Climate Change and Cultural Adaptation

Some Lessons of the Past

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Edited by Bo L B Wiman, Ingela M B Wiman, and Sherri L Vanden Akker

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THE ART OF NATURAL RESOURCE MANAGEMENT

POETICS, POLICY, PRACTICE

EDITED BY

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Ingela M.B. Wiman and Fanni Faegersten

Climate Change and Cultural Adaptation: Some Lessons of the Past

"But where there is danger there grows also what saves."
– FRIEDRICH HÖLDERLIN

Introduction: Fragments, Methodological Challenges, and Hypotheses

The discovery of the spectacular wall paintings on the island of Santorini conveyed a glimpse of the day-to-day life in the Greek archipelago at the end of the seventeenth century BC. One of the frescoes shows a landscape on the river, with palmtrees, lions, monkeys, and an avian fauna of swimming birds – all features of a warm, moist climate quite different from the dry Mediterranean summers of today. Are these painted scenes depictions of real conditions on a Greek island, or do they merely reflect artistic opinions influenced by nearby Egypt, or are we perhaps even facing a picture of the great Nile itself?[1]

Geomorphological, botanical and faunal data suggest that environmental change occurred in Greece in the early Bronze Age. For instance, was the paleobotanically observed decline of the oak pollen levels from Lake Kopais from around 2000 BC caused by man-made land-clearance, by climatic changes, or by other natural processes?[2] The ancient Greek literature provides two quotations that almost invariably are cited when questions on the reason behind the eroded hills of the modern Greek landscape are discussed. Plato, in the dialogue *Critias*, refers to the barren looks of the hills of Attika, a characteristic which he assumed was due to ancient manmade deforestation.[3] In *Meteorologica,* Aristotle observes that change towards a more arid climate negatively affected fruitful cities but profitably drained out swampy places, making them prosperous.[4]

These examples serve as a reminder of the methodological difficulties involved in characterizing ancient environments. In particular, changes in climate variables in antiquity are difficult to assess, as are indeed the potential historical responses to such changes. Addressing the causes for sudden abandonments and for foreign immigrations is one of the most challenging problems of modern archaeology. The forces of change could reside in transformations of internal societal structures (such as nucleation,[5] warfare, revolutions, supposed immigration) as well as in a mixture of climatic factors and their ensuing effects, such as on epidemics, migrations, and deteriorating lands which, at times, forced the abandonment of human settlements.[6] On the other hand, it could merely reflect the emergence and diffusion of new myths in order to glorify a humble past.[7]

During the early 1970s, there seems to have been a shift in the way the relationship between ecological change and human adaptation has

been perceived. Scholars then turned from static models towards more dynamic and complex ones, striving to understand how disequilibrium between population and the carrying capacity of the surrounding habitat is, perhaps, a rule rather than an exception.[8] Cultural coping strategies able to deal with harsh conditions may conceal smaller variations in climatic conditions, whereas a more profound change would be likely to show up in the archaeological records. Anthropogenically induced change, such deforestation, can be as disastrous as climate inflicted incidents and can have quite similar outcomes regarding micro-climate and environmental stresses.[9] However, disaster need not follow, provided that adequate know-how be introduced in order to "regain pre-existent ecological conditions" if possible.[10]

There are, indeed, substantial scientific rationales for studying and understanding ancient adjustments to climatic change in order to better understand current human responses to present-day global warming. Despite the several unprecedented features of today's change, we ought to benefit from consulting what records may exist of earlier human experience in these matters. However, the very concept of "human response to climate change," in the context of ancient cultures, could be dubious unless a critical attitude is taken towards proposed explanatory models for culture-and-climate relationships. Climate may change slowly and gradually, as a process involving hundreds of years or more, or change may be sudden and drastic, covering perhaps less than one human generation. Accordingly, the response of human cultures will vary considerably, and generalized models will be hard to propose.

Dr. M. Jochim notes:

"The problem is that modelling, particularly at the community and ecosystem levels, has the inherent weakness that afflicts all deductive modelling; it can only predict behaviour under conditions for which the model has been designed." [11]

If a pattern of human response to climate change were at all discernible, one would perhaps expect that slow and gradual climatic impact would give people, as well as ecological systems, time to adapt and to invent (in the latter case, to respond with) new strategies for coping with change, whereas sudden and drastic change would be conducive to abandoned lands and/or disaster.[12] Furthermore, one might hypothesize that colonization may occur rather quickly after an isolated, sudden, climatically anomalous event, but that the former economic and political structure would be replaced by quite another.

Gradual change could, hypothetically, also go on unnoticed, without the cultural investments in new land-use practices, for example. At a later stage of the process it would be needed to cope with accumulated effects of many marginal changes.

The following sections intend to briefly illustrate the above ideas. Examples have been gathered from three types of societal organizations, hunter/gatherer, agricultural, and nomadic societal structures, in order to illustrate different responses of these types of human economies to climatic and/or environmental changes. Some strategies invented by contemporary cultures seeking sustenance in marginal areas, mainly oriented towards agriculture, are also discussed and commented upon, being important examples for comparison purposes. It is acknowledged that it is vital to future discussions of "sustainable development" to study and gath-

er inspiration from such ingenious strategies of small-scale solutions to environmental stress of various kinds.

The Gradual Climate Change between Paleolithicum and Neolithicum and Its Implications for Drastic Culture Change

This example is chosen mainly because it provides a clear-cut and unquestioned proof of an ancient climate-related incident. Chronologically, this section of the essay spans the final phase of the Quaternary, thus the Holocene period, our "geological present." While the Pleistocene period[13] covered the first 3 to 4 million years of the Quaternary, the Holocene period has – geologically – "just started," beginning about 11 000 years ago at the end of the last Ice Age. The ice sheet – which had covered vast parts of Europe – finally began to leave Scandinavia during this time, around 9000 BC. The change that very obviously took place in climate during that period was one of the factors that started a new, quite extraordinary, cultural process commonly named "the neolithic revolution".[14]

Until the beginning of the Holocene period, prehistoric man had been living in nomadic groups with a subsistence based on game hunting and the collecting of wild food-plants. The game were followed on their yearly routes for forage, and in that way, a variety of environmental niches came to be discovered and used by man. Spectacular wall-paintings from cave-dwellings and female figurines with greatly exaggerated gender characteristics have been interpreted as keys to the beliefs and life-style of these peoples.[15]

As the temperature steadily rose during the early Holocene, a crucial new course was commenced by cultures in the Near East. In the archaeological material from several seasonal settlements in the Near Eastern and Levant areas evidence can be seen of man's transition from a nomadic hunter-gatherer to a sedentary farmer. The archaeological record reveals that genetic and morphological changes occurred in grain like emmer, einkorn (primitive wheat) and barley, where grains from slightly later periods have six rows of seed instead of two.[16] This genetic change – or domestication – was partly due to regular cultivation of wild plants over a certain period of time.[17]

In searching for the reason for the beginning of agriculture, many explanations have been proposed. Some of them state that changes in cultural systems emerge from impulses within the own group; from natural technical advances and innovations. Others build on the belief that changes and transitions are due to pressure from outside the system (ecological changes, for example) or from population growth, forcing man to produce food stuffs more efficiently.[18] Binford (1968)[19] was one of the scholars who claimed that pressure from over-population forced man to change his economy, and who identified the pressure as being an effect of sedentism. With sedentism, the maintainance of low birth-rates – always practised in a hunting society – would no longer be necessary.

But why, then, did sedentism occur? Binford falls back on a techno-environmental explanation. The sedentism, he argues, resulted from the availability of "optimal" environments in the early Post-Pleistocene, in conjunction with the necessary technological know-how. Later scholars have contributed slightly different ideas. Among others, Bender[20] argued that devel-

oping social relations might have been one of the causes for the economic change. Back in 1968, H.E. Wright argued that the warmer period after the last Ice Age set the stage for primitive farming in the Near East. Through archaeo-ethnobotanical evidence, he was able to show that an ecological shift took place in the area, due to the rise of temperature, altering the former cool steppe into a warm oak-pistachio savannah.[21] The warmer climate made it possible for barley and emmer to immigrate into the savannah, followed by mountain living animals, and – therefore – by man. On the new open living sites, man was able to start to cultivate grains and, later, to become domiciled. Wright stressed that this evidence of simultaneous environmental and cultural change was by then (1968) far too well documented to be ignored. It is evident that climatic change provided the opportunity for this period of human progress.

Some doubts have been voiced on this matter, however. For example, in 1988, Roger Lewin posed the following question: if the climate were such a decisive factor for the sedentism of man, would not the Neolithic "revolution" have occured earlier, during the last 75 000 years of the Pleistocene, when conditions favorable to sedentism already must have existed?[22] In recent years, Henry has proposed an interesting explanation to this dilemma. He discriminated between conditions that were *necessary* and conditions that were merely *sufficient* for the "rise of agriculture." Necessary conditions were naturally the food-grasses themselves and also the know-how; the technology for the processing of the grains and tools for collecting, grinding and storage. These devices were already present. In fact, in the course of the last Ice Age they were invented by Neanderthal man for grinding colour pigments which were deployed in ritualistic paints and thus in religious ceremonies. Henry's conclusion is quite thought-provoking:

> "Given what may seem to be an overly ecologically oriented or even environmentally deterministic approach to the problem, I think it is worthwile to note that had it not been for some Neanderthal driven to grinding pigment for ritual purposes, it is unlikely that most of the world would be sustained by agriculture today."[23]

Thus, the importance of the – often intangible – cultural factor is sometimes overlooked in explanations of prehistorical changes.

The pre-neolithic culture seems to have been rather uniform throughout most of Europe, albeit abandoned at different times depending on the recession of the ice sheet. It might be assumed that this conformity was due to the economic structure of a hunting-gathering society. Religious cults existed and were manifested in hunting scenes painted on cave walls, and the fertility aspect of the female gender was predominant in preserved figurines. Measurable technological developments mainly concerned the refinements of stone tools for hunting and equipment for manufacturing minerals into paints, and organic materials into adhesives, for making the famous cave paintings. Hunting strategies seem to have reached a state of perfection towards the end of the period in question. Preserved human remains indicate that the state of nutrition within the population was quite satisfying. Detectable diseases were connected to injuries rather than to the infectious or parasitary diseases later to afflict sedentary populations.[24]

In the case dealt with above, the process of cultural change appears to have been slow and gradual, coinciding with the melting ice core. It was slow enough to allow people to adapt to

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environmental changes. Possibly the most serious aspects of ambient change lay in their afflicting man as predator on a diminishing resource of animals. The decline of the resource base was either caused by the climatic change itself or by the very skilfully applied hunting strategies that evolved towards the end of the Paleolithic period.[25] Ambient change was also sufficiently gradual to allow time for the abandonment of the former sustenance stress on hunting, in favour of increasingly refined gathering techniques. Concerning religious rites, the era must have witnessed a rather sudden shift away from earlier customs. In the Neolithic period, emphasis seems to have been on depicting domesticated fauna in cultic paintings, rock-carvings and sculpture. Most notably, the bull was depicted as the strongest and most potent of the domestic animals. Female figurines, however, still had a profound emphasis on gender characteristics, tempting one to the conclusion that fertility aspects were as prevalent in Neolithic as in Paleolithic cultural contexts.[26]

The introduction of agriculture all over the world was a gradual process, reaching various parts of the world at different times. Agriculture seems to have been implemented in Jericho around 8000 BC and in Southern Scandinavia around the millennium shift 4/3000 BC.[27] There are few records in the scientific literature about climatic disturbances; existing records concern the time when agriculture had been firmly established in the Mediterranean, dating from the end of the third millennium BC, and consisting of both contemporary written documents (cf. the sections on the Egyptians and the Sumerians below) and resulting from present-day archaeological investigations. Apart from the Sumerian man-made disaster described below, it seems that the Bronze Age period witnessed a series of serious naturally induced climatic events.

Climatic Disturbances in the Aegean Bronze Age and Their Possible Effects on the Cultural Changes Occurring during That Epoch

Traditionally, the three chief archaeological phases of the Bronze Age (c. 2600 - 1200 BC) on the Greek mainland are referred to as the Early, Middle and Late Helladic periods, abbreviated EH, MH and LH. The three phases are each divided into three subphases; for example, the EH I, EH II and EH III periods. At least two periods of more or less serious disturbances are recorded in the archaeological remains. The first occured at the end of EH II, around 2200 BC,[28] and resulted in a series of destructions and abandoned sites. The second, which occured at the end of the Bronze Age, resulted in the destruction of the Mycenaean palace culture.

The transition EH II – EH III

During the second subphase of the Early Helladic period, EH II, East-central and Southern Greece had reached a comparatively high level of civilization, with the beginning of urbanization in places like Lerna and Tiryns on the Peloponnesos. These developments came to an abrupt end in EH II - EH III with archaeological evidence of abandoned sites and destruction at many places. An intensive survey in the Berbati valley shows a decreasing number of sites; of twelve previously inhabited sites only one remained.[29] In southern Argolid just two out of twenty-three remained populated in EH III.

Some scholars have blamed these disturbances on "the arrival of Greek-speaking peoples," i.e. the coming of the Greeks.[30] In earlier scientific frameworks it was thought that the newcomers brought new devices with them, such as horseshoe-shaped or rectangular houses, new types of vases, and new customs as, for instance, placing cemeteries outside the settlements. This view has recently been challenged. Most of the purportedly "new" devices were already present at the time of the destructions and, furthermore, most of the important ancient centers were reoccupied, with no significant changes. Even the number of sites that were actually destroyed has been subject to debate. As Wells *et al.* point out:

"However, with much good will it is possible to suggest, that of the certainly destroyed sites, more of them fell during EH II:D than during any other subphase of either EH II or EH III."[31]

It is true, however, that the period from EH II and EH III seems to have witnessed a decline in the amount of populated sites, and that the total population continued to decrease during the EH III period.[32] Towards the end of the Middle Helladic period, the situation seems to have brightened. Thus, this event lasted some two hundred years, and – given that Forsén's findings are correct – was not combined with any significant cultural change. That is, the causes for this disturbance probably are to be found in some factor other than a hostile invasion by Greek-speaking people.

Indications of environmental change towards the end of EH II

The possibility that the disturbances discussed above, which occurred towards the end of EH II, were caused by some environmental factor has been proposed by several scientists.[33] Lake deposits show a decline of oak pollen, and the old avian fauna of predominantly swimming birds seems to have been mingled with, or replaced by, birds preferring a dryer climate, such as partridges, pigeons, ravens, and crows.[34] It seems that the decline was at least added to by some environmental disequilibrium. The recorded data, however, do not exclude the possibility that this change was caused by anthropogenic activity, because "...a contributing factor may have been the catastrophic loss of soils from the hillslopes that resulted from centuries of uncontrolled land clearance and erosion."[35] Part of the background to this EH II destabilization thus seems to have been a period of population growth followed by the expansion of the cultivated area.[36]

Although van Andel *et al.* have argued that there are few local evidences in Greece that point towards a climatic impact during this period,[37] there are strong indications of altered conditions in the south-eastern Mediterranean. Mellaart points to the decline in the Bronze-age II culture in Anatolia (which he dates 2300 BC) and Weiss *et al.* propose the theory that the fall of the Akkad empire was triggered by an abrupt climate shift around 2200 BC:

"These data define the major effects of an abrupt climatic change at "2200 BC, namely imperial collapse, regional desertion, and large-scale population dislocation."[38]

Bell has convincingly shown that a period of drought afflicted Egypt around 2200 BC, as documented in contemporary Egyptian texts,[39] approximately during the same period as the disastrous development in Greece took place. The whole Egyptian governmental system was

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seriously marred by this drought, which not only caused a temporary great famine but also seems to have broken the trust in the pharaonic system as a guarantee for a well-ordered and balanced nature. It is invaluable to be in the possession of contemporary records of an ancient climate catastrophe. Otherwise the outcome of this decline in Egypt, which was accompanied by deteriorating faith in traditional values, and eventually brought on the collapse of a governmental system, would not have been known to posterity.

Data from the Dead Sea in Israel and from Sahel points to a transition to a more arid climate sometimes between 5 000 and 4 500 BP.[40] It cannot be directly inferred that the weather patterns of Greece were the same as those further to the south or east. Neumann, however, has pointed out that winter temperatures of Athen's Hellinikon A/P and Latakia in Syria are strongly correlated.[41] In a later work, Prof. Neumann emphasizes the climatic correlation between Europe and the Near East.[42] A period of a dryer climate throughout all of the eastern Mediterranean is thus highly probable.

van Andels *et al.* provide some highly interesting data from Argolis that seem to shed new light on this issue. An intensive surface survey of most of the southern peninsula in Argolid was combined with soil profiles from the area. A rather long period of debris flows was identified in the soil profile from the EH II period onwards. The soils were again stable from c. 2000 BC. This could be the effect of a new technique to prevent soil erosion that was implemented in the area: construction of terrace walls on hill slopes and the walling in of spring-flood watercourses.[43] Due to this technique, the soils remained basically stable until 500 BC, according to van Andels *et al.*, when population growth necessitated the use of marginal lands for intense grazing (which led to land-clearance and the subsequent release of sheep and goats onto marginal lands, with no accompanying effort to stabilize the landscape with terrace-walls or other constructions designed to prevent soil-erosion). Thus, a land clearance in EH I, with resulting population expansion in EH II, probably caused man-made environmental problems, such as soil erosion and deforestation. These shifts, then, came in conjunction with a likely change towards a drier climate. At first, these disturbances caused abandonments on a large scale (and perhaps nucleation into less afflicted parts of Greece). van Andels *et al.* suggest that in responding to this situation people in the area learned to control erosion by constructing terracing walls. As part of a strategy to cope with a combination of internal and external change, a technology was conceived and implemented that contributed to recovery, admitting a certain time-span for the repopulation of the area. Prosperity then returned at the end of the MH period. It is generally difficult to date terraces, and archaeologists have until recently paid little attention to this feature of the landscape. There is, however, clear archaeological evidence of terracing walls dating from c. 1750 BC on the islet of Pseira off east Crete.[44]

The "Mycenean drought" (approx. 1200 BC)

The final phase of the Bronze Age on the Greek mainland is called the Mycenaean period, a name derived from the powerful Mycenae, the leading city-state within the society at the time. This city was once the seat of the legendary king Agamemnon and was made famous by Homer in the Iliad, the story of the Greek siege of Troy. Mycenae was a strategically placed city, overlooking the rich Argive plain. The society was,

partly at least, organized as a redistributionary economic system; i.e., goods were delivered, stored and accounted for in the administrative centres of the time (most important were Mycenae, Tiryns, Sparta, Thebe and Pylos) and were redistributed from the centres to the citizens. This system enabled a high degree of specialization. The various soils could be used intensively for cropping – to which they were particularly well suited – but most importantly, such a system allowed for the sustenance of skilled artisans and a learned class: scribes, administrators, "historians,"[45] and priests. It seems that this economic system created both societal wealth and demographic growth. According to estimates by Angels, the population density in the eastern Mediterranean rose from 1 individual per square kilometer in the Neolithic period, to about 35 at the end of the Bronze age.[46] But the civilization was facing a rapid decline since "... the era around 1200...presents the most widespread horizon of destruction on Greece over many centuries of her history."[47] During the period from 1200 to 1000 BC, the population in the entire Mediterranean decreased by 30%, in Greece by 75%, and, in the densely populated Messenia, by 94%.[48] The subsequent period in Greece is referred to as the Dark Ages (1100 to 800 BC), characterized by an almost complete break with the former life style and with a slow recovery.[49] Along with culturally fruitful influences from the East, the large population growth – considered the main reason for the Greek colonization period in the second half of the eighth century BC – also provides evidence of recovery from about 800 BC.

Possible causes for the deterioration

Explanations given for the decline that set in around 1200 are very similar to those proposed for the desertion period towards the end of 2000 BC, *viz.* invasions (the famous Dorians), palace revolutions, drought and famine. If Dorian invaders were the cause for the destructions, why did the Dorians not assimilate some of the higher Mycenaean culture, as is historically common for invaders to do? The art of writing, for instance, practiced by the Mycenaeans for at least a couple of hundred years, died with them. It was not restored until c. 400 years later. Why did the Dorians not rule as the Mycenaean kings, by adopting a well functioning administrative system? Should not a process of assimilation have occurred, especially since the Dorians seem to have inhabited almost the same localities? The know-how of writing apparently did not survive; nor did much else of the superior culture, except some traditional pottery-making, architecture and metal-working.[50] Therefore, it seems most likely that the controlling system of the palace culture had fallen apart *before* the Dorians entered the scene. Some factor other than invading Dorians likely underpinned the change.

In 1966, R. Carpenter hypothesized that a severe period of drought afflicted the Mediterranean in the period around 1200, and lasted well into the ninth century BC.[51] His findings were criticized at the time for lacking scientific acribi (his book is based on a series of lectures and lacks footnotes and other references) and for a period were not seriously considered. Aristotle, however, had a similar explanation for the decline of Mycenae:

> "But this land changes in its turn and in time becomes thriving. For as places dry they improve, and places that formerly enjoyed a good climate deteriorate and grow too dry. This has happened in Greece to the land about Argos and Mycenae. In the time of the Trojan War, Argos was marshy and able to support few inhabitants only, while Mycenae was good land and therefore the more

famous. Now the opposite is the case for the reason given above: for Mycenae has become unproductive and completely dry, while the Argive land that was once marshy and unproductive is now under cultivation. What has happened in this small district may therefore be supposed to happen to large districts and whole countries."[52]

No doubt, it would be useful to collect the evidence *pro* and *contra* such a climate change as an explanation for the decline. One indicium for a major change in climate is the long duration *per se* of the decline. Initially, the change was forceful enough to completely demolish a functioning culture pattern. New vital cultural structures were not shaped until the formation of the Greek polis-states some centuries later. Furthermore, the Hellenic culture was not the only one to be afflicted in the period. There are recorded disturbances throughout the eastern Mediterranean area.[53] Further evidence for a climate change has been proposed by Kraft *et al.* who observed that marine retrogression indicates a dryer period at the time.[54] They do not exclude cultural activities as contributing factors to this recession, however. A large dam was constructed in Mycenaean time about 4 km east of Tiryns. Its water flowed into the gulf of Argos and may have contributed significantly to infilling the harbour area.[55]

It seems that Mycenae sought sanction for their redistributional system from the gods. The king was probably though a guarantee for good relations with the divine sphere of influence.[56] The Pylos tablets tell of splendid gifts to the gods at the year of its destruction.[57] The nature of these evidence, however, makes it impossible to determine if this was a special year when particularly entreating gifts had to be offered in order to avoid some impending disaster, or just referred to the normal annual quantum.

It is certain that many features of the Mycenaean culture survived to posterity. Many of the later Olympic gods are already present in the Linear B tablets. The Homeric eposes rely to a high extent on traditions and stories transmitted from older times.[58] Large Bronze Age gods and religious centers, such as the one on Delos in the Cyclades, survived and attracted cult also in succeeding historic periods.[59]

Discussion

Harding has pointed to the popular misconception that major climatic shifts take so long time to develop that people hardly notice a difference in their lifetime. The truth is very much to the contrary, and the importance of climatic change, especially in marginal areas, should not be underestimated. Heat and cold afflict humans, as well as domesticated animals and plants with, among other things, climate-related diseases.[60] During the Bronze Age, as compared to modern times, the climate favoured quite another biotope in Southern Scandinavia, with wine and mud-tortoise; yet the average temperature was only 1 degree C higher during the Bronze Age than it is now. Recent droughts in the Sahel zone in Africa and the infamous dry years of the 1930s in the USA are known examples of drastic climate change with widespread disastrous effects on the population. The "Little Ice Age" afflicting Europe between approximately 1300 and 1600 AD was caused by a reduction in temperature of only 1 to 2°C.[61]

Recent archaeological research and excavations have paid more attention to natural conditions prevailing during the time period investigated at a given archaeological site. For instance, the University of Texas in Austin has carried out an extensive investigation of the

territory of the Greek colony of Metaponto in Italy. An area 42 square km large was surveyed; more than five hundred sites of the Greek and Roman countryside, mostly of the Classical period, were revealed. This survey was combined with an intensive study of material remains of ancient crops and animals and excavations of almost a dozen rural sites including the Pantanello necropolis. The investigation unmasked a close connection between population density and natural conditions. In the second half of the fifth century and the early fourth, there was a sharp decline in the rural population. The study showed that this decline was accompanied by a water-table rise of about half a meter between the sixth and fourth centuries BC. A climate change towards a wetter period was thus highly probable. Among other things, some parts of the area became too swampy for safe habitation, and the population was seriously afflicted by malaria, as revealed by the skeletal remains.[62]

The Egyptian and Akkadian cases referred to above serve to illustrate that the overall socio-economic effects of drastic climate change perhaps are particularly disastrous in cultures based on faith in the divine sanction of the established societal system. Climate-related diseases among men and animals, and crop-failure and parasite outbreaks of unknown magnitude, might put an end to the power of even mightier kings than the Pharaohs. The quotation from Weiss *et al.* (note 37) defines the "responses" of a sedentary, basically agricultural, population to abrupt climate change in a nut-shell: *imperial collapse, regional desertion, and large-scale population dislocation.* It is a fact that almost all recorded climatic changes listed above have involved massive *völkerwanderungen*, a fact that earlier scholars mostly considered the cause for, not the effect of, climatic and other environmental changes. Harding observes:

> "Indeed, it may be that archaeology has a crucial role to play in assisting climatologists in the correlation of climatic episodes...The data of archaeology and of paleoclimatology are not closely comparable, yet each can provide the other with surprising insights."[63]

Alongside the wide-spread agricultural societies, less rigid societies developed, mainly among the herders of the great Eurasian grasslands. In time these evolved into the huge empires, as exemplified by the Great Kahns, introduced to western civilizations by Marco Polo.[64] Smaller nuclei of people practicing transhumance and nomadism gathered also in the highlands of the Balcan states and in the arid regions of the southern Sahara. The Touaregs of Sahel exemplify the twofold stress put on such cultures when exposed to both climatic and political changes.

A Modern Example: the Touaregs

The West African Sahel separates the sand dunes of the Sahara from the relatively well-watered regions to the south, along the Ivory Coast. It is thus a marginal area, which becomes a favourable habitat only with increased precipitation. Nomadism has been the way that man has adapted to these harsh environments, moving with his cattle in search of areas treated to fortuitous showers. This is the mode of living practised by the "People of the Veil." In this area, the temperature ranges from the 46° C in May to 4.5 °C on cold December nights, and the mean annual rainfall amounts to between 50 and 150 mm.[65] Here, the Touaregs or *Kel Tamasheq*, as they call themselves, have adapted to the envi-

ronment by utilizing almost all natural resources possible – either directly or through the medium of animals – which they have obtained in amounts sufficient to sustain life by moving from area to area.[66] For centuries, the Touaregs have performed their limited migrations, following the cycle of annual rains and hence of herbaceous forage.[67]

There are several different groups of Touaregs, all of them divided into tribes. For the Kel Oni-Touaregs and the Kel Gress-Touaregs, caravan trade has been the most important economic factor, based, naturally, on the herding of camels. Other groups, like the Ullimmid-Touaregs, are strictly cattle herders. The wealth and the pride of the Touaregs are their great herds of camels, but they also keep large numbers of goats and sheep.[68] The herds must consist of different types of animals, since they have different values as food, as means of transport, and as stored wealth. They also make use of pasture of different types and at different distances from the camps.[69]

At the beginning of October, the trading Kel Oni-Touaregs – living in the Aïr-massif of central Sahara – trade goods with the settled farmers of the mountainous area. In exchange for goats, dried meat, cheese or fat, they obtain salt, millet and dates; goods which they transport on their camels through the Ténéré desert, and are able to sell at prices far above those they payed.[70] This trade brings goods to remote parts of the desert, and with the money he aquires at the southern markets, the Touareg can feed his family for the entire coming year.[71]

During the six-year period from 1968 to 1974, the Sahelian desert-area was subject to a great drought.[72] The worst affected areas were those furthest north, where the rainfall is always sparsest and the ecological balance the most fragile. Millions of people were struck by an immense famine. The worst situation was that of the nomads. The rainfall deficit over the years 1970-1973 was approximately one-third in the Sahel and one-quarter in the farming zone.

The most important adaptive strategy of the nomads in times of drought has been flexibility and movability. During earlier times of drought, the Touaregs used to move with their camels over distances extending up to 500 kilometres, to find new pasture areas. But with the narrowing frame of subsistence the Touaregs found fewer areas to escape to. Some of the nomads' pasture areas used to look as if they were abandoned, but in fact they played a central role by offering reserve-plains in which to take refuge, in times of drought. These seemingly abandoned areas had been put under the plough; and so the nomads could no longer turn to them in times of need.

As a means to acquire food during past droughts, the Touaregs used to raid various groups and capture slaves, which they sold to slave traders along the West African coast.[73] This system began to collapse with the abolition of the slave trade on the coast. It became completely destroyed with the French suppression in North Africa and the subsequent spread of French administration in the late 19th century.

During the recent six-year drought the Touaregs had to face the catastrophe with very restricted possibilities to escape it. By 1973, four years of severe drought had driven many Touaregs hundreds of kilometres to pasture areas where there already were other, often hostile, groups of herding people.[74] Touaregs brought great herds of animals to waterholes that they had previously not frequented, causing bitterness and sometimes fights.[75]

In escaping the drought by migrating south-

wards, the Touaregs and their herds were subjected to diseases carried by the tsetse fly and other insects in country with a thicker scrub and tree cover than they had usually experienced.[76] The circumstances, together with the famine, finally forced a large number of the nomads to sell their weakening animals and their tents or jewelry for food. To a great extent, the Touaregs had to leave their traditional way of life and move to the cities where supplies of food were distributed.[77]

More than any other event, the West African drought led to discussions about centenary trends in the world's weather. Sahelian rainfall has been predicted to decline due to a change in global air pressure belts dating back 20 to 40 years. Prof. Caldwell, of the University of Canberra, Australia – considered by many a leading authority on demographic problems in Africa – does not seem inclined to accept this theory of decline. According to his investigations, the rainfall has fluctuated within normal range during our century.[78] The Sahelian drought in the 1970s was parallelled by a vast drought in the same area between the years 1913-1914. It is significant that the people subjected to the 1970s drought did not die on anything like the scale of 1913-1914. There is also some evidence that the 1913 drought was climatically worse than that of the present day in the savannah farming zone, but perhaps not in the Sahel.[79] A theory of secular decline, therefore, is not well supported. So far, no permanent changes in the North African desert climate have been proved. It would be most interesting to study this society more closely as it is, indeed, involved in a process of human response to climatic change, the ultimate effect of which seems to be a rather fast collapse of the Touareg culture.

"Not a Drop of Water Was Wasted" – Flexible Strategies Invented in Marginal Areas

In the discussion of possible cultural effects of climate change much can be gained by investigating coping strategies invented by people living in marginal areas. Such studies can present not only historical examples of cultural systems but also still extant ones, like the Touaregs' above, which allows greater insight into the organisational structures and belief systems invented to assure stability in a society. Such intangibles are often difficult to trace in past societies.[80]

With increasing aridity, the Berbers – a North African people – developed rather sophisticated land-use practices, msaking the best possible use of all the scanty precipitation in the area. They practiced the so called "Wadi agriculture" similar to the one practiced by the Nabateans of the Negev (see below). Run-off waters were extensively used everywhere in the Arid zone, as shown by the relics of man-made terraces and dams that can still be observed even in the remoter and almost desertic areas.[81] Other Berbers sought refuge in the mountains of the central Sahara, and there developed a complex nomadic, feudal civilization reflected in the Touareg society. Traditional Touareg society seems to be ruled by very rigid norms based on family units. An economic system relying mostly on husbandry and migrations to more fruitful areas in periods of drought is seriously afflicted once agriculture or new boundaries are introduced. Migration and transhumance have been practiced for generations by people leading herds to winter and summer pasture. The application of modern, large-scale argricultural methods, including drainage of swampy landscapes, irriga-

tion practices or flooding by embanking dry areas; the world-wide introduction of western-type cattle, and the drawing of superfical, political boundaries have almost put an end to entire cultures, for instance in the Balcan states, in the Fenno-lapponian regions in northern Scandinavia, and to Indian tribes in North America.

History, as written today, tends to prove that a rigid social system, as found in the Touareg society, for instance, is probably more severely harrassed by environmental and political changes than are flexible social systems, as found in agricultural communities eolving in response to harsh surroundings. The Hopi Indians, for example, living in barren parts of north-eastern Arizona, invented farming techniques that enabled them to make their living for generations in a very dry area.[82] Gumerman characterizes the most salient features of the Hopi organization as follows:

"The Hopi cultural system, often characterized as structurally very rigid, is a highly flexible organization functionally, which allows effective coping behaviour in an extremely patchy environment. The effects of drought, torrential summer rains, short growing season, violent sandstorms, and highly localized showers can be minimized by a social and religious organization which stresses community welfare, sharing, and cooperation. For example, since clans own the productive agricultural land and since that land is divided among many different environmental zones, such as irrigated plots, sand dunes, and arroyo bottoms of various sizes, some crops in some environments are bound to reach maturity. The individual household does not have to assume the entire risk of crop failure by maintaining a single large plot in one environment. Insted, the clan acts as an insurance system, spreading the risks and stabilizing through diversification."[83]

From a purely technical standpoint it should be noted, for instance, that the Hopis planted crops in dry arroyo bottoms using both the central stream bed and the surrounding marginal parts. A strong flood in any given year would cause crop failure in the midstream area but successful maturity at the marginal parts. Conversely, a weak flood would secure crop maturity midstream and failure at arroyo margins. This example of an ingenious strategy to achieve sustainability in a system constrained by limited natural resources is well in line with a "safe-fail," flexible behaviour. A similar system of water-harvesting was invented by the Nabateans living in the Negev desert. The annual precipitation seldom exceeds c. 130 mm per annum, but practically every precious drop of this was preserved. A system of superimposed canals were built diagonally over a hill slope. These canals caught the water which was conducted to large cisterns placed at the bottom of the hills. Recently the Israeli have brought this old system into function, virtually bringing "the desert to bloom."[84]

In an article in New Scientist in reference to many examples of ingenious practices, F. Pearce observes:

"There is nothing unique about the Negev. Rainwater harvesting must once have been the rule rather than the exception in the world's deserts. But the real lesson, visible from the *pampas* to the Negev and from the *qanats* of Iran to the floating gardens of Mexico, is that a vast diversity of expertise in water management has been lost in the headlong rush towards modernity. Often archaeologists can piece together the fragments. But how much better to learn the wisdom of the practitioners themselves. The *mughani*, the Bedouin and the farmers of Lake Xochimilco may between them hold as many secrets about the success of farming in hostile lands as all the consulting engineers that have ever made their sales pitch for an aid project to green the desert."[85]

Recent books on environmental problems have criticized the "prevailing mood of pessimism" in the quest for alternative and promising technological devices in order to bring about sustainable development in the future.[86] One important contribution of sciences like archaeology and anthropology may be the presentation of historical examples of sustainability obtained without accompanying environmental degradation, examples which may provide hope and inspiration. But there is a clear need also to learn from less successful enterprises of the past.

Small-scale solutions versus large-scale enterprises

Water control, one measure to assure sustainability, has been practiced almost from the very start of sedentary agriculture. It has consisted of ingenious strategies to preserve and keep precipitation – as exemplified by the Hopis and Nabateans, described above, and the traditional agriculture of northern India, described below – or has involved the construction of embankments with irrigation canals. History provides a wide variety of examples of failures and successes resulting from various damming and irrigation systems.

Egyptian versus Sumerian irrigation

The two most ancient hydraulic cultures are Egypt and Mesopotamia. The hydraulic techniques were based on two different principles, however. Egypt was dependent on the yearly inundations of the Nile, providing water for a small-scale irrigation system. The inundation also provided a rich covering of silt on the fields and a beneficial washing away of salts by the flooding water, successfully preventing salination. Egypt has profited from these natural beneficial conditions throughout the five millennia of its existence. But from the nineteenth century onwards, irrigation schemes have been imposed on Egypt, and with the construction of the Aswan High Dam the irrigated land has grown to almost 100% of the total cultivated land.[87] Development in Egypt has not been improved by these enterprises. Reports of increased salination and calcifying rates, the deposition of silt on the bottom of Lake Nasser instead of on the fields, and evaporation from the lake, which has caused the Delta to receed, are examples of processes diminishing the fertility of Egyptian soils.[88]

The ancient Sumerian people might serve as a complementary example of how a large-scale irrigation system may have unexpected negative environmental effects. The city-states of the Sumerians, such as Ur, Lagash and Larsa, situated in southern Iraq, were dependent on irrigation for farming. Control of the water sources was vital for the survival of each individual state and a cause of incessant warfare among them. In order to secure control, a large navigable canal was built between the great Eufrates and Tigris Rivers towards the end of the third millenium BC. Over time, among other factors, this canal created irreversible environmental damage from which Irak is still suffering. The flooding of the rivers and the insufficient clearing of silt from the canals caused the groundwater table to rise. It transported minerals from the extremely salty bedrock of Mesopotamia to the surface soils. Since in Mesopotamia evaporation exceeds precipitation, this phenomenon led to a severe salination. The fertility of the soils was greatly reduced; by 1700 BC the harvests had decreased to one third of the yield recorded in temple archives from 2600 BC.[89] Ecological and cultural power was transferred to the rulers of Babylon, north of Sumeria proper,

situated at higher lands. But by 1300 BC middle Mesopotamia, too, was affected by salination. The centre of power moved northwards to Assyria where there are no further indications of salination in the ancient archives.[90]

The Uri Project in Kashmir contrasting to the Chipco movement

The Uri-project in Kashmir is attempting to construct a huge dam that will provide 3.5 TWh electricity per annum. The project has support from the Swedish government with 1.2 billion SEK, the largest Swedish aid-project ever. One of the primary benefits expected from this project is the protection of the remaining forests in the area.[91] Dissenters, however, argue that:

> "...during long sojourns in India we have never seen any electrical stove. Most villages in Himalaya are not even connected to the electrical grid...To state it clearly, there is really no target group for the energy."[92]

The popularity in the First World for projects of this type is based on the presumption that they are simultaneously profitable to their entrepeneurs and to the local population, and are morally justifiable. To save forests is a *bona fide per se* behind which many vested interests may be hidden. These projects also provide good examples of the Western attitude towards technological development in Second or Third World nations, which is often characterized by an uncritical faith in the all around benefits of implementing large-scale technology, regardless of local cultural and ecological conditions.[93]

Quite a contrasting "save the forest"- project has recently emerged in the lower Himalayas, in Uttarkhand, a territory consisting of the eight most nothern districts of the province Uttar Pradesh, home to the universally known tree-hugging-movement, Chipco Andolan.[94] (Chipco means in the local dialect, garhwali, "to hug," "hugging," thus literally "hugging the trees.") When Great Britain took control of the territory in 1815, the inhabitants of the area were described as rich, despite their rather small farmsteads. Well built terraces and small-scale irrigation brought maximum profit, while simultaneously preventing erosion. The surrounding rich forests gave additional crops, fruit, vegetables, honey and nuts. Soon this idyllic condition was blurred, when access to the forests became prohibited by the authorities, and governmentally controlled forestry on a large scale was implemented. Mira Benh, one of the Western women who followed Mahatma Gandhi, moved in 1947 to a village below the Himalayas. She became aware of the connections between the abundant floodings of the plains, and the large-scale felling of trees in the mountains, and realized that trees have a great capacity to keep ground water intact. In the 1960s, an extensive network of roads opened the mountains to commercial exploitation. Resultant local activities and actions against deforestation became a part of the struggle for independence. In thinking on means for liberating India, Mahatma Gandhi stressed the advantages of the self-supporting village based on agriculture, of civil disobedience and of non-violent methods of resistance, *satyagraha*. These ideas are still vital sources of inspiration for the people of the area. It was due to the initiative of the local women, in line with Mira Benh's ecological awareness, that a movement against deforestation was established in the villages of Uttarkhand. When a local program of reforestation was successfully implemented, the Prime Minister of India, Indira Gandhi, accepted in 1980 the demands from the Chipco-movement and wrote a bill prohibiting

all felling of trees growing above 1000 m altitude in the mountains of Uttarkhand.[95] It is crucial that no aid-program be planned without the participation of the local inhabitants of the area in question.

Discussion, Conclusions, and Suggestions for further Comparative Research

There are many pitfalls and caveats involved when dealing with the relations between man and nature, in modern as well as in prehistoric time. Particularistic models for explaining change, such as those partly exemplified in this study, tend to concentrate on one issue, hence overlooking others of the same, or of greater, significance. Ideally the answers to questions such as "how does climate change affect human behavorial patterns?" always should address dynamics of the society-environment system. Humans strive to "pacify," rather than subject to, nature in their struggle for survival, and the challenges nature presents are met with a variety of coping stategies involving techno-economic inventions, socio-cultural stratifications and ideological patterns. Thus, a state of disequilibrium between population and resources seems to be the norm.[96]

Although the examples given in the preceding sections are fragmentary, and several questions about the intrinsic societal forces underpinning cultural change (i.e., forces existing even in the absence of external environmental change) have not been addressed, the examples offer a few indications about the importance of what might be called "cultural buffers" in societal response to change in external factors (such as climate) or semi-external factors (such change in soil fertility partly caused by society itself).

With respect to the paleolithic changes, one of the most noticeable facts was the extinction of the megafauna. Two main models of explanations have been proposed:

(1) human hunting – the "overkill" hypothesis (discussed above);
(2) climatic change.

According to Sallares, "the second explanation is preferable, because the correlation between climatic change and the extinctions is close, while the correlation between the spread of *Homo sapiens sapiens* and the extinctions is much weaker." [97] Sallares takes the mammoth as an illuminating example. As an animal that had prospered in remote, mostly depopulated areas in northern Siberia, the causes for its extinction cannot be blamed on human hunters. Rather, climatic change was probably the cause. The great grasslands of Euroasia, the "Artemisia steppe," gave way to perennial vegetation as the climate changed rapidly at the end of the last glaciation. The large herbivours depending on these grasslands quickly declined in number, with subsequent effects on the carnivors. The humans depending on the animals had to develop and refine gathering techniques, this being eventually conducive to independent farming. The decisive factor here was the changing climate and the invention of farming techniques thus forced upon the human populations. Hunter-gatherer societies, however, are still present in African bush districts, even though the hunting base for these people is fragile. It should be stressed that agriculture does not secure a life of leisure but rather requires hard and tedious labour, which is in contrast to the hunter/gath-

erer way of life. For the development of such techniques, need – not human curiosity – must have been a driving force. The simplest, and therefore the most obvious, explanation is that, in this case, climatic change closed all other possible channels for sustainability.

The case of paleolithicum might therefore support such models that stress shortage and/or population stresses as an impetus for technological achievements and cultural change.[98] Not surprisingly, it is generally along such lines – "necessity is the mother of invention" – that explanations for cultural change have been sought. However, well designed archaeological investigations, such as the University at Texas project discussed earlier, combined with pollen analyses, dendrochronology and studies of faunal variations, are clearly much needed to help provide more reliable bases for reconstructing past climate-vs-culture conditions. It is, above all, the shortage of adequate data that hampers a full understanding of the relations between man and his environment, as is evident from the section above that deals with the Bronze Age disturbances on agriculturally oriented societies.

Gumerman is rather critical of the idea of assigning climate change a decisive role in prehistoric cases of small-scale abandonments. In order to investigate the causes for any prehistoric desertion it is important to find out also *how* an area was abandoned:

> "The virtual absence of whole artifacts, including even the most common domestic finds suggests a nearby move to a known location. In other cases whole villages are left with all the appurtenances of daily life remaining, and in still other instances, much of the household inventory was destroyed before moving, suggesting different kinds of "abandonement" processes were operating."[99]

In reviewing the two cases of Bronze Age abandonments in the light of the above statement, it seems clear that the disturbances in mainland Greece between EH II and EH III did not put a complete end to an earlier life-style. The house of the Tiles in EH II Lerna, for instance, was buried in a thumulus with traces of sacrifices, as if the former inhabitants were subject to some ancestor cult.[100] Therefore, the former life-style seems to have been re-established once conditions became better, i.e., the abandonments did not imply a cultural dichotomy (rather, a mere interlude), ruling out invasion and related explanations. This fact, if seen in connection with the written evidences from Egypt, contemporary climate events in the Near and Middle East, and the succeeding fauna of species typical of a more arid climate, speaks in favour of a rather drastic climate change hitting the south-eastern Mediterranean at the end of the third millennium BC. There are indications that this climate change was combined with environmental degradation in Argolis, suggesting that a period of drought had a worse outcome in densely populated areas that to a high degree occupied marginal lands. The possible climate change cannot in itself have been large enough to have caused the extinction of a whole population in the district, since the former traditions survived to a certain extent.

With respect to the second Bronze Age disturbance in Greece, occurring at the end of the period, data are less scarce. This event seems to have been much more widespread (although this interpretation may well be due to the mere existence of more abundant data). Cultural turmoil is recorded from Peloponessos to the Cyclades, the Levant, Irak and Egypt during that period. But even in the Mycenaean case such decisive cultural factors as language, religion and

literature survived to posterity. Again, the most obvious explanation for the decline in this period is a collapse of central administrative power,[101] although the collapse may well have been induced by unfavourable climate conditions impeding faith in the ruling superstucture of the time.

Generally, one would expect that slow, gradual changes, such as during the Holocene period, would generate less radical change in the life styles of a human society than would sudden but shortlived change (involving, for instance, little-understood factors such as climate-related diseases and parasitic microorganisms turning from endemic to epidemic levels, and thus affecting domesticated monocultures of both plants and animals). However, the examples of climate change discussed above, indicate that the *magnitude* of the change is an additional, little understood, but perhaps overriding factor. The Bronze Age examples imply that certain cultural elements, mostly relating to the ideological and techno-economical (in this case agricultural) subsystems, are highly resilient and able to guarantee the survival of certain traditions and cultural behaviour, which re-appear in only slighly different shape once conditions eventually improve. For instance, whereas hunting/gathering techniques of the Neolithic period essentially were irreversibly abandoned, agriculture as a principle of sustenance withstood change, although refinements evolved. There may be limits to the rate of cultural adaptation, and these would define whether or not a specific rate of change in external factors (such as climate regimes) would be catastrophic; if the rate of external change could be coped with, refinements in existing cultural elements would result. For fundamentally new elements to evolve, one might speculate that external change would settle at an entirely new state where completely new niches would be required, lest the culture subject to the external change become extinct.

One should therefore distinguish between cultural capabilities to deal with *processes* of external change, and abilities to cope with a fundamentally new set up of external factors. As to coping with rates of external change, Gumerman *et al.* observe:

> "Our current awareness of the importance of cultural buffers is so pervasive that one scholar suggests that climatic factors have only an indirect influence on population movement."[102]

This line of reasoning leads us to the decisive factor of large-scale versus small-scale strategic solutions. Generally, an important lesson derived from the above is that changing climatic conditions are destructive to societies relying on one or just a few technological solutions to the sustainability problem. Modern western-oriented societies adopting monocultural communities of crops, for instance, may in this respect be classified as rigid structures, as opposed to "more primitive" societies, which built in safe-guards against failure by developing a wide spectrum of strategies and may, therefore, be classified as flexible structures. The Nabateans, the Touaregs, the Hopi, the Uttharkand, and other examples, suggest that the flexibility of human societies must be maintained: local, small-scale systems may well hold important keys to adequate response to large-scale change. Maintaining cultural diversity is likely to be the ultimate tool releasing the creativity of latent response pools.

Notes

[1] Morgan L., *Study in Aege* 1988.

[2] A brief c an extensive *Twilight of t* Jonsered, 19 in the coding ied in Botter (Eds.), *Man's terranean Lar*

[3] Plato, *Cr*

[4] Aristotle,

[5] Chisholi *An essay in L*

[6] See, e.g., *Culture Char* 1973.

[7] When ev pressed part o lier historical present in the area is a more ruled by a 'ma the Israelites? April, 1992, p ans into Greec *inthia, the Gy* XII. 1992.

[8] Gumerma *Environment'*, Seminar Series 13-24.

[9] Cf. the di and Demitrack historic Greece pp. 379-396.

[10] Cf. the di

[11] Cf. the di concept in Arc *osystem Appro Practice*, Ann A pp. 75 - 90, es

Notes

[1] Morgan L., *The Miniature Wall Paintings of Thera. A Study in Aegean Culture and Iconography*, Cambridge, 1988.

[2] A brief discussion of these questions together with an extensive bibliography is found in Forsén J., *The Twilight of the Early Helladics*, Paul Åströms Förlag, Jonsered, 1992, pp.241-247. The difficulties involved in the coding of percentage pollen diagrams can be studied in Bottema S., Entjes-Nieborg G. & van Zeist W. (Eds.), *Man's Role in the Shaping of the Eastern Mediterranean Landscape*. A.A. Balkema, Rotterdam 1990.

[3] Plato, *Critias*.

[4] Aristotle, *Metereologica*.

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[14] In his influential work of 1936, *Man Makes Himself*, Gordon Childe introduced the concept of a "neolithic revolution". The development of scientific dating methods and their indication of a more gradual change have – successively – deprived the word "revolution" of its accuracy.

[15] The period under discussion is treated here as if composed of a homogeneous population. This is not the case and is one of the outspoken difficulties when dealing with these questions. The Ice-age cave-paintings, for example, are typical mainly of the Western parts of the Mediterranean, for Spain and France.

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