreat of the glaciers of the Northern Hemisphere, wetter climates, comparable to those of the Sudanian savannah, rapidly advanced northwards reaching the northern Sahara (over 15°N of latitude) by 10,000 year BP. There, between about 10,000 and 7700 year BP, human societies developed from hunting and gathering to multi-resource pastoralists. From about 7700 BP until 7000 BP, rapid climatic deterioration caused the progressive restriction of these pastoral societies from northern to southern Egypt (a distance of over 1000 km) and by 5000 BP such societies were practically limited to the northern Sudan. During this climatic deterioration, from about 7000 BP to about 5000 BP, societies rapidly developed, in refuges like the Nile Valley, from multiresource pastoralism to complex Pharaonic societies.

Brookfield provides a generalized picture of what occurred to the Holocene populations of North Africa and how they adapted and were moulded by the numerous climatic changes that occurred, in particular the several droughts. The migration of many people into refugia like the fertile Nile Valley led to the development of the highly stratified Pharaonic civilization. Whereas it is possible to provide a general history of these transitions, as the societies become more complex it is more difficult to relate cultural changes to environmental changes accurately. This must await more precise numerical dating methods that will allow ordering of events on a centennial scale.

In *Chap. 7 (Paleoenvironments and Prehistory in the Holocene of SE Arabia)* Goudie and Parker present details of geomorphologic features of the Rub al Khali of SE Arabia. Included are dunes, lakes, and fans. Their careful numerical dating allows a reconstruction of the environmental changes that occurred in the late Quaternary. These changes can be linked to various societal changes that occurred in response to wet and dry phases. Important events included Upper Pleistocene aridity, lower Holocene wetness, an abrupt, short-lived drying at ca 8.2 ka, another drying at 6.0 ka, and a pronounced dry event from 4000 ka. Populations were

able to respond to these changes by emigration, returning when conditions ameliorated.

Goudie and Parker consider the major drying events that have affected northern Africa during the Holocene (8200; 5200 and 4200 cal year BP) and try to determine their influence on the societies of southeast Arabia. The populations of some societies permanently diminished while others responded by repeatedly leaving and re-colonizing an area as environmental conditions worsened or ameliorated respectively. This implied that localities existed in the region that were less affected by the climatic change and were sufficiently fertile to accommodate the influx of displaced people, peacefully or otherwise. The same kind of thing occurs nowadays in various parts of the world, as environmental, and particularly economic, refugees make for the richer countries. Food-aid to poorer countries helps populations to stay in place, but in the long run, it is incapable of helping them to live sustainably within their local landscape.

In *Chap. 8 (Human Paleoecology in the Ancient Metal-Smelting and Farming Complex in the Wadi Faynan, SW Jordan, at the Desert Margin in the Middle East)* Hunt and el-Rishi report on the remote, arduous Wadi Faynan, between the Edom Mountains and the Wadi Araba in southern Jordan. It was a major center for copper production from the Chalcolithic to the Byzantine period. A field system dating from the Classical period shows that some kind of agricultural activity accompanied the industrial operations. The authors review the human paleoecology of the Faynan complex and provide new geoarchaeological evidence of the environment in which the metal producers worked and what they ate. They conclude that during the Classical period extensive arable farming was unlikely—ploughsoils and the pollen of cultivated species are very rare, while mollusc assemblages are inconsistent with crops. The Faynan system required large numbers of draught animals to supply the enormous quantities of fuel required for smelting, to transport the ore from mines to smelting sites, to export finished copper and to import foodstuffs. Most of the latter could not have been grown locally because of lack of water, as well as low yields caused by the ubiquitous metal pollution. Consequently, it is suggested that agricultural activity was restricted to supplying some forage for the large population of pack animals that the mining operations required, and for feeding penned, imported livestock. Most food must have been imported, and since it was not locally grown, would not have bioaccumulated heavy metals. Benefit to the health of the metal workers was a collateral result of this dependence on relatively unpolluted, imported food. Inhalation and ingestion of airborne particles and contaminated water remained however, as hazards to the working population (Pyatt et al. 2005).

Since antiquity, communities have been established in locations inherently incapable of supporting the population. Mining communities are a case in point, and the Wadi Faynan mining community of SE Jordan is a particularly good example. Established in a harsh desert area (utilizing slaves as well) virtually all the necessary food and supplies for humans and much for the working animals was imported in exchange for ore. Nowadays, with the help of modern technology, willing populations establish a civilized existence by bringing in water and greening the desert, as modern Israel shows. Although admirably successful at least in the short term, these experiments remain precarious, being unsustainable by the local natural landscape.

In *Chap. 9 (Empire and Environment in the Northern Fertile Crescent)* Wilkinson covers the first millennia BC and AD in the Near East, and relates the cultural landscapes of the later territorial empires of the Near East to the local, including the atmospheric environment. During this time, landscape changed in ways that were new to the area. Massive canal systems were constructed on a monumental scale by the Sasanians for example, though more representative are smaller scale features such as extensive irrigation systems of dispersed farms, villages and villas. The latter commonly resulted in the colonization of new lands between pre-existing "tell" settlements or within the uplands. These dispersed settlements commonly resulted in terrain that had previously been fairly stable, becoming eroded and thereby contributing increasing amounts of sediment to the lowlands as valley fills. Landscape degradation was not simply the result of local phenomena, population pressure or agriculture for example. The needs of the empire had to be served, which meant that goods and services not obtainable locally, had to come from distant locations. These distant locations suffered environmental degradation for the greater good of other parts of the empire. The extension of settlement into marginal lands was frequently associated with the construction of extensive canal systems in areas that had not been irrigated before. These allowed environmental limitations to be

over-ridden, but also imposed their own proxy environmental record by withdrawing significant amounts of water from streams. By creating the preconditions for soil erosion, the spread of human settlement in the landscape exacerbated the effects of rainstorms and deluges when they occurred.

Population pressure and large structured societies such as the Empires of the Fertile Crescent imposed maximum exploitation on fertile lands and occupational expansion onto marginal landscapes. This required modifications to the landscape and redistribution of waters for irrigation. The consequence was a degradation of the environmental conditions not just for local sustenance but also for the demands of burgeoning distant populations of the empire. This environmental degradation at a distance is now the normal global pattern as our demands span the globe and endanger the sustainability of producing societies located far from the societies consuming the fruits of their production.

In *Chap. 10 (The Interplay Between Environment and People from Neolithic to Classical Times in Greece and Albania)* Fouache and Pavlopoulos examine the Neolithization of Greece and Albania, during the Holocene climate optimum. Palinological investigations indicate agricultural clearances as early as that period through it is not until the Bronze Age that arable agriculture and animal husbandry notably shaped the landscape. Natural disasters such as volcanic eruptions and earthquakes have actively contributed to the geomorphologic evolution here for millions of years, and continue to do so. What is new is that the opening of the landscapes by human beings led to the development of erosion in often spectacular yet discontinuous ways as a result of original combinations of climatic and/or anthropic forces. The most spectacular consequences were the alluviation of valley bottoms and the progradation of deltas and coastal plains.

Anthropic deforestation particularly since mid-Holocene, as well as other activities such as grazing, have been important factors in helping to modify pristine landscapes, augmenting the rate of natural processes in doing so. Highly anthropicized nations such as Greece clearly show the results: hydraulic regimes (runoff in particular) have been changed, intensity and rates of erosion from slopes have been increased, and sediments redistributed. The results consist, among others, of modification in soil characteristics with development of catenas at different scales from local mounds to mountainous areas characterized by eroded hilltops and thickened mid-slope and slope-foot soils. At a larger scale, new landscapes are produced such as silted valley floors, and extended coastal and deltaic areas that locally prograde seaward.

In *Chap. 11 (The Nuragic People: Their Settlements, Economic Activities and Use of the Land, Sardinia, Italy)* Depalmas and Melis examine some aspects of the little known Nuragic population of Bronze Age Sardinia. The people were primarily sheep-herders and farmers, though toward the end of their culture, perhaps under Phoenician and other influences, they adapted to fishing along the coast. They adapted to various landscapes, first the fertile slopes of lava plateaus near springs, later the tops of the plateaus, as well as higher lands, and along the few narrow floodplains of the island. They seem to have mostly avoided the larger lowlands of the Campidano tectonic basin perhaps because it was partly covered by wetlands, so that it was prone to malaria: a rampant scourge during subsequent Roman times (Burke and Worcester 1996; Hays 2005). They take their name from the high stone towers called ‘nuraghi’, or ‘nuraghe’, which they constructed. Two main types were built, one resembling a high platform with a corridor as entrance, and a second the ‘tholos’ type, with a truncated conical, internally domed tower. More ancient smaller settlements had a single nuraghe, larger more recent ones had two or more. A settlement of huts surrounds some. About 9000 towers were constructed from Middle to Late Bronze Age. Analysis of the relationship between the monuments and the settled areas indicates that the presence of nuraghe was mainly determined by the environmental resources and the possible economic exploitation of the area, rather than any defensive consideration. The Nuragic people used a wide range of bronze and stone tools as well as animal power, and caused a significant degradation of the environment, primarily in the final stages of the Nuragic period.

Relatively stable, mid-latitude climatic conditions of isolated regions, such as the island of Sardinia, have fostered the development of stable ancient cultures, such as the Nuragic. During their existence, they did not change much because they did not need to change. As the population grew, the Nuraghi people slowly expanded to occupy adjacent landscapes—mostly highlands and high plains, and avoiding some the largest lowlands containing wetlands locally infested by malaria. Such cultures, lacking internal reasons for

change, are more prone to modifications and amalgamations from outside—trade, immigration and conquest, for example, however some inherent original traits may persist for millennia.

In *Chap. 12 (Floods, Mudflows, Landslides: Adaptation of Etruscan–Roman Communities to Hydrogeological Hazards in the Arno River Catchment (Tuscany, Central Italy))* Benvenuti et al. analyze the different histories of three Etruscan-Roman sites, Pisa, Gonfienti, and Lago degli Idoli, located respectively in the vicinity of the estuary, in mid-course, and in the headwaters of the drainage basin of the Arno River, central Italy. Pisa had fluvial harbors that were occasionally affected by catastrophic floods, but both the Etruscans and the Romans continued to repair their facilities to avoid losing those economically important, irreplaceable sites. Gonfienti was mainly a commercial and agricultural settlement that was repeatedly damaged by floods and mudflows and was eventually abandoned during Etruscan times. Finally the Lago degli Idoli was a forested spring-site affected by local landslides, which none the less remained an essentially pristine locality. It was sacred to the Etruscans, but there is no archaeological evidence to indicate that the more pragmatic Romans held it in religious esteem.

Localization of settlements of ancient cultures and civilizations as they developed were carefully chosen to suit their needs, given the technology available. Natural processes and/or human activities induced damages. Wherever possible, changes to the landscape and environment, inconvenient to the human inhabitants, were remedied. Where this became too difficult, flexible populations abandoned the sites and migrated. More structured societies avoided abandonment by repairing and rebuilding, provided that expenditure of effort and resources were justified by the returns from a region, including considerations of viability or defense. Religion offered less practical reasons for the occupation or abandonment of a site. The sacred spring at Lago degli Idoli is a good example—revered by the Etruscans, was given no religious status and not visited by the Romans.

In *Chap. 13 (Landscape Influences on the Development of the Medieval–Early Renaissance City-States of Pisa, Florence, and Siena, Italy)* Martini et al. recognize that growth and decline of any advanced society is a complex matter. Political and sociological factors generally dominate in all but the earliest stages, though environmental conditions remain influential. The environmental factor is examined here in the context of the development of the neighboring city–states of Pisa, Siena and Florence during medieval to early-Renaissance times. Pisa developed first because its harbor was used by the early crusaders. During medieval times, Siena was next, favored by its hilly position which lay on a major pilgrim route to Rome. Florence flourished last, favored by its position along the Arno River. Pisa was handicapped by the siltation of its harbors and partly because of the extensive wetlands surrounding the city. The difficulties of Siena related to the limited space available for expansion within a walled hill-top town. In addition, there was a debilitating absence of water. Both reasons stunted any potential growth and curtailed the city's industrial capabilities. Florence suffered from river floods occasionally, but having access to abundant hydraulic power could run mills for its industries. It finally prevailed over its two neighbors.

Socio-economic and political factors and technology generally determine the fate of advanced societies, but some are also strongly influenced by the landscape they develop in. This is illustrated, for example, by the medieval-early Renaissance city-states considered here. Pisa and Florence are located in the same drainage basin, with Siena on a nearby hill. Landscape characteristics favored a particular society over its neighbors for a certain time, but became a liability later.

In *Chap. 14 (Paleo-Hazards in the Coastal Mediterranean: A Geoarchaeological Approach)* Morhange and Marriner examine the roles of human impacts and natural hazards in shaping the evolution of Mediterranean coastlines during the Holocene; where, when and how societies transform the coastal zone; at what scales and rhythms the changes take place; and what coastal sedimentary archives tell us about human–environment interactions. During the past 20 years, geoarchaeological research in the Mediterranean has attempted to understand the interplay between culture and nature, and more particularly how environmental potential and processes (sea-level changes and sediment supply for example) have played a role in Holocene human occupation of the coastal zone. This approach has drawn on the multidisciplinary study of sedimentary archives to attempt to differentiate between anthropogenic and natural forcings. The authors argue that the latter has played an increasingly secondary role with time. Archaeologists today are increasingly aware

of the importance of the environment in understanding the natural frameworks in which ancient societies lived, and multidisciplinary dialog has become a central pillar of most large-scale Mediterranean excavations. Three important spatial scales of analysis have emerged, local, regional, and Mediterranean.

Climatic changes and human activities bring about erosion and redistribution of sediment. One effect is the siltation of harbors, with the resulting sedimentary deposits containing artefacts that illustrate habits and technologies of the various societies that made and used them. One observation to note (here and equally with Chap. 8) is that pollution is not a modern invention—witness the toxic lead concentrations in the pre-Hellenistic site of Alexandria, Egypt (Véron et al. 2006).

In *Chap. 15 (Mount Etna, Sicily: Landscape Evolution and Hazard Responses in the Pre-Industrial Era)* Chester et al. report on the Etna area of Sicily. In terms of the relationships between people, land and the creation of distinctive landscapes Etna is fascinating because, in spite of the ever present threat of volcanic eruptions and earthquakes, the flanks of the volcano attracted settlers in large numbers throughout the pre-industrial era. In this chapter the authors argue that this contrast with the barren and increasingly highly eroded lands of the Sicilian interior, was present in pre-historic times, but became more marked in the 2000 years which stretched from the Classical era to the late nineteenth century. Indeed, elements of contrast may still be seen in the landscape today. The reasons for Etna's attraction not only relate to the agricultural and irrigation potential of the region, but also to a range of social and economic factors, not least the ability of people successfully to develop indigenous and distinctive means of coping with the ever present threat posed by earthquakes and lava incursions.

The choice of a society to colonize a dangerous volcanic region is largely a pragmatic one. The benefits—good agricultural terrain with fertile soils, geothermal resources in places—outweigh the risk of eruptions and earthquakes. In areas of explosive volcanism (Vesuvius for example), tragedies that recur over a long time, and loss of entire villages or displacement of societies once every several centuries, are apparently acceptable risks. Etna is a quieter volcano, and although frequent eruptions and earthquakes occur that are damaging to local features, they seldom lead to a high mortality. People have adapted to them, and in some places have even succeeded in diverting the path of lava flows from important sites.

In *Chap. 16 (Romanian Carpathian Landscapes and Cultures)* Cioacă and Dinu examine human–landscape interactions in the mountainous areas of the Romanian Carpathians through geomorphic and geoarcheaologic analyses. Bottom valleys of intermontane basins, mountain slopes and high planes were progressively populated by Neolithic societies as population pressure imposed, and climatic conditions allowed, the higher terrains to be inhabited. As new lands were utilized, husbandry evolved technically to adapt to the characteristic of the various terrains. Intermontane basins and valleys led initially to isolation of their populations that therefore acquired distinctive characteristics. Isolation ended as communication increased between valleys, the peri-Carpathian planes, and the rest of Europe. Eventually Romania was conquered and colonized by Romans. The amalgamation of the ancient Dacian culture and new customs introduced from Rome produced the Daco-Roman civilization that was the precursor of current Romanian civilization. Although major changes in landscape and human habits have occurred through the ages, great parts of the Carpathian forests and the "wood culture" that developed in them persist today.

Cioacă and Dinu provide an insight into the adaptation of ancient societies to mountainous areas. These remain partly isolated in intermontane basins and valleys, and partly expand progressively from the more fertile and accessible valley bottoms onto the surrounding highlands and adjacent lands. As communication and commerce expanded to wider areas, continent-wide influence and eventually conquest and amalgamation with other societies led to the development of the modern civilization that nonetheless partly preserves some of the original attributes imparted by the local landscape.

In *Chap. 17 (Sea-Level Rise and the Response of the Dutch People: Adaptive Strategies Based on Geomorphologic Principles Give Sustainable Solutions)* Jungerius examines the complex and schizophrenic relationship of the inhabitants of the Netherlands with the sea. On the one hand, half of the land is a creation of the sea as ally. On the other, the sea is the enemy, with loss of land due to sea-level rise. For the last millennium, the inhabitants of the Netherlands have had to adapt their strategy of survival against the threat several times. The first strategy was learning to cooperate

and coordinate defense against this common foe. The next and simplest strategy was preventing the floods from inundating the land by building dikes around polders. Pumping excess water out of the polders with wind mills and later mechanical pumps was the following step. Then it became necessary to strengthen the coastal dunes, the original, natural defense line. This was effectuated by supplying sand. For the fifth strategy the roles were reversed: the sea was forced to retreat and the bottom of the North Sea was converted to new land. Strategies based on geomorphologic principles used by nature to build the coast have invariably been shown throughout time to give the most sustainable results.

Jungerius provides insight into the ongoing, millennial battle of the inhabitants of the Netherland against the North Sea. This is not the only place in the world where land reclamations from the sea have been made, another example being the very extensive reclamations of east China along the Yellow Sea coast since ancient times. It stands apart from others however, because of the sophisticated technology that has been applied locally and the careful management of the waters and of the ripening of the reclaimed land for agricultural purposes. The strategy has not necessarily been to build only immobile, impermeable barriers to completely seal off marine and river flood waters from every locality at all times. Technogically more sophisticated barriers that open under normal sea conditions have also been built in places. Passage of tidal water is thereby allowed, and ships can pass between sea and canal. During major sea storms the barriers are closed. Furthermore certain areas have been set aside to be flooded during storms or river floods to alleviate pressure against the existing sea-dams. Of interest also is the defensive use of water during wartime. Inundation of vast areas can be effected to impede or retard the advance of enemy armies. Amsterdam, for example, was surrounded by such floods which acted like a vast moat during the Second World War (WWII). The water was kept shallow—about 10 cm depth—so that boats could not be used by the enemy. Similarly large areas of Eastern China were inundated by cutting the levees of the Yellow River to retard the advance of Japanese armies just before, and during WWII, as well as in ancient times against earlier enemies.

In *Chap. 18 (Perception of Volcanic Eruptions in Iceland)* Thordarson examines the perception the inhabitants of Iceland have of volcanism. Iceland is one of the most volcanically active regions on Earth, and its inhabitants have been exposed to volcanic eruptions and their consequences since the time of settlement about 1140 years ago. It is not surprising therefore, to discover that the nature and consequences of volcanic eruptions are imprinted on the cultural landscape of the nation. This evidence along with excellent preservation of historical records provides an ideal platform for evaluating social aspects of volcanism. A first pass assessment of these records indicates that throughout the country's history, an eminently practical, down-to-earth and matter-of-fact view towards volcanic eruptions has prevailed among the Icelanders.

Iceland is a land of fire (volcanoes), tremors (earthquakes), and ice (glaciers and outburst floods). Its environment is harsh but ameliorated by the warm North Atlantic Current. Volcanic activity provides thermoelectric power, and warm water for heating houses. Soils are fertile and are cropped to hay as fodder principally for sheep and horses, and some barley in the south. The sea around the island is a well managed, rich fishery. Occasional explosive volcanic events and climatic changes have created havoc and famine leading to major emigrations from the island. On the whole however, the people have adapted well and communally, to the often harsh life on this rugged landscape. The harshness comes through in the flourishing literature of the island, from the sagas of the Norse colonists, to writers of modern times such as Halldór Laxness, who won the Nobel Prize for Literature in 1955. Illustrations are another source of knowledge about the Icelanders perception of their lives, the problems they face being represented as monsters roaming the land.

In *Chap. 19 (Holocene Environmental Changes and the Evolution of the Neolithic Cultures in China)* Mo et al. report on the Neolithic cultures of east and north China. The Neolithic cultures first appeared about 10,000–8000 years BP and flourished preferentially in the areas of the Yangtze, Yellow, and Western Liao rivers because of mild climate, copious precipitations, and fertile soils. Low-lying floodplains were most suitable to the development of rice culture, while fertile loessial soils on higher ground became the locus of dryland agriculture based on foxtail and broom millet. Initially the various cultures of the different regions continued to evolve and flourish almost simultaneously. From 6000 to 5000 year BP many new cultural changes occurred as production techniques.

Most significantly, the society became stratified. From 5000 year BP onward, the evolution of the Neolithic cultures of the various regions diverged due to local response to strong climatic and other environmental changes. The authors catalogue resulting crop failures in certain areas and increasing flooding in others, as well as internal and external social conflicts that led to cultural regression and decrease in populations in most areas. Environmental conditions, particularly soil fertility, ultimately led to the prevalence of the culture of the Zhongyuan region of the middle Yellow River area. This culture gradually influenced the culture and politics of the other regions, and became the center of Chinese civilization.

Mo et al. synthesize information about the complex, numerous societies that evolved and waned during Neolithic times on the various landscapes of eastern China. Temperature, precipitations and soil fertility greatly affected the progress of humankind in the region. As today, so in the past, a rice-culture was prevalent in the warmer, wetter lowlands of the southeast affected by monsoonal precipitations, while wheat culture prevailed in the northeast due to the wide expanses of very fertile loessial soils in lowlands and hills. It was the fertile valley of the middle-lower Yellow River in the north that sustained the consistently evolving cultures that became the cradle of modern Chinese civilization. The dark side is that the easily eroded, re-worked loessial soils of the valley, were frequently ravaged by floods, and large populations were continually threatened, then as now.

In *Chap. 20 (Landscape and Subsistence in Japanese History)* Barnes reviews the evolution of Japanese civilization in terms of adaptations to life in a tectonically active island arc, dominated by volcanoes and mountains and with what little level ground there is, mostly confined to the coast. The early hunter-gatherers, focussing on inland mountains and on coastlines, contrast with the imported wet-rice technology focussed on the lowland plains. Why different ethnic groups did not develop to exploit these radically different environments is a topic explored in depth. The bifurcation of the historic agricultural system into wet-rice cultivation and dry-field production is another important topic. The modern situation differs from the historical in that food importation has had devastating consequences for local farming. The future of food production in Japan relies not only in reversing the decline of indigenous production but also on the retreat to higher ground as sea-level rise takes its toll on the bottomlands—now the locus not only of the major paddy areas but also of urban and industrial developments.

Barnes offers a brief, clear review of the evolution of the Japanese civilization in a tectonically active region consequently subjected to numerous earthquakes and landslides. It is also vexed by powerful sea storms and the occasional tsunami along the coasts. The country is for the most part mountainous with only a third as coastal plains. These are part removed from agricultural production by expanding urban areas and their associated infrastructures such as routes of communication, power lines and so on. From early times Japanese populations adapted well to the complex landscape and flourished, managing the production of rice. Japanese society, like many others evolved on islands, remained isolated and self sufficient for a long time and acquired characteristic and lasting traits and customs. Once opened to the world it rapidly developed into a modern, successful, technological society. As such, it has lost self sufficiency with regard to food and mineral resources and must rely on imports in exchange for manufactured goods.

In *Chap. 21 (Evolution of Hydraulic Societies in the Ancient Anuradhapura Kingdom of Sri Lanka)* Dharmasena analyzes the development of a sophisticated hydraulic civilization in the dry lowland of the northern part of Sri Lanka. The first of many invasions from mainland India in 3000 BC introduced the religious beliefs that governed the sacred town of Anuradhapura in the north, where the hydraulic civilization was centered. Early societies of northern Sri Lanka developed agricultural practices near rivers. They were dependent on unreliable monsoon rains and vexed by recurring droughts and floods. Irrigation canals were soon built and small scale systems of irrigation were in operation possibly by 500 years BC. Subsequently the Sinhalese constructed a complex system of canals and water storage reservoirs locally called ‘tanks’, after the Portuguese ‘tanque’, to provide a technically sophisticated irrigation system to regulate water distribution. Completed by the first century AD, several large-scale irrigation works existed fed both by harvesting the runoff of catchment basins and where possible by diverting water from streams. The organization of small tanks into a cascading sequence within micro-catchments allowed great efficiencies in water use. For instance, drainage from the paddy fields in the upper part of the

cascade flowed into a downstream tank for reuse in the paddy fields below.

The original ancient hydraulic civilization of the dry zone disappeared after the twelfth century AD. Breakdown of the efficient irrigation management system, climatic change, malaria, depletion of soil fertility, foreign invasions, and famine are some of the reasons cited. However, the tank-cascade irrigation systems based on natural drainage basins is still considered a valid, lasting technology that, suitably modified for modern needs is being recommended for restoration.

Sri Lanka is a country with two very distinct geological/geomorphologic and climatic regions: a hilly, wet southern part and flat, dry northern lowlands. The expansion of the population throughout the northern dry lowlands was made possible by the implementation of an early, sophisticated irrigation system consisting of interconnected small reservoirs and good management and conservation practices of the water resource. This irrigation system has lasted for millennia, as have others such as the qanat system of Mesopotamia satisfying the need of a vital resource in hot, dry countries.

In *Chap. 22 (Disease in History: The Case of the Austronesian Expansion in the Pacific)* Sallares focuses on the role of pathogens in history, taking as a specific example the possible effects of malaria on the prehistoric migrations of speakers of Austronesian languages from Taiwan across the Pacific and Indian Oceans. Both the view that malaria assisted the Austronesian migrations and the view that it hindered them have been expressed in previous literature. In recent times many of the western Pacific islands, where malaria is present, have been less densely populated and have suffered lower degrees of environmental degradation as a result of human activity than the islands of Polynesia in the eastern Pacific where malaria has never been present. This chapter investigates the role of malaria in the Austronesian migrations and its relevance to landscape history in this part of the world. Human genetic mutations believed to be associated with resistance to malaria, provide the scientific evidence on which the argument is based. The conclusion is that malaria probably hindered rather than helped the Austronesian migrations.

Landscape is a contributing factor in the evolution and demise of cultures and migrations of populations. Elements of the landscape such as its productivity of natural, cultivated or raised macro-organisms are usually considered to be paramount when dealing with the well-being of human populations. The role of microorganisms, though less understood until recently, has been massive in determining the fortunes of many societies. Suffice to mention only the effect of the Black Death in fourteenth century Europe, in addition to the long history of malaria, as emphasized by Sallares, a scourge that persists in places around the world. Malaria is closely tied to elements of the landscape such as wetlands and some tropical forests, and had important effects in shaping some societies. Italy provides a number of telling examples of the deaths from malaria of war-leaders, of powerful political people such as popes and cardinals, as well as famous artists such as Dante Alighieri (Sallares 2002). A more concrete effect is seen where communication routes have been planned to avoid infected areas. Malaria has clearly affected the migration and peopling of the Western Pacific islands. Deforestation of some islands for agricultural purposes changed the landscape so that wetlands formed in places. These became breeding grounds of the mosquito hosts of the malarial microorganism. This led to health problems and loss of population due to death and/or migration. In a seemingly ironic, but common fate, islands and other localities in the world have undergone more anthropic change in the absence of malaria, than in its presence.

In *Chap. 23 (Farms and Forests: Spatial and Temporal Perspectives on Ancient Maya Landscapes)* Dunning and Beach analyze some aspects of the Maya civilization. The Maya Lowlands, once thought of as a relatively homogeneous region, is actually a mosaic of habitats to which the ancient Maya adapted many and varied systems of water management and agriculture. The overall trajectory of ancient Maya civilization is probably best represented by a metastable equilibrium model in which periods of relative environmental and population stability were punctuated by episodes of sudden change. Older models correlated peaks in population with maximal environmental degradation in the Late and Terminal Classic periods (600–900 AD). Several recent cases, however, indicate that the greatest impact was caused by relatively small populations. Conversely large, densely settled populations sometimes stabilized the landscape through careful conservation measures. Episodic periods of severe drought played the greatest havoc with the ability of the Maya to adopt successful long-term strategies to meet their food and water needs. Interior regions of the

Maya Lowlands with less secure water sources were the most likely to experience extreme cycles of population growth and decline. In the long term, coastal and low-lying areas with perennial wetlands generally experienced less severe perturbations, but even here the Maya had to adapt to rising sea and groundwater levels and widespread landscape burial.

The Maya civilization has been long studied, but new discoveries continue to be made and fresh insight achieved. This complex, structured society became progressively more populous and less resilient and mobile in its relationship with a changing environment. Changing climatic conditions, and spells of drought, combined with intense deforestation that allowed increased soil erosion, produced a progressively deteriorating environment. As a sophisticated society the Maya tried to combat the inevitable by innovative agricultural practices, building reservoirs to supply water during periods of drought, and maintaining them free of silt. As environmental conditions deteriorated, conflicts between communities increased and military predation occurred. Some sites could persist for a time, while others had to be abandoned and the population migrated. Some areas may have been overwhelmed to the point of collapse by an unsustainable influx of refugees. If history teaches lessons, this is one of them, and the problem of environmental refugees is becoming a serious one again in the modern world.

In *Chap. 24 (Water Follows the People: Analysis of Water use in the Western Great Plains and Rocky Mountains of Colorado, USA)* Wohl reviews the challenges presented by the semiarid climate of the State of Colorado in western USA, to development of contemporary sustainable societies. The first settlers of European descent who reached this region in the mid-nineteenth century immediately began to engineer water supplies, rather than adapting their lifestyles to aridity as had wildlife and indigenous peoples. Extensive manipulation of surface and ground water supplies has facilitated rapid growth of irrigated agriculture and locally dense human populations, but has also produced unintended effects including water pollution and endangerment of native plant and animal species. Water shortages resulting from persistent drought and increased population and water consumption, are forcing contemporary societies in the region to use water more efficiently, to allocate water differently among competing human users, and to maintain sufficient surface and ground water supplies to support endangered species and river ecosystems. The South Platte River basin of Colorado serves as the primary case study to explore these regional issues.

Wohl focuses her analysis on the water management of modern societies in the semi-arid USA, specifically in the Rocky Mountains and foothills of Colorado. Her title ironically reflects the misleading nineteenth century slogan 'water follows the plough', concocted to entice settlers to homestead in the arid west. The low precipitation along the orographically unfavorable eastern mountain flank and nearby plains was not sufficient to support an expanding agriculture modelled on the practices of the well watered east. Modern technology has allowed the tapping of water from the humid western side of the mountain chain and its transmountain transport to the eastern side. This is one more example of humans creating, nowadays mostly for the purpose of short term financial gain, an artificial condition not sustainable by the local landscape, instead of trying alternatives, dryland techniques of water agriculture amongst them.

In *Chap. 25 (Frozen Coasts and the Development of Inuit Culture in the North American Arctic)* Park examines the effects on past and present inhabitants of the extreme seasonal changes in landscape in the North American Arctic due to sea-ice formation and breakup. Archaeological research has demonstrated that over time the people of this daunting region developed a complex adaptation to the frozen-coast environment, which includes the sea ice. Early aspects of this adaptation included the hunting of small sea mammals in open water from the shore or from the floe edge, followed by the hunting of larger sea mammals in open water from boats. The later and more complex aspects of the adaptation included the hunting of ringed seals at their breathing holes and living for some or all of the winter far out on the sea ice. The successive stages of this adaptation to the frozen-coast landscape can be identified in the archaeological record of the Arctic through the sequential appearance of technological artefacts such as harpoons, drag floats, snow knives and lamps.

Some landscapes cannot be drastically changed by its inhabitants: adaptation of the human lifestyle is the only answer. This is the case for Arctic regions where ice is a major component of the landscape. Ice-distribution, sunlight, and temperature drastically change seasonally, and thereby totally modify the landscape and its natural resources. Hunting and gathering, and

in modern times, import from the south, are the only means of sustenance in North America. In Europe and Asia, husbandry of reindeer is also practiced. Park examines the resilience of the ancient northern people of North America and their delicate adaptation to this variable, frozen landscape. Adaptation was possible because the people could rapidly change their habits and locations according to the seasons and to longer time periods. European tools and habits were eventually introduced, and the forced agglomeration of people into unmovable villages occurred. Old time famine could now be avoided, but severe, mainly psychological health problem, have become endemic. In addition, global atmospheric circulation has ensured that the overall environment of these remote communities is being subtly polluted from distant sources in the industrialized south. As with other indigenous northern populations of the continent, a new Inuit culture is evolving that cannot be sustained by the local landscape. This makes for a difficult transitional period.

1.2 Commentary

The basic problem for any species in the biosphere is ecological: how to derive sufficient sustenance from its environment that it has a good chance to survive and pass on its genes (Hardin 1993). Humankind is no exception to this fundamental requirement. Where we are exceptional is in succeeding so spectacularly. Big, fierce animals need a large territory to support them and are consequently rare in nature (Colinvaux 1978). We have developed a foraging strategy of so successful a kind, that although our Paleolithic ancestors passed through the bottleneck of near-extinction (Wilson 2006) we have become the one big, fierce animal that is not rare. On the contrary, we are so good at the ecological practice of competitive exclusion (Rees 2004) that we are now as a society (or pack) the most successful predator in all biomes, terrestrial and marine. Competitive exclusion for *Homo sapiens* means that we take over all major landscapes as human habitat, from lowlands (Jungerius[2]) to highlands (Cioacă and Dinu), from coasts (Morhange and Marriner) to continental interiors (Wohl), from frigid (Park) to tropical (Dunning and Beach), from tectonically quiet (Depalmas and Melis; Dharmasena) to tectonically active (Barnes; Chester; Fouache and Pavlopoulos; Thordarson), from sparsely populated (Goudie and Parker) to highly urbanized (Barnes; Jungerius; Martini et al.) and from dry (Brookfield; Brooks; Cremaschi and Zerboni; Hunt and el-Rishi; Wilkinson) to wet (Barnes). Even active volcanoes are no absolute barrier to human settlement (Chester et al.; Thordarson).

Elevation and relief have often presented problems to human settlement and the general pattern of landscape adaptation has been to populate flat coastal and near coastal areas first, as well as deltas and riparian zones (Benvenuti et al.; Cioacă an Dinu; Mo et al.). Desert regions have also presented difficulties, especially where an acceptance of the natural state of a landscape (Brooks; Cremaschi and Zerboni) is replaced by a determination to use advanced technological resources to fix the problem (Wilkinson). Water has always been problematic in areas of karst (Dunning and Beach; Fouache and Pavlopoulos), where drought is produced by excessive drainage through the highly porous limestone landscapes.

Once we lived by hunting, gathering and scavenging, then some 10,000 years ago, our foraging strategy changed in a revolutionary way. We took charge of food production in the technology called agriculture. All our subsequent history is a kind of footnote to that Neolithic Revolution that took place first in SW Asia, North Africa and China (Brooks; Mo et al.; Wilkinson), slightly later in the Americas (Dunning and Beach), and later still as the technique diffused out from the heartlands—for example 7000 years ago in the western Mediterranean (Chesworth Chap. 3), about 5000 years ago in Sri Lanka (Dharmasena). The food production system drives all human economic activity (Smith 1776/1990), and as such is the basis of our various socio-political systems. Once farming started, technologies developed that allowed humanity to avoid (no doubt temporarily) the usual control on the size of a population—that is, the negative feedback that Darwin (1859/2010) called natural selection and Spencer (1864–67/2002) the survival of the fittest. All of our subsequent history, and our current predicament, is colored by that fact. The first population explosion began with the Agricultural or Neolithic Revolution and subsequent spurts in population growth have followed each expansion of farming onto new landscapes, and each advancement in agricultural technique. Our agro-footprint has been extended onto virtually all arable

[2] Undated references are to chapters of this book.

landscapes of the temperate zone (Barnes; Cioacă and Dinu; Mo et al.; Wohl) into warmer climatic regimes (Dharmasena; Dunning and Beach) and even into the sub-Arctic (Thordarson). Some landscapes still retain an attachment to hunter-gatherer economies (Barnes; Park), and Romania (Cioacă and Dinu) is interesting in having an area of unique woodland culture where agriculture is practiced in harmony with a kind of forest-craft which pre-dated it. One way or another, humanity has adapted and developed appropriate foraging strategies for all climatic zones.

By the time the Agricultural Revolution had reached the Atlantic coast of Europe, the first civilizations and cities had appeared in Mesopotamia and Egypt (Brookfield; Brooks; Chesworth Chap. 3), the first scripts had been invented, and new technologies involving new materials had come into being. Methods of cultivation and water-management had advanced and were changing landscapes in widening circles of influence spreading out from the original centers of civilization. Cities were a new feature of the landscape, and in spite of superficial differences, are recognizably the same the world over, with monumental architecture, elaborate communication systems, a division of labor, a stratified social system with a hierarchy that commonly hardens into a caste or class system.

The stratified nature of urban civilization created new needs amongst the populace, and made new demands on the landscape. Subdivision of labor was formalized and specialized artisans of various types plied their trades and sought for, and worked with earth materials from clay to base and noble metals, as well as gemstones, to make pots, implements, jewellery and weapons. Mining communities grew up to serve their needs, and an industrial element was added to the growing human footprint on the landscape. Hunt and el-Rishi (this volume) describe an early example from Jordan—a prehistoric foretaste of the Industrial Revolution that began to transform human society centuries later. Excavations and mine sites became a common feature of Middle Eastern landscapes, where the rift that runs from the borders of Turkey, down the Jordan valley, the Dead and Red seas and into Africa. It is the site of numerous red-beds copper deposits that have been worked since Chalcolithic and Bronze Age times.

One of the clear trends since the beginnings of civilization has been the increase in human technical abilities, associated with and dependent on the development of new energy sources. Energy is the key to modifying a landscape—the heat of the sun in nature, often adapted by humans in the form of water and wind power, and supplemented by human and later animal muscle. Modification of landscapes by cultivators started with scratching and digging sticks and progressed through the simple wooden plough to the metal mold-board plough pulled by oxen, and much later, the horse. By the Iron Age even the heaviest soils could be tackled, and the temperate clay plains of the world came under agricultural attack for the first time.

With the exploitation of fossil fuels on an industrial scale, starting with coal in the eighteenth century, anthropic landscape-changes on a massive scale began to appear for the first time in Europe since the great earthworks of the Neolithic. The Netherlands provide a case in point. In their constant battle with rising sea levels, the Netherlanders soon saw the advantage of adopting the Newcomen and Watt stationary steam engines to increase their power to drain territory and change seascape to landscape (Jungerius). Interestingly, after centuries of experience the engineers in the Netherlands have concluded that the best defenses were provided by the natural dunes and that the best strategy here is to work with nature and fortify the dunes. This is an attitude that brings to mind the fatalistic approach of North African societies, who in a sense, worked with nature (if in a passive way) when they adjusted their lives to aridification (Brooks; Cremaschi and Zerboni; Goudie and Parker).

The uncontrolled growth of human numbers has created the need to commandeer ever more territory to grow food. The point of saturation has now been reached in that all the best landscapes for arable agriculture have now been taken over according to the Millennium Ecosystem Assessment (2005) and modified by the farmer. The Mediterranean region was the first natural biome to become a more or less completely anthropic one (Sect. B2, this volume), a fate that has since overtaken the Mediterranean biome in California, Chile, Australia and South Africa and other areas including those reported in this book. It is also pushing agriculture into the marginal and inappropriate landscapes of arid regions, such as great parts of the western United States (Wohl). Water has always been a problem for farms and urban settlements in this region, and for that reason, river diversions and reservoir construction have been common since the nineteenth century. Now, engineering technology is capable and powerful

enough to bring water from the far side of the Rocky Mountains (Wohl). But at what stage do we decide with the North African herdsmen and nomads that the landscapes of the Desert biome are inappropriate places for high human and animal populations?

Biome-modification is practiced by all organisms but we do it on a larger scale and more thoroughly than any others. In this, we appear to have overshot the ability to support ourselves sustainably by about 25%. The consequences are:

(a) Habitat destruction particularly by deforestation of the landscape, and by competitive exclusion generally. Coastal plains were particularly vulnerable to biome modification (Barnes; Mo et al.; Morhange and Marriner). The temperate grassland and much of the temperate forest biomes have also been appropriated by *Homo sapiens* (Chesworth Chap. 3). A complete utilization of the Earth's photosynthetic capacity is threatened, with dire consequences for biodiversity.
(b) Over-exploitation of abiotic resources such as soil, leading to erosion (Fouache and Pavlopoulos; Wilkinson), acidification (Chesworth Chap. 3), salinization (Brook; Wohl), compaction, drainage impedance and soil fertility losses (Mo et al.). Problems of water supply become increasingly prevalent most obviously in arid areas, and water-management becomes necessary, starting with the irrigated, canalized landscapes of the Neolithic societies in the valleys of the Tigris and the Euphrates and in North Africa (Bookfield; Brooks), but less obviously in ostensibly humid areas such as the East Anglian region of the UK (Chesworth Chap. 3) or the Siena region of Italy (Martini et al.). Since the Industrial Revolution, over-exploitation of minerals and fossil fuels has become a major problem.
(c) Over-exploitation, overkill and even mega-kill by hunting, fishing, and collateral damage of the biotic resource. Die off of indigenous animal communities in island habitats of the Mediterranean, as well as elsewhere, seem always to coincide with settlements of such landscapes by humans.
(d) Effects of introduced species on native species (the agricultural tool-kit expanding out of the Levant eventually into the Americas, as well as adventitious introductions). This is particularly critical in terms of introduced microbes, with the famous example of the Spanish conquistadors, who, though few in number were able, with the considerable help of their European microbial allies, to conquer the Aztecs and the Incas. The introduction of malaria in the Pacific (Sollares), of smallpox into North America in the mid 1600s, and the encouragement of schistosomiasis by irrigation works in Africa, Egypt are striking examples (Kloos 2002).

The geologists dictum 'the present is the key to the past' no longer holds in at least one important respect. Until the present, no large organism has become a dominating geological force at the surface of the Earth. Now, for better or worse, *Homo sapiens* has achieved that distinction and we have entered a new division of geological time: the Anthropocene. Every chapter of this book is testament to the new era, and provides multiple examples of the modifications that a thinking, self-aware and ingenious primate has made.

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