The Pendulum of Paradigms

"But where shall wisdom be found? And where is the place of understanding?"

(Job 28:12)

In the year 1909, Yale University geologist and geographer Ellsworth Huntington was granted a leave of absence and funds to tour Palestine and its neighboring countries. Huntington was not a stranger to Asia; within the previous ten years he had investigated the flood patterns of the upper Euphrates in eastern Turkey, traveled with a research team to regions of present-day Uzbekistan and Turkmenistan in Central Asia, and toured the Sinkiang province of Western China.

At that time, the Near East was part of the by then tottering Ottoman Empire. Turkish governors still ruled the main urban centers, but the rural areas were controlled by local *sheikhs* frequently engaged in petty warfare among them. The nomadic bedouin eked out a meager living by their traditional practices of herding sheep, goats and camels, exacting tribute from passing caravans and, from time to time, raiding their neighbors, both nomadic and sedentary. Travelers to the more remote areas of certain regions thus had to secure protection from the bedouin, usually at the cost of a hefty *bakhsheesh*.

Upon arriving in Palestine, Huntington embarked upon a risky journey into the Negev Desert far to the south and also visited the eastern regions bordering the desert of Transjordan and southern Syria. The ruins of Petra, Ruhaiba, 'Auja el-Hafir (Nessana-Nezzana-Nizanna), Palmyra and Jerash greatly impressed him, and he concluded that only a profound change in climate could account for the large-scale desertion of these once-flourishing cities. He concluded:

> *Extensive travels in Asia Minor, Persia, India and central Asia led the author to adopt certain theories as to changes of climate and their relation to history. Descriptions of Palestine suggested that the same changes of climate have taken place there. Hence it seemed that in no other country could the theories be so well tested; for not only is Palestine so situated that climatic variations would there produce notable variations in habitability, but also its known history extends back to remote antiquity.*[1]

[1] E. Huntington, *Palestine and its Transformation* (New York, Houghton Mifflin Company, 1911).

Huntington compiled his observations from Central Asia, including changes in caravan routes, levels of the Caspian Sea and of the Nile and other rivers and so forth, and correlated them with the rise and fall of ancient Near East civilizations. He added to his own observations those of scholars and educated travelers to many different countries and concluded that all the historical transformations of the time were consequences of global climate changes. He sought to explain these changes in the cyclical pulses of solar activity and claimed that changes in the physical environment affected the quality of life and nature of man and, therefore, human history.

Huntington used these conclusions to support his "deterministic" paradigm, which held that the physical geographic conditions of the earth's regions mold the spiritual and physical character of the peoples in those regions. In *Mainsprings of Civilization,* Huntington states:

> *"Our first conclusion is that we live in the midst of an intricate series of cycles, some of which are closely associated with atmospheric differences. How far atmospheric electricity and ozone are causes or merely concomitants of the cycles in business and in the reproduction of animals we do not know, but clearly the field for further study is wide and alluring.*
>
> *Long cycles as well as short cycles have engaged our attention for quite a while. During the present century the evidence of cycles with a length of hundreds of years has gradually become clearer. One of their chief characteristics is variation in the number and intensity of ordinary cyclonic storms. This opens the way to a study of specific periods such as the Golden Age of Greece, the Dark Ages in Ireland, and Revival of Learning in Western Europe. These give an idea of the way in which climatic cycles appear to have influenced the activity of the human mind as well as the vigor of the body, the production of food, and the capacity of a region to support people."*[2]

Huntington's Deterministic School, as it became known, was widely accepted from the beginning of the twentieth century until the start of World War II. The Belgian mathematician, statistician, and astronomer Lambert Adolphe Jacques Quételet (1796–1874) laid some of the earliest foundations of this school of mind by introducing the application of statistical methods in biology, anthropology, and social studies. Quételet claimed that, using statistical methods, one could distinguish the "average human being" (*homme moyen*) in different societies living in environments with similar characteristics and concluded that the physical environment shaped the average "profile" of its inhabitants, including their moral code.

Quételet's theory was adopted by the British history-philosopher Henry Thomas Buckle (1821–1862), who suggested that the general laws of history include physical laws, such as climate, soil type, etc., which decide the character and moral code of human society. The German geographer Friedrich Ratzel further developed these ideas in a series of books and articles he published between 1885 and 1904 on the influence of the natural environment on man

[2] Ibid. *Mainsprings of Civilization* (New York, Arno Press, 1972).

and society. Unfortunately, one of Ratzel's terms "*Der Lebensraum*", which he used as the title for a book published in 1904, was perverted by German Nazi ideologists to justify their conquest of neighboring lands. Ratzel himself never justified conquest and expansion based on racist ideology.

In time, the geographic deterministic school joined forces with that of the Darwinian evolutionists who maintained that the natural environment influences the character of societies through the process of mutation and selection, favoring the best adapted and, therefore, fittest mutant. Applied to human society, this theory maintained that over the millennia, through selection and survival of the fittest, environments with harsh living conditions produce people better able to cope with hostile circumstances.

In the late 1930s, for various reasons, the deterministic paradigm lost credibility among geographers. For one, misuse of the school's scientific conclusions and terminology (racial characteristics, *Lebensraum*, etc.) by Nazi ideologists prior to World War II fostered contempt of this worldview and its terminology.

Second, several world-renowned archaeologists began to assign much greater importance to human factors and less to forces of nature as the major determinant of the fate of societies and countries. Among them was Sir Flinders Petrie, professor of Egyptology at the University of London and one of the fathers of modern archaeology, who carried out many excavations in Egypt and southern Palestine in the first half of the twentieth century.

Sir Leonard Woolley, the famous explorer and archaeologist who discovered the city of Ur in Sumer, also favored anthropogenic causes of change. In the years before World War I, C.L. Woolley and T.E. Lawrence (known to many as "Lawrence of Arabia") collaborated in surveying the deserts of the Sinai Peninsula and the Negev. Summarizing their findings in *The Wilderness of Zin*,[3] the two dispute Huntington's conclusions about desertion of the cities in this region.

The eminent American archaeologist W.F. Albright, who conducted excavations at numerous sites in the Levant, also denounced Huntington's theories and wrote in *The Archaeology of Palestine*:

> *"In his famous book, Palestine and Its Transformation (1912), the late Ellsworth Huntington explained most of the historical vicissitudes of Palestine in accordance with his hypothesis of cyclic oscillations of climate and rainfall. By an uncritical combination of data from literary sources with a superficial study of archaeological remains, then inadequately understood even by professional archaeologists, he concluded that there had been a series of drastic shifts in the water supply of the land since the second millennium B.C. Systematic archaeological research has proved that all his deductions were wrong. . . On many such erroneous inferences Huntington built up an elaborate superstructure of historical interpretation."*[4]

The American archaeologist, N. Glueck, who conducted an extensive survey of Transjordan and the Negev, agrees with Albright. In his book *Rivers in the*

[3] C.L. Woolley and T.E. Lawrence, *The Wilderness of Zin*, new ed. (London, Jonathan Cape, 1936).

[4] W.F. Albright, *The Archaeology of Palestine* (Hardmondsworth, Penguin Books, 1949) 251.

Desert he writes:

> *"The conclusion seems inescapable, wherever it has been possible to check, that the major factors affecting the course of human history certainly in the Near East, and probably elsewhere, during the last ten thousand years, are those over which in general there is a large measure of human control."*[5]

Another American, soil scientist and agricultural engineer W.C. Lowdermilk, also helped undermine the deterministic paradigm and establish the axiom "blame the human". Working in China after World War I to help the Chinese fight drought and famine, Lowdermilk concluded that man is responsible for catastrophic soil erosion and economic disasters. He preached his "eleventh commandment" against the sin of causing land wastage from erosion due to improper methods of soil tilling and recommended soil conservation to counter the severe erosion in many areas in the United States that resulted from improper tilling and irrigation. He attributed the decline of the agricultural societies of the Near East to invasion and conquest by Arabs – desert people who lacked knowledge of soil and water management.[6]

The anthropogenic argument was strengthened by the environmental and socio-economical catastrophe taking place in the Great Plains of the United States extending over parts of Colorado, Kansas, Texas, Oklahoma and New Mexico. The region was labeled "Dust Bowl" in the 1930s, when strong winds carried off the topsoil in heavy dust storms that blocked the sun and occasionally swept across the entire country to the east coast. At the time, agronomists and soil scientists blamed the devastation on the farmers' agricultural practices, giving little weight to the severe drought that has triggered the process, beginning in 1931 and lasting for seven years. The drought and the soil erosion caused by the windstorms destroyed the agricultural economy of the region, forcing thousands of bankrupt families to abandon their farms.[7]

The Israeli ecologist M. Evenari and his collaborators, water engineer L. Shenan and plant ecologist N. Tadmor, having for many years studied the ecology of the Negev and the irrigation methods of its ancient inhabitants, blamed the invading desert people for the desertion of the region's cities and agriculture.[8]

Palestine's Jewish population strongly backed anthropogenic causes of desertification, as it seemingly supported Zionist ideology. Archaeological evidence indicated that the area was densely populated and, therefore, enjoyed prosperity and a flourishing agriculture during the second half of the first millennium B.C.E. when Judaea was first an independent Jewish state and later under Roman occupation. If desertification was the result of Arab conquest and subsequent centuries of neglect, then human enterprise could correct the

[5] N. Glueck, *Rivers in the Desert* (New York, Norton & Co., 1968) 12.

[6] W.C. Lowdermilk, *Palestine, Land of Promise* (London, Golancz, 1946) 155.

[7] D.E. Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York, Oxford University Press, 1982).

[8] M. Evenari, L. Shannan, and N. Tadmor, *The Negev: the Challenge of a Desert* (Cambridge, Harvard University Press, 1971).

damages to the environment and make the land habitable for millions of Jewish refugees and immigrants.[9] Indeed, the entry on Huntington in the 1960 edition of the *Encyclopaedia Hebraica* states that

> *"Contrary to Huntington's suggestions, the present accepted opinion is that there is no proof of the occurrence of remarkable climate changes during the period of history. The level of the lakes in Palestine and Syria did not go down while years of severe droughts are known from ancient periods prior to the drying up of the Levant."*[10]

New data on climate change and its impact on European history began to be published in the early 1970s, challenging the consensus that a stable climate prevailed in past historical periods and that human activity was the cause of environmental deterioration. The British archaeologist R. Carpenter argued that the extreme historical transformations in Greece were due to climate changes.[11] In France, the historical-geographers such as F. Braudel, Le Roy Laudrie and others in the school associated with *Annales* developed similar ideas.[12] In Britain, the climatologist H.H. Lamb led the school that began to investigate the relationship between climate change and history. He demonstrated the effects of climate change on Europe's environment and history and presented ample evidence to support the occurrence of the "Little Ice Age" between the mid-16th and mid-19th centuries of the Common Era (C.E.). Other investigations supported his conclusions.[13]

In the Near East, the geographer D. Amiran interpreted the archaeological findings at Tell Arad and suggested that this city flourished prior to the 27th century B.C.E. i.e. during the Early Bronze Age, due to a more humid climate, which changed later. Also the archaeologist H. Ritter-Kaplan suggested in 1974 that a severe climate change in the 3rd millennium B.C.E. negatively impacted settlements in the region. A few years later H. Weiss presented his view that the decline of the Late Bronze Age civilization in the Near East was the result of climatic change. Subsequently, the climatologist J. Neumann as well as the archaeologist R. Amiran presented observations to correlate climate changes and historical events.[14]

From the late 1980's through the 1990's, the role of climate change on major transitions in human history gained increasing recognition. This change in

[9] I. Troen, "Calculating the "Economic Absorbtive Capacity" of Palestine: A Study of the Political Uses of Scientific Research" *Contemporary Jewry* 10 No. 2 (1989) 19–38.

[10] *Encyclopaedia Hebraica* (Jerusalem, Encyclopaedia Pub. Co., 1960) Vol. 14: 816. (Hebrew).

[11] R. Carpenter, *Discontinuity in Greek Civilization* (Cambridge, Cambridge University Press, 1966).

[12] N. Brown, "Approaching the Medieval Optimum, 212 to 1000 A.D." in *Water, Environment and Society in Times of Climate Change*, eds. A. Issar and N. Brown (Dordrecht, Kluwer Academic Publishers, 1998) 69–97. E. Le Roy Laudrie, *Times of Feast Times of Famine, A History of Climate Since the Year 1000* (New York, Doubleday, 1971).

[13] H.H. Lamb, *Climate History and the Modern World* (London, Methuen, 1982). Idem. *Climate: Present, Past and Future* (1977). (paperback edition, *Climatic History and the Future* Princeton University Press, 1985).
M.L. Parry, *Climatic Change, Agriculture and Settlement* (Folkstone, Dawson, Archon Books, 1978).

[14] D.H.K. Amiran, "The Climate of the Ancient Near East: The Early Third millennium B.C. in the Northern Negev of Israel" *Erdkunde* 45, 3 (1991) 153–167.

perspective was influenced in part by studies of the impact on the Sahelian droughts between 1968 and 1984, which showed that the anthropogenic contribution to desertification of the region was clearly secondary to that of the climatic conditions. Furthermore, paleo-environmental research prompted by studies of the greenhouse effect and by the development of objective research tools, such as environmental isotopes (oxygen 18, deuterium, carbon 13 etc., see Glossary), helped to draw attention to the decisive impact of climate change on the natural as well as the human environment. Analyses of the chemical and isotopic composition of ice cores from both Greenland and Antarctica provided the first objective data on climate changes in the last millennia, which could be correlated with historical events.[15]

In Syria's Tell Leilan region, T.J. Wilkinson of the University of Chicago's Oriental Institute studied the vulnerability to climate change of an agricultural system along the margin of a desert. He based his study on the relationship of present-day land-use to the environment. Projecting the output of his contemporary modeling on the past he concluded that:

> *"Bronze Age settlement and land-use systems of upper Mesopotamia were brittle systems and were therefore vulnerable to collapse. Under conditions of maximum production it is likely that even a short-term dry period may have resulted in collapse but certainly a significant run of dry years would have resulted in considerable production deficits which in turn could precipitate collapse."*[16]

H. Ritter-Kaplan, "The Crisis of the Dryness in the 3rd Millennium B.C.E. and Its Applications According to Excavations in Tel-Aviv Exhibition Garden" in *The Land of Israel, Braver Book,* 17 (1974), 333–338. (Hebrew)

H. Weiss, "The Decline of Late Bronze Age Civilization as a Possible Response to Climatic Change" *Climatic Change* 4 (1982) 173–198.

Idem, M.A. Coutry, W. Wetterstrom, F. Guichaard, L. Senior, R. Meadow and A. Curnow, "The Genesis and Collapse of Third Millennium North Mesopotamian Civilization" *Science* 261 (1993) 995–1004.

J. Neumann and S. Parpola, "Climatic Change and the Eleventh-Tenth Century Eclipse of Assyria and Babylonia" *Journal of Near Eastern Studies* 46 (1987) 161–182.

Idem. and R.M. Sigrit, "Harvest Dates in Ancient Mesopotamia as Possible Indicators of Climatic Variations" *Climatic Change* 1 (1978) 239–252.

R. Amiran, "The Fall of the Early Bronze Age II City of Arad," *IEJ* 36 (1986) 74–76.

[15] W. Dansgaard, S.J. Johnsen, H.B. Clausen, and C.C. Langway, "Climatic Record Revealed by the Camp Century Ice Cores" in *The Late Cenozoic Glacial Ages*, ed. K.K. Turekian (New Haven, Yale University Press, 1971) 37–56.

Idem. , S.J. Johnsen, D. Clausen, N. Dahl-Jensen, C.U. Gundstrep, H. Hammer, and H. Oeschger, "North Atlantic Oscillations Revealed by Deep Greenland Ice Cores" in *Climate Processes and Climate Sensitivity,* eds. J.E. Hansen and T. Takahashi, (Washington D.C., American Geophysical Union, 1984) 288–298.

Idem., S.J. Johnsen, N. Reeh, N. Gundstrep, H.B. Clausen, and C.U. Hammer,"Climatic changes, Norsemen and Modern Man" *Nature* 255 (1975) 24–28.

[16] J.T. Wilkinson, "Environmental Fluctuations, Agricultural Production and Collapse: A View from Bronze Age Upper Mesopotamia" in *Third Millennium B.C. Climatic Change and Old World Collapse*. G. Dalfes, G. Kukla and H. Weiss, eds. (NATO ASI Series, Sub series I Global Environmental Change, 1997) 67–106.

The significance of the "resiliency" and "brittleness" of the agricultural systems on which ancient society almost entirely depended is apparent from this study. It proved to be particularly important in the volatile belt between the sown land and the desert where agricultural settlements spread during wetter periods and declined during drier ones. Wilkinson points out the importance of negative feedback effects on driving collapse in the peripheral regions – for example, continuous cultivation downgrades the soil's fertility and structure, which in turn fosters wind and water erosion. He notes that although such processes could have resulted from the natural increase in population, a drastic change of climate would heighten the vulnerability of human societies as well as of the natural system.

The Tell Leilan excavations provided additional evidence for the role of climate change in the collapse of the Mesopotamian civilization towards the end of the third millennium B.C.E. and resulted in a special NATO workshop on this issue.[17] Other meetings followed the workshop where representatives of various disciplines presented evidence from other regions, all showing a trend towards a more climate-oriented paradigm.[18]

Zohar gathered evidence from a different angle. For more than twenty years he studied the ethnography of the transhumants and pastoral nomads of the Old World and their interaction and effect on the agrarian and urban cultures of the Fertile Crescent.[19] Their influence was most apparent in the so-called 'intermediate' or 'transitional' periods, often called "Dark Ages", intervals between the times of flourishing of urban civilizations in the ancient Near East. The very fact that civilizations rose and fell in a rhythmic pattern around every thousand years or slightly more suggests that factors far beyond the scope of human influence were at work.

Similar developments in contemporaneous cultures in neighboring, as well as more distant, parts of the globe could be explained only by climate change. The impact of shepherd tribes on their sedentary neighbors – considered so important by the earlier archaeologists – had to be reevaluated. Pastoral nomadic way of life was certainly one of the most important and basic socioeconomic components in the culture and history of ancient Near Eastern societies, but not as it was traditionally perceived.

The introduction of large herds of domesticated livestock by the nomads – particularly the black goats which are crucial to nomads for clothing, tents, rugs, and, in fact, their very survival – was, indeed, very detrimental to the vegetation, and thus, to the farmers. Furthermore, by burning the native bush

[17] G. Dalfes, G. Kukla and H. Weiss, eds.,. *Third Millennium B.C. Climatic Change and Old World Collapse* (NATO ASI Series, Sub series I Global Environmental Change, 1997).

[18] A.N. Angelakis and A. Issar, eds., *Diachronic Climatic Impacts on Water Resources*, NATO ASI Series, (Berlin, Springer Verlag. 1996) Vol. 36.
A.S. Issar and N. Brown, eds., *Water, Environment and Society in Times of Climate Change* (Dordrecht, Kluwer Academic Publishers) 1998.
M. Yoshino, M. Domros, A. Dougueedroit, J. Paszynski and L.C. Nkemdirim, eds., *Climates and Societies – A Climatological Perspective* (Dordrecht, Kluwer Academic Publishers, 1997).

[19] M. Zohar, *Early Transition Periods in the Archaeology of Syria-Palestine*. unpublished Ph.D. thesis, (The Hebrew University Jerusalem 1993).

and tree vegetation in order to promote the growth of fresh fodder, the nomads destroyed the natural plant cover in the most arid and sensitive landscapes (and continue to do so). Therefore, to Wilkinson's point that continuous cultivation exacerbated soil erosion, Zohar would add the deleterious effect of herds grazing on the stubble of fields – normally seen as a vision of pastoral tranquility that can be seen all over the area of the Fertile Crescent towards the end of a rainless summer. Although the herd's droppings fertilize the fields a bit, their trampling turns the dry soil to dust, carried away by the strong winds of autumn and winter (any bargain between the shepherd and the farmer apparently has always been at the expense of the latter). Still, all the damages inflicted by the animals and their owners are only aggravating factors in a chain of events whose ultimate cause is climate change itself.

The emerging "neo-deterministic" paradigm incorporates a variety of factors that may be considered in measuring the impact of a historical climate change on the natural and human systems. This framework views man and nature as interacting components of one system at a certain locus on space-time-information coordinates. The space coordinate defines the geographical zone; the time coordinate refers to the historical period; and the information coordinate describes the general anthropological character of the society – that is, the cultural and genetic level a society has reached as a result of co-evolutionary processes.

W.H. Durham describes these processes in detail. In his view of the evolution of human society, two information systems – genetic and cultural – characterize and differentiate societies. The genetic characteristics of human society are determined through Darwinian selection and adaptation to the environment; the cultural characteristics are derived from traditions passed from generation to generation through behavioral and verbal codes. It is important to stress that the two processes of evolution are complementary.[20]

The present authors also believe that the survival of human societies in problematic regions and during periods of stress requires special emphasis on the faculty of creativity and invention, which in itself probably derives from co-evolutionary processes. Creativity can also be defined as the level of intelligence achieved by the majority of population. Intelligence, as distinguished from instinct, is the ability to develop a novel way of reacting when an entirely new situation comes up.[21] It can be variously manifested – for example, by a technical innovation, such as a new method to assure a steady supply of water in time of drought or to adopt a new crop in times of famine; or by a new military strategy, such as an offensive or defensive tactic against an invader.

The resiliency of the natural system in an arid zone largely depends on its physical properties for storing and delivering water. These can be present in surface water, subsurface water (groundwater), or a combination of the two. The storage capacity of rivers and lakes often depends on the storage of local groundwater, which overflows as springs to become rivers and lakes. In some

[20] W.H. Durham, *Coevolution, Genes, Culture and Human Society* (Stanford, Stanford University Press, 1992).

[21] A Bitterman, "The Evolution of Intelligence" *Scientific American* (January 1965), 92–94.

cases, the storage capacity of a surface water system depends on the amount of precipitation in remote parts of the drainage basin.

Thus, for example, the extensive drainage basin of the Nile, fed by rains falling in the tropical and sub-tropical zones has a high storage capacity which is further augmented by the enormous swamps of the Sudd in the southern Sudan. In contrast, the flow of the Euphrates and Tigris is regulated by the storage capacity of the limestone aquifers of the Taurus and Zagros Mountains. This storage capacity of aquifers feeding springs that give rise to rivers or lakes depends on the permeability and storage coefficients of the water-bearing rocks as well as on the geological structure – i.e. the topographical and geographical distribution of the water-bearing strata.[22] For instance, the ancient settlement of Jericho was able to withstand many climate changes because its supply of water for irrigation derives from a spring fed by a limestone aquifer drawing from a large area of the eastern Judaean hills. Localities near such springs often maintain their ancient names for millennia, attesting to the permanency of the habitation despite many population changes.

In general, the ability of a society to withstand the impact of climate change and its consequences depends on the totality of the resiliencies of its subsystems, both societal and natural. Yet, the magnitude of the impact, its duration, and the accumulation of secondary damages also play decisive roles.

This book will discuss the major climate changes that affected the Near East over the last ten thousand years, as determined by time series of proxy-data. The response of the societies to these changes will be investigated through an examination of their cultural and socioeconomic structures as well as the characteristics of the supporting natural system. We will not exonerate the human race entirely from its grave sins against its environment and the natural world. We do not claim that a few years of crop failures toppled any society. However, we shall demonstrate that major changes in civilizations did, indeed, coincide with major changes in the global climate. It goes without saying that we do not assume that every climate change automatically entailed a cultural and historical change. Common sense, however, allows but little doubt that extreme climate changes influenced the welfare of pre-industrial agrarian civilizations, especially in a semiarid region

In its very general aspects, the swing of the pendulum of paradigms from its deterministic peak in the first decades of the twentieth century to the opposite peak of anthropogenic disposition in the mid-twentieth century, and the beginning of a neo-deterministic trend corresponds with the process suggested by Kuhn.[23] In a nutshell, this process says that scientists think and build their theories within the general framework of the prevailing "truths" in their society. Also, the reluctance of most contemporary archaeologists, historians and geographers to accept conclusions based on new data with re-

[22] The reader who is interested in more details regarding water resources in arid regions is referred to: D.N. Lerner, A. Issar, and I. Simmers, *Groundwater Recharge: a Guide to Understanding and Estimating Natural Recharge* (Hannover, Verlag Heinz Heise, 1990).
A.S. Issar and S.D. Resnick, eds. *Runoff, Infiltration and Subsurface Flow of Water in Arid and Semi-Arid Regions* (Dordrecht, Kluwer Academic Publishers, 1996).

[23] T. Kuhn, *The Structure of Scientific Revolution* (Chicago, Chicago University Press, 1970).

gard to the involvement of climate fits well with Kuhn's model. Yet, in this special case, there is an additional aspect, which has to do with Snow's conclusion about the schism between "the two cultures," i.e. the physical-natural sciences versus the humanistic sciences.[24] This schism was illustrated by the divorce between the scientist familiar with the global importance of the second law of thermodynamics and the Shakespearean scholar versed in interpreting Hamlet. Regarding archaeological research, classical archaeology, as a branch of the science of history and linguistics, belongs to the humanities. On the other hand, most of the paleo time-series proxy data is based on investigations in the physical (mainly environmental isotopes), geological (mainly sedimentological) and biosciences (mainly pollen and dendro-chronology). The evolution of the world of sciences does not promise closure of the breach between the two intellectual cultures, as the general trend is towards further reductionism and increasing expertise in narrow fields of specialization. Thus, a future divergence within and between the two cultures seems inevitable.

Investigation of the reasons for the swing of the pendulum reveals that the instrument enforcing the "Kuhn's model" transformation from one paradigm to the other was the development of specialization in the sciences. On the one hand, this brought further specialization, but on the other hand, specialists who looked beyond the walls of their expertise could see other fields in which their special methods could be applied. It was up to these experts to open their minds to test new methods, and, if successful, apply them. Thus, the field of gravity enforcing the swing of the paradigm pendulum was the evolution of science, while the force of friction hindering this motion was the reluctance of scientists to introduce new methods not part of their expertise.

One example of this is the absence, until recently, in most scholarly works discussing the archaeology, history and geography of the Near East, of a correlation between the archaeological findings and the results of investigations of recent paleo-climates conducted by isotope experts (except for the use of ^{14}C dating), geologists and botanists. The change to the new paradigm, gaining ground slowly in the last three decades of the twentieth century, can be observed in the increasing appearance of interdisciplinary literature. This new approach began during the 1970's, with the increasing involvement of paleobotanists in environmental interpretations[25] (although in various reports the

[24] C.P. Snow, *The Two Cultures and a Second Look*. (New York, New American Library, 1963).

[25] S. Bottema, "Late Glacial in Eastern Mediterranean and the Near East" in *The Environmental History of the Near and Middle East Since the Last Ice Age* ed. W.C. Brice (London, Academic Press, 1978) 15–28.

A. Horowitz, "Palynology-climate and Distribution of Settlements in Israel" *Kadmoniot* 13, no. 3–4 (1980) 51–52. (Hebrew)

A. Leroi-Gourhan, "Diagrammes polliniques de sites archéologiques au Moyen-Orient" *Beihefte zum Tübinger Atlas des Vorderen Orients* W. Frey, H.P. Uerpmann, and A. Reihe, eds. (*Beiträge zur Umweltgeschichte des vorderen Orients*, Tübingen 1981) 121–133.

Idem and F. Darmon, "Analyses Palynologiques de Sites Archéologiques du Pléistocène Final dans la Vallée du Jourdain" *IJES* 36 (1987) 65–72.

W. Van Zeist and S. Bottema, "Vegetational History of the Eastern Mediterranean and the Near East During the Last 20,000 Years" in *Palaeoclimates, Palaeoenvironments and Human Communi-*

trend to put the blame on man rather than on climate still prevails[26]. The interdisciplinary approach is exemplified also by involvement of other humanistic sciences, such as anthropology, sociology, economics, etc. The widening of the interdisciplinary movement involves a closer interaction with the physical sciences, as exemplified by the symposium on the decline of the Early Bronze Civilization of northern Mesopotamia mentioned earlier.[27]

A recent example could be seen during an international conference, sponsored by the Center for Old World Archaeology and Art at Brown University, was held in May 1990.[28]

In his opening presentation of this very same conference, the historian W.W. Hallo from Yale University concluded that

> *"I thus reject all field theories that threaten to obscure the boundaries between natural history and human history . . . The traditional hypotheses for explaining the crisis of the 12th century B.C.E. are mostly concerned with natural disasters such as earthquakes, famine, or climatic change. But all these rest on the chance recording of what are basically perennial factors. The transition from Bronze Age to Iron Age should be seen rather in terms of human role".*[29]

In contrast, the present authors argue that the agricultural evolution was generated in principle by the warming and aridization of the Near East, with human societies reacting to survive these changes. Similarly, the urban revolution and flourish of the Early Bronze, the renewal of relative prosperity during the Middle Bronze and of the Iron Age were due primarily to the abundant precipitation that enabled the accumulation of resources by all levels societies. Decline came when these conditions worsened.

A similar case will be made here to draw the background of the natural environment – in particular, the role of climate change on the historical events discussed in the above mentioned conference. In agreement with the conference's keynote address, which aimed to "synthesize" and asked the participants *"to venture beyond the boundaries of their own specializations"*, the present authors recommend to trespass the boundary of the natural habitat in order to encompass the broadest spectrum of all potential causes, natural as well as anthropogenic.

To cross the boundaries and get a rather detailed picture about the natural habitat the time series of proxy data related to this period should be examined

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ties in Eastern Mediterranean Region in Later Prehistory (Oxford, British Archaeological Reports, International Series 133, 1982) 277–321.

[26] U. Baruch, "The Late Holocene Vegetational History of Lake Kinneret [Sea of Galilee], Israel" *Paléorient* 12, no. 2 (1986) 37–48.
N. Liphschitz and Y. Waisel, "The Effects of Human Activity on Composition of the Natural Vegetation During Historic Periods" *Le-Yaaran* 24 (1974) 9–15 (Hebrew), 27–30 (English abstract).

[27] Dalfes et al. eds., *Third Millennium B.C. Climatic Change.*

[28] W.A. Ward and M.S. Joukowsky, eds., *The Crisis Years: The 12th Century B.C. From Beyond the Danube to the Tigris* (Dubuque, Iowa, Kendall/Hunt Publishing Co.1992) 208.

[29] W.W. Hallo, "From Bronze Age to Iron Age in Western Asia: Defining the Problem" in *The Crisis Years*, 1–9.

in detail. Further progress, however, in this direction is still needed, and is constantly coming forth

The present work attempts to take an interdisciplinary approach in which the data from the fields of research of its authors (hydro-geology and archaeology) are interwoven to construct the environmental-cultural picture of the past. Simultaneous with this construction, they conducted a dialogue explaining their respective techniques, which helped each to arrive at certain similar or distinct conclusions. This approach will be followed in the ensuing chapters of this book, particularly in Chap. 2, where it will enable readers from the two different banks of the chasm separating between the "two cultures" to understand the different methodologies of the fields.