Arie S. Issar
Mattanyah Zohar
Climate Change – Environment and History of the Near East

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2nd Edition

With 34 Figures

Springer

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To Margalit and to Aviva
the same and even more!

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List of Abbreviations

ABD	The Anchor Bible Dictionary, ed. D.N. Friedman, 6 vols. New York, London, Toronto, Sydney, Auckland, Doubleday, 1992
AGU	American Geophysical Union
ANET	Ancient Near Eastern Texts Relating to the Old Testament, edited by James B. Pritchard, 3rd edition with supplement, (Princeton, N.J., Princeton University Press, 1969) abridged edition The Ancient Near East, An Anthology of Texts and Pictures (Princeton, N.J., Princeton University Press, 1958)
BAR	Biblical Archaeology Review
BASOR	Bulletin of the American School of Oriental Research
CAD	The Assyrian Dictionary of the Oriental Institute of the University of Chicago, 24 volumes, (incomplete), Chicago & Glueckstadt, starting 1964
COWA	Chronologies in Old World Archaeology, ed. Robert W. Ehrich, 3rd edition, 2 volumes, Chicago-London, The University of Chicago Press, 1992
GSA	Geological Society of America
GSI	Geological Survey of Israel
HUJI	Hebrew University Jerusalem Israel
IEJ	Israel Exploration Journal
IJES	Israel Journal of Earth Sciences
NEAEHL	The New Encyclopedia of Archaeological Excavations in the Holy Land, ed. E. Stern, 4 vols., Jerusalem, The Israel Exploration Society-Carta, 1993
OCA	The Oxford Companion to Archaeology, ed. Brian M. Fagan, New York-Oxford, 1996
Palaeo 3	Palaeogeography, Palaeoclimatology, Palaeoecology
PEQ	Palestine Exploration Quaterly

Copyright and Authors Acknowledgements

Figures 3, 3a, & 3b. M. Bar-Matthews, A. Ayalon and A. Kaufman, "Middle to Late Holocene (6500-Year Period) – Paleoclimate in the Eastern Mediterranean Region from Stable Isotopic Composition of Speleothems from Soreq Cave, Israel," in *Water, Environment and Society in Times of Climate Change*, eds. A. Issar and N. Brown (Dordrecht, Kluwer Academic Publishers, 1998).

A. Frumkin, M. Magaritz, I. Carmi and I. Zak, "The Holocene Climatic Record of the Salt Caves of Mount Sedom, Israel", *The Holocene* 1, no. 3 (1991) Journals-Department-Arnold.

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G. Lemcke and M. Sturm, "$\delta^{18}O$ and Trace Element as Proxy for the Reconstruction of Climate Changes at Lake Van (Turkey): Preliminary Results" *Third Millennium B.C. Climatic Change and Old World Collapse*. G. Dalfes, G. Kukla and H. Weiss, eds., (NATO ASI Series I: Global Environmental Change, Vol. 49. Berlin, Springer-Verlag, 1997)

R. Bookman (Ken-Tor), Y. Enzel, A. Agnon and M. Stein, "Late Holocene lake levels of the Dead Sea", Geological Society of America Bulletin v. 116 no. 5/6, (2004) p. 561

Figure 12. D.C. Kypris, 1996, "Cyclic Climatic Changes in Cyprus as Evidenced from Historic Documents and One Century's Rainfall Data," In A.N. Angelakis and A. Issar, eds. *Diachronic Climatic Impacts on Water Resources*, (NATO ASI Series I, Vol. 36, Berlin, Springer-Verlag. 1996).

Introduction

When the first edition of this book was published in 2004, the following year 2005 has happened to have been the warmest year since 1880, when the first reliable worldwide instrumental records came into existance. Claiming no linkage between the publication of our book and the temperature record, yet this record demonstrates the trend of increase in the global surface temperatures during the past 20 years, reinforced by evidence of rise of atmosphere's and oceans' temperatures, and increased melting of ice and snow in the arctic and antarctic regions as well as on mountain tops. All these observations are paralleled by the increase in the quantity of heat trapping gases in the atmosphere, causing most probably, the global greenhouse effect.

In order to try and predict, what might be the impact of this effect on the on the natural and human environments of the Near East, (Figs. 1–1d) the authors adopted the saying that the past is the key for the future. The practical conclusion of this principle says that the acquiring knowledge of the impact of past climate changes on the nature and human societies, may allow conclusions with regard to future possible impact of climate changes. By correlating proxy data of all types, paleo-sea and lake levels, paleo-hydrology, pollen profiles, environmental isotopes as well as archaeological and historical documents, the authors tried to collect as much as possible of this knowledge. The region investigated spans the Fertile Crescent in the wider sense which arcs from northeastern Africa and Egypt to Syria-Palestine and Mesopotamia, skirting the Anatolian, Iranian and Caucasian highlands. Since the so-called "Holy Land" has attracted western scholarly attention for nearly two centuries, and resulted in extensive and intensive historical and archaeological research, most data mentioned in the book were derived from this area. It is, therefore, natural that the historical documentation of the book reflects the uneven distribution of western research over the last two centuries with centers of gravity in the Levant, Egypt, and Mesopotamia.

The presentation of the archaeological and historical material follows a broad timetable beginning with the origin of mankind in Africa and its spread across the rest of the world, all seen as resulting from ever-changing climates and environments. Despite the fact that the archaeological evidence includes most of the major excavation sites of the Fertile Crescent, old and new, and often goes into detail, particularly in the formative years of the ancient civilizations in these areas, the principal aim was to convey an overall picture of cultural development of the entire region and clarify the importance of climate change

during the process. It goes without saying that it was not every climate change automatically entailed a cultural and historical change. However, there can be little doubt that extreme climate changes influenced the welfare of pre-industrial cultures and civilizations whose subsistence entirely dependents on agriculture and husbandry, especially in a semi-arid region.

The understanding of the role of climate change on major transitions in human history gained increasing recognition by the general public during the late 1980's and throughout the 1990's. Studies of the African droughts have shown that human activity was clearly of secondary importance to the desertification of the Sahel and the magnitude of the subsequent human suffering. Albeit there is little doubt that the impact of agriculture and pastoralism on the natural environment was, and still is, catastrophic, yet it is the negative climate change, which triggers the non-sustainable processes, such as the invasion of the sand dunes to the coastal plain of Palestine during the warm phase starting in the 7th century A.D.[1]

Concern about the possible impact of the Global Change on the world-wide hydrological cycle brought about this research in the framework of the International Hydrologic Program (IHP) UNESCO and WMO. The results of this work, which was on a global scale were reported by Issar in a previous book.[2] Its basic conclusions were that major climate changes occurred during the Holocene and that these changes had influenced the hydrological cycle in the different parts of the globe in different ways. In regions having a Mediterranean type climate, warm periods spelled dryness while cold periods were humid. The contrary was the rule in regions with "monsoon" type climates. In regions along the margins of climate belts these changes had a decisive impact on the history of the inhabitants, as the shift of the belts spelled either dryness thus desertification or abundant rains, which spelled lushness. This phenomenon was especially recognizable in the history of the Eastern Mediterranean region.

In parallel to the studies of Issar, Zohar was studying the ethnography of the transhumant and semi-nomadic pastoralists of the Old World and their interaction and effect on the agrarian and urban cultures of the Fertile Crescent. He found that these effects were most apparent in the so-called 'intermediate' or 'transitional' periods, sometimes called "Dark Ages", intervals between the times of flourishing of urban civilizations in the ancient Near East in a seemingly periodic pattern. Excavated sites with archaeological layers dated to this periods often show signs of increased violence, such as destruction layers. They are roughly contemporary in all parts of the region and beyond but with distinct characteristics and variable durations.[3]

The conformity between the conclusions of Issar and Zohar's investigations brought them to compile the first edition of the present book and in which

[1] A.S. Issar, *Geology of the Subterranean Water Horizons of the Shephela and of the Sharon Regions* Ph.D. thesis. Hebrew University, Jerusalem (1961, Hebrew with summary in English).

[2] A.S. Issar, *Climate Changes during the Holocene and their Impact on Hydrological Systems*, Cambridge University Press, Cambridge UK (2003).

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

the Neo-Deterministic Paradigm is presented. This paradigm argues that the principal cause for major developments and several decisive events of the Middle Eastern history were often accompanied by climate changes, while human intervention played a secondary role, attenuating or intensifying the effects of the natural impact. This conclusion seemingly rejuvenated the Deterministic Paradigm prominent at the beginning of the 20th century, which argued that climate change by itself could explain the birth, the flourishing and the demise of the ancient civilizations.[4] The modification of this paradigm by Issar and Zohar concern the role of the human ingenuity to invent devices and tools helping them to mitigate the impact of climate changes in the positive cases, while in the negative cases over-exploitation of natural resources in a non-sustainable way amplify the impact of the natural hazards leading to decline and collapse.

As could have been foreseen, the suggestion to swing back the pendulum of paradigms from that of blaming peoples for their misfortunes and putting the blame on climate changes was not acceped by most historians and archaeologists. Since the beginning of historical writings in antiquity, the humanities have considered the rise and decline of human societies as the outcome of acts of gods, God or men. The Enlightenment and the industrial revolution prepared the ground for a more realistic world view based on the natural sciences which engendered the Deterministic Paradigm of the 19th and early 20th century. The majority of archaeologists and historians then discarded the Deterministic Paradigm since the thirties of the 20th century and returned to the Anthropogenic Paradigm, according to which all blame was put on human society for its failures. One of the major faults was the human interference with natural processes thus causing environmental, economic, and political calamities.

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.

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.[5] 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 regard to the involvement of climate fits well with Kuhn's model. Yet, in this special case,

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

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

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.[6] 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 in our case 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 in most scholarly works about 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 recent change to the new paradigm, only slowly gaining ground 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 paleo-botanists in environmental interpretations[7] (although in various reports the trend to put the

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

[7] 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* W.C. Brice (ed.) Academic Press, London, pp. 15–28 (1978).

A. Horowitz, "Palynology-climate and Distribution of Settlements in Israel" *Qadmoniot* 13/3–4:51–52 (1980, 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 pp. 121–133 (1981).

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

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

blame on man rather than on climate still prevailed)[8]. 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 as well as books comprising of a number of inter-discplinary studies.[9]

In our case archaeologists, not to speak about historians educated in the faculties of humanities, the evidence of climate changes based on proxy data can be compared to discussing 'Schroedinger's cat paradox" in a seminar of theologians. An illustration to the Kuhn's and Snow's theories is the difference between the reviews on the 1st edition of this book. On the one hand by a senior archaeologist, who works for many years in the region and sticks to the old paradigm[10] and on the other a young pedologist who investigated soil profiles of the deserted city of Abila, one of the Decapolis sites in Jordan.[11]

Another 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.[12] In his opening presentation, the historian W.W. Hallo from Yale University concluded:

> *"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."*[13]

---

[8] U. Baruch, "The Late Holocene Vegetational History of Lake Kinneret [Sea of Galilee], Israel" *Paléorient* 12/2:37–48 (1986).
N. Liphschitz and Y. Waisel, "The Effects of Human Activity on Composition of the Natural Vegetation During Historic Periods" *Le-Yaaran* 24:9–15 (Hebrew), 27–30 (English abstract) (1974).
R. Rubin , "The Debate Over Climatic Changes in the Negev, Fourth – Seventh Centuries CE". *Palestine Exploration Quarterly* 121:71–78 (1989).
S.A. Rosen, "The Decline of Desert Agriculture: A View from the Classical Period Negev", *Symposium: Agriculture in Arid Environments: Archaeological Perspectives World Archaeological Congress 4* University of Cape Town (1999).

[9] 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).
H. Fischer, T. Kumke, G. Lohmann, G. Floser, H. Miller, H. von Storch and J.F.W. Negendank (eds.) *The climate in historical times: towards a synthesis of Holocene proxy data and climate models*. Springer, Berlin (2004).

[10] O. Bar-Yosef, "Issar & Zohar Book review" – *The Holocene* 15/6:933–934 (2005).

[11] B. Lucke, *Abila's Abandonment* M. S, Thesis BTU, Cottbus, Germany, Yarmuk University, Irbid (2002).

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

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

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 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.

The authors are convinced that the conservative negative attitude is slowly changing, mostly due to the ever increasing quantity and quality of scientific research of the earth's past, mainly by geologists, geochemists, botanists, climatologists etc. The data obtained by these investigations cannot be ignored and will force the traditionally opposing academic worldviews to accept the obvious: All human cultures and civilizations were, and still are, a product of their environment. In the temperate and the arid zone it was, above all, the availability of water, which had the most profound effect on the development of human societies.

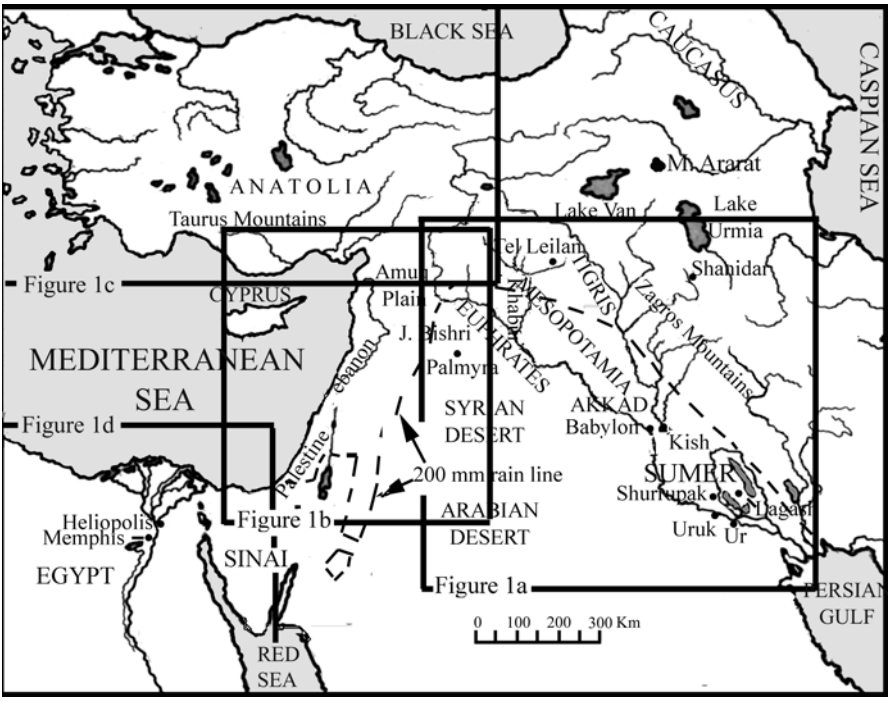


Fig. 1. General key map of the Near East

Fig. 1a. Mesopotamia

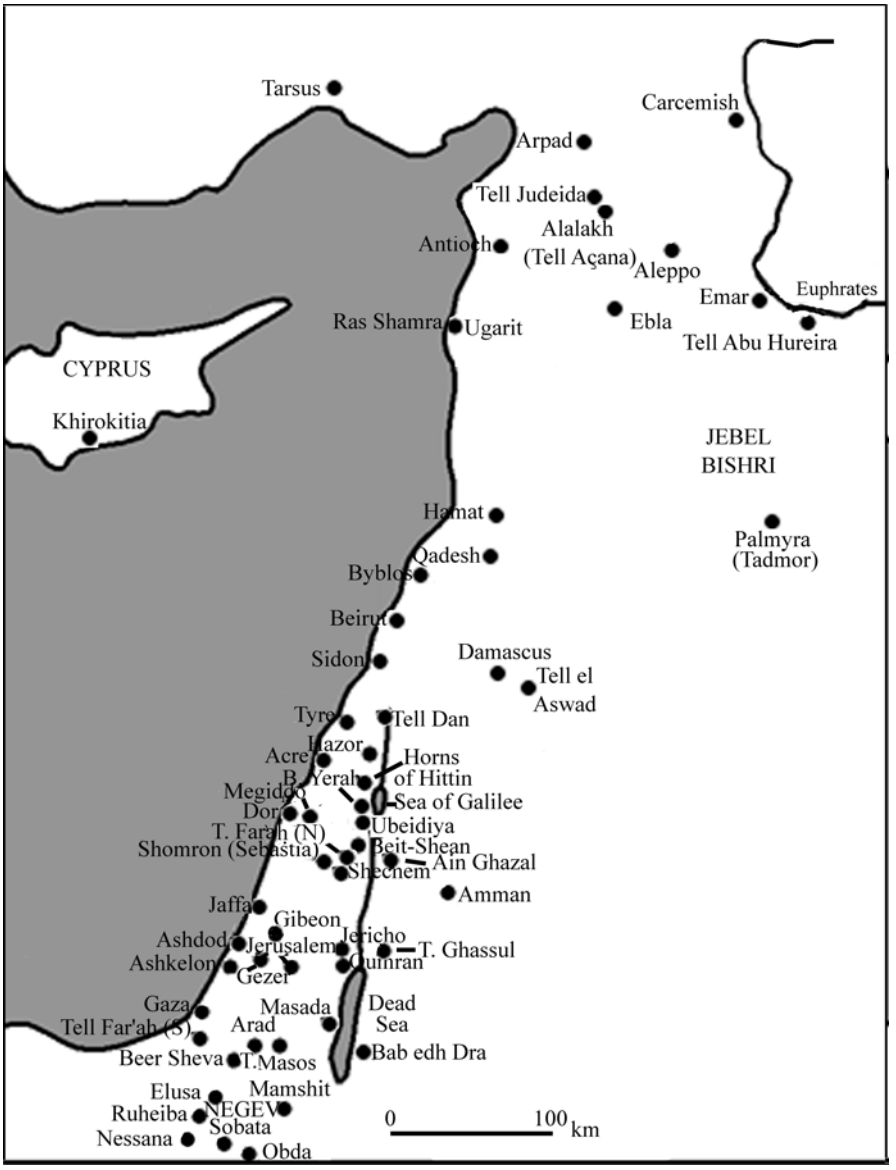


Fig. 1b. Levant

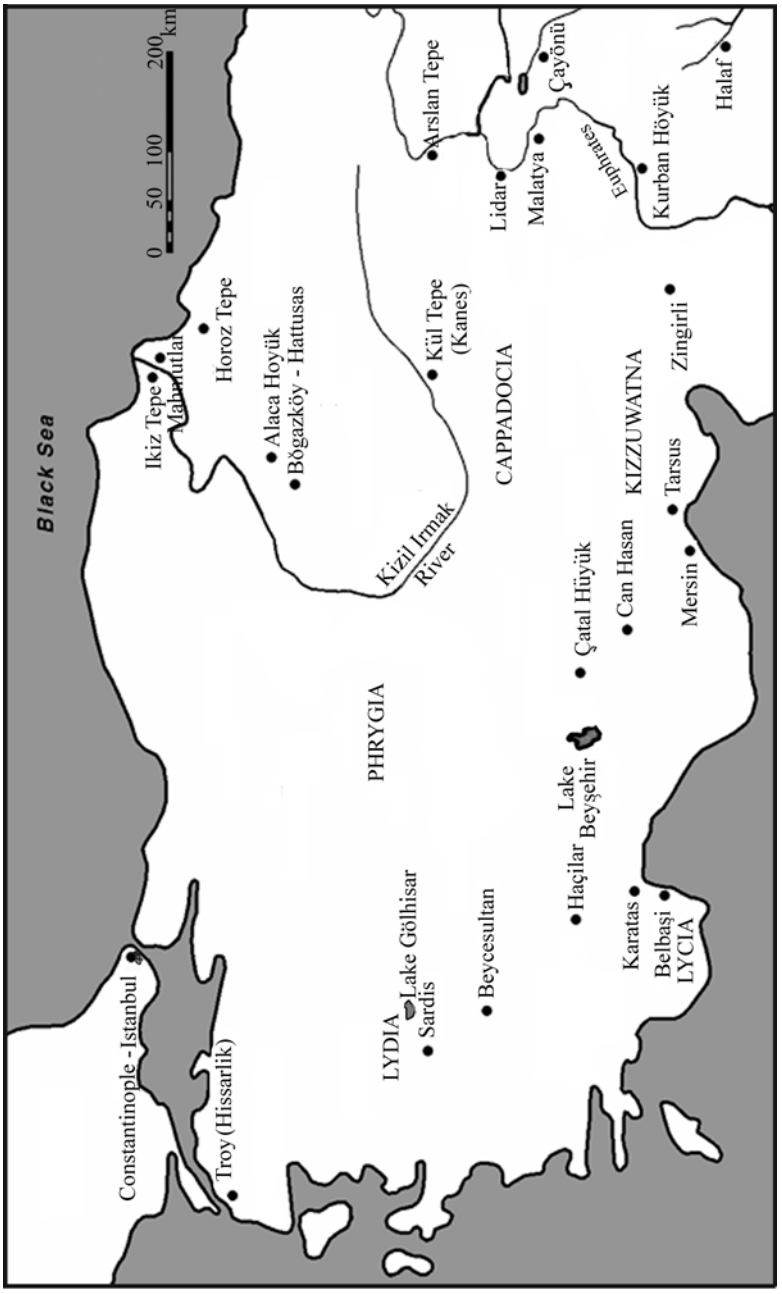
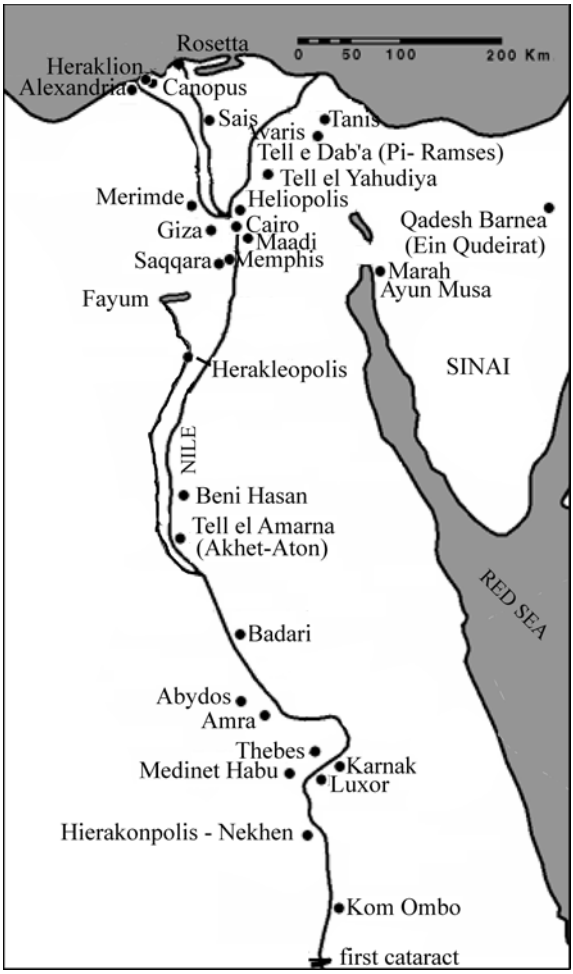


Fig. 1c. Anatolia

Fig. 1d. Egypt



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CHAPTER 1

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 *sheiks* 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 bedouins, usually at the cost of a hefty *baksheesh*.

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] Huntington op. cit.

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

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

published between 1885 and 1904 on the influence of the natural environment on man 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, 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]

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

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

The American archaeologist, N. Glueck, who conducted an extensive survey of Transjordan and the Negev, agrees with Albright. In his book *Rivers in the 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 botanist 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*, Norton & Co., New York (1968).

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

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

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

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[9] I. Troen, "Calculating the "Economic Absorbtive Capacity" of Palestine: A Study of the Political Uses of Scientific Research" *Contemporary Jewry* 10/2:19–38 (1989).

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

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

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

[13] H.H. Lamb, *Climate History and the Modern World*, Methuen, London (1982).
H.H. Lamb *Climate: Present, Past and Future*. Princeton University Press, (1985).
M.L. Parry, *Climatic Change, Agriculture and Settlement*, Archon Books, Folkstone, Dawson (1978).
S. Leroy, and D. Stewart conference on "Environmental Catastrophes and Recoveries in the Holocene", *Abstracts: Department of Geography & Earth Sciences*, Brunel University Uxbridge, UK (2002).

[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* 45/3:153–167 (1991).

Once the idea of impact of climate on the history of human society became acceptable and in the same time more data from the Mediterranean Region, archaeological as well as paleo-environmental, became available, more publications relating climate changes to history were published.[15] Although the present authors do not agree with all the conclusions arrived at in these publications, yet the fact that climate change is considered as a factor, which shoud not be overlooked, spells a "Kuhnian type" revolution.

In the same time, on the global scale, 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 Appendix II), 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. Although most of the data available concerns climate changes during the Pleistocene, some of the investigations concentrated on the Holocene and enabled a better understanding of the impact of climate changes during this period on human history. An important step was taken when the WMO and UNEP established the Intergovernmental Panel on Climate Change (IPCC). The task of this panel is to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.[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: 333–338 (1974, Hebrew).

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

H. Weiss, 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* 261:995–1004 (1993).

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

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

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

[15] N. Roberts, T. Stevenson B. Davis, R. Cheddadi, S. Brewster and A. Rosen, "Holocene climate, environment and cultural change in the circum-Mediterranean region". In: *Past Climate Variability through Europe and Africa*. R.W. Battarbee, F. Gasse and C.E. Stickley (eds.), Springer, Dordrecht, pp. 343–362 (2004).

A. Rosen, "Climate change, landscape, and shifting agricultural potential during the occupation of Tel Megiddo". In: *Megiddo IV*. I. Finkelstein, D. Ussishkin, and B. Halpern (eds.) Eisenbrauns. pp. 441–449 (2006).

A. Miller Rosen, *Civilizing Climate: The Social Impact of Climate Change in the Ancient Near East*. AltaMira Press (2006).

[16] 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*, K.K. Turekian (ed.), Yale University Press, New Haven, pp. 37–56 (1971).

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