

Beyond Zero Population: Ethnohistory, Archaeology and the Khmer, Climate Change and the Collapse of Civilizations

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Abstract

A number of publications, both books and articles, have appeared in recent years attempting to prove that there is a correlation between global climate change and the collapse of complex human societies and is one example where emphasis is placed on climate over human activity. This paper addresses a possible exception to this emphasis of global effects. While societies under stress from weather changes may undergo significant economic and political change in response, Joseph Tainter has shown that a local systems analysis is best applied to determine the contribution of the internal dynamics of a society, rather than assign climate the ultimate effect. In this paper ethnohistorical and archaeological sources are reviewed indicating varied responses to climate challenge. We find that some, like Khmer society, are initially sustainable responses to local conditions and an exception to the proposed global collapse theory. However, failure of surrounding populations created pressures on Khmer society that destabilized adaptations to environmental stress forcing collapse. Like the Bronze Age collapse in the Mediterranean, local accommodation was insufficient for continuation on existing patterns. Others like the Japanese modified population densities and social forms to weather stress. Implications for today concern continued population growth worldwide and rising consumption are continued stresses that must be considered in the context of climate change. Pre-Neolithic population densities and modern technology could be a means of adapting human society to the constraints of quality of life and diminishing returns of technology.

Keywords: Khmer history; Climate change; Civilization; Collapse; Sustainability; Resilience

Introduction

Climate change factors

The debate over contemporary factors and effects of climate change has created a search for evidence of climate change in the past and the effect of climate change on past civilizations [1,2]. Environmental determinism has had a long history even if one only begins with the comprehensive treatments by Ratzel. It was offered as a central agency in anthropology in America by Clark Wissler [3] and developed by some of his students and associates [4]. Other theoretical questions concerning specific regions were addressed by researchers in the post world war II period as in that by Schwartz [5]. More recent efforts have attempted to utilize modern techniques to assess social responses in a variety of regions and cultures [6]. Speculation from the archaeological record has been made in the recent past, the first thorough analysis by Bell [7]. At about the same time Frank [40] began a long series of works attempting to describe cycles of accumulation and dispersal of wealth driven by a number of factors including climate that still requires precise characterization. Both were preceded by Carpenter's [8] study of European civilizations and their responses to what he considered to be significant climate change in the past. Morato et al. [9] applied archaeological techniques to interpret patterns in California related human ecology, investigating cycles of weather still of use in understanding contemporary drought conditions.

Information in archaeological reports has often been collected and interpreted as products of general theoretical propositions [10]. Nevertheless, archaeological investigation can provide sources of interpretation on how people lived and responded to climate change in the past. Scientific interest in the relationship between human ecology and changing patterns of the distribution of plants and animals has a long history [11]. Determining specific patterns of exploitation and human agency has depended on the development of new techniques [12,13], yet often interpretation is problematic as in the identification

of carbon in strata and anthropogenic fire [14].

Reviews [15] of the Intergovernmental Panel on Climate Change (IPCC) report that climate change is "Very likely" due to human agency and Crowley [16] has shown that climate warming factors of pre anthropogenic decadal-scale are unlikely to explain present warming. The 5th Assessment Report (AR5) strongly reinforces this view. In March of 2013 two articles appeared demonstrating considerable support for this conclusion. One study tracked the spread of plant life into colder zones [17] and another reported on studies of ice and sediment cores to calculate temperatures in an unbroken record over the past 11,300 years [18].

Methods

Ethnohistory and climate science

The role of societal collapse based on environmental degradation and anthropogenic driven climate change in the past has been proposed by a number of books in the last four decades and a recent review [19] questioned the robust nature of these theories. Keeping in mind the paleoclimatological background [20] it seems obvious that human input to climate change has been considerable as population has increased and technological demands on carbon based fuels and especially non-renewable fossil fuels has dramatically accelerated. Yet an editorial in *Nature* [15] notes the field of research into climate

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change demonstrates some degree of uncertainty. Some uncertainty can be identified in the process of manufacturing models [16,21], while some results from how past climate in human ecological settings is interpreted. For example, William Ruddiman [22] has argued convincingly that human farming in the Neolithic produced significant greenhouse gases to affect the planet's climate. Not everyone agrees with this view, and Schmidt [23] has criticized some of Ruddiman's interpretations of the data. Williams [24] pictures a slightly different scenario, but consonant with Ruddiman's general scenario. Taylor et al. [25] have shown how a significant change in climate can take place in a relatively short period of time, Holocene – Yonger Dryas Transition – over a 40 year period in 5 year steps driven by not a single factor, e.g., volcanism, but rather on a number of coincident changes leading to atmospheric modifications in water vapor. Chandler [26] commented on how the reduction in solar radiation 115,000 years ago could not in itself be responsible for maintenance of year-round snow cover of the glacial period that followed, and suggested several contributing processes including tundra expansion.

Combination of environmental factors and climate change have likewise contributed to the collapse of human civilizations, especially where human activities have made societies, as Caldararo notes [13] less resilient and degraded the ecological resources, consistent with cycles of expansion and reduction of extent and complexity [3,27]. Tainter [28] argues a more complex combination of factors, but ultimately it is a systems theory where he sees complexity as expensive and inputs (“investments”) as having diminishing returns. All complex societies, therefore, in Tainter's view are limited systems fragile in that the diminishing returns are often offset by outside challenges that overwhelm the ability of the system to respond. In many ways this approach is reminiscent of Bell's [7]. However, as Sanders [29] has shown for the evolution of states in ancient central Mexico, many civilizations develop within ecological settings that provide substantial challenges for sustainable food production and yet, in a pattern of Toynbee's challenge and response hypothesis [30], the cultural foundations of the social structures that evolve are adapted to severe variations and can respond displaying substantial plasticity. We can see this in the ethnological literature as in Barth's [31] analysis of Iranian nomads where the Basseri are less able to adapt to pressures from the government than the Yomut and Komachi who were able to maintain social cohesion longer due to redistributive traditions the Basseri lacked.

The Khmer context

Some analysis of climate data, for example, Yancheva et al. [32] have produced a useful record of climatic change in East Asia but their claim that these changes were sufficient to cause civilizations to collapse is premature. What is contradictory to their argument is the history of the Khmer whose architecture, and empire rises before the onset of their identified dry periods and ends long after the last dry period terminates [33-35], from before 400 A.D with the appearance of the Funan kingdom. to the mid-15th century. In fact, Briggs [36] argues:

The Kamanbuja or Angkor Period extended from 802 to the capture of Angkor by the Siamese in 1431 and the definitive removal of the capital to the southeastern part of the kingdom in 1432. During all this period, the capital was at, or near, Angkor. This was the Classical Period of Cambodian history-the period of the far-flung empire, of the marvelous works of architecture and art, of the wonderful Sanskrit inscriptions.

But recent archaeological work has placed this view in question,

discounting the ethnohistorical record as associated with specific special interests of the states the writers were reporting for and privileged in their interpretations. A three part relationship is constructed from this new evidence creating an original state, Funan, a successor, Angkor and with its failure, a Khmer Empire [37].

This later Khmer empire's collapse is often attributed to disease (e.g., malaria) but a study by a Chinese diplomat/social scientist, Chou Ta-Kuan [38], in the 13th century reports on a society in orderly condition. Agriculture is observed to be continuing without special stress, social order is apparent and food stuffs are plenty. Other researchers than Yancheva, et al. cite the possibility of a failure of the irrigation system [1], but there is no evidence of this in the eye-witness reports of Chou Ta-kuan [38], Ma Tuan-lin [39] or of Arab and Indian merchants and visitors. This may give us an idea how people view significant changes and adapt to them as short term problems [68]. Complicating this is Stark's [37] argument that serious decline began after 1250 A.D. long before the climate event (Figure 1).

Ghosh [68] compared these reports and his conclusions parallel those of Higham [33] who decided that the decline may have been the result of a number of factors together weakening the state but that the final blow was the military threat from the Thai kingdoms that eventually sacked the city of Angkor in 1431. One could perhaps argue, as Bell [7] did and Frank [40] and Chew [41] assert, that the climate change created regional instability and that while the Khmer were able to adjust their technology and behavior to the local changes affecting agriculture, the peoples around them were under increasing ecological stress. Others argue that as more archaeological work is done the decision to abandon the site will become clearer, but it seems to have been a combination of the result of human urbanism and agriculture as well as climate change in their estimation [42].

Discussion

History of collapse studies

Some authors make reference to Jared Diamond's book *Collapse* [43] which is a renewal of Ratzel's views, (derived from works like Vico's cycles and those of Ibn Khaldun, Spengler, and Sima Qian in 105 B.C.E. and others) along with a popularization of some more complex

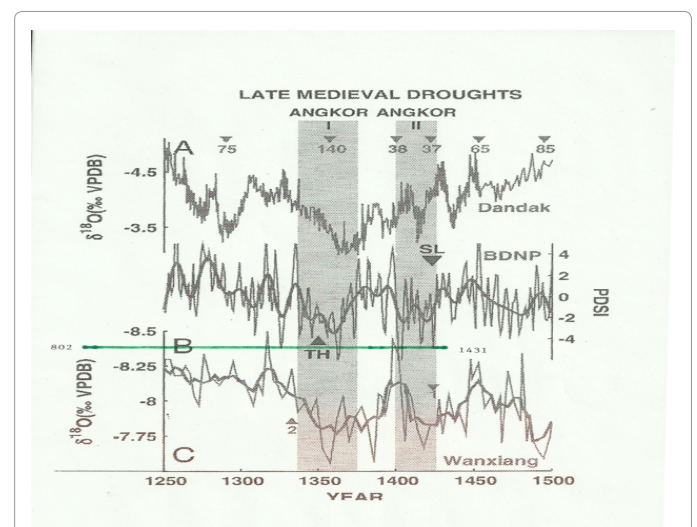


Figure 1: The green line shows the period of greatest cultural development of Khmer culture according to Briggs [1].

discussions in Joseph Tainter's *The Collapse of Complex Societies* 1988) in his questions regarding the focus on human activities as having significant role in the collapse of civilizations, in a recent review [19]. Diamond in his *Guns Germs and Steel* [44] has built his vision of civilization on the belief that development is the highest value of human achievement. He ignores the anthropological premise that there is no one path of human expression, that industry, food production and masses of people are not necessarily positive values or ends. That the Australian Aborigines in 50,000 years do not produce an Einstein and a Theory of Relativity or build a machine because this might not be a necessary outcome of human life seems lost to him. To make up for what seems a deficiency compared to a progressive ideal of civilization, he returns to environmental determinism. That civilization is not necessarily a special achievement but rather a form of social complexity reached by some social insects some hundred million years ago [45], should allow us to assess it as any behavioral response of animals.

What Tainter [19,28] shows is that societies have numerous components that allow them to sustain substantial losses in various spheres, economic, political and climatic, and yet survive and even expand. On the other hand, if these components are lacking or degraded due to internal conflict, mismanagement of resources, etc. they will be less resilient and will collapse or contract. Tainter [28] does not place as great an emphasis on the allocation of energy in societies in the production of prestige goods and their consequences as Shepard Clough [46] does. Brian Fagan's [47] position is more in support of Clough. However, Willey and Shimkine's work [48] supports Tainter's argument, they note that, like the Khmers, Mayan society experienced a substantial population growth before collapse; this put pressure on the food production capacity of the land, rising class distinctions and socio-political conflict and competition set the stage for collapse. Scarborough and Burnside [49] extend this parallel from Mayan history to Bali. Webster [50] argues that this population expansion left the Maya particularly vulnerable to droughts that occurred later. This could be the case with the Khmer, but mediated through outside pressures; still growth of population does not necessarily indicate social stress [51], but the opposite, positive conditions for reproduction and especially food supplies.

Marcus [52-54] has described a cyclical pattern of collapse and renewal for the Mesoamerican pre-Columbian states, termed the "dynamic model." Environmental degradation by overpopulation during a growth cycle which coincided with a climate challenge would accelerate collapse.

Debate on a correlation of food supplies and population has varied as Hutchinson [55] has shown. A key element is social discipline and the symbols that maintain social solidarity, a factor examined in detail by Blackman [56]. Nevertheless, the Khmer flourished when Buckley, et al. [1] argue they should have been in decline. One has to note, however, that the period between the low points in 50 year intervals shows a considerable rebound in rainfall and though the authors interpret additions to the Khmer water system during this time and after, even this indicates organization and response. Nevertheless, Khmer collapse takes place after a period of monumental building as in the Mayan case and as is seen at the end of the Sixth Dynasty in Egypt. Reorganization and renewal take place later among the Khmer but further downstream [56].

Mound builder societies present a unique problem as Abrams [57] notes: "The archaeological expectations of a collapse do not appear for Hopewellian societies. Neither evidence of widespread diseases nor heightened death rates have been recovered. Similarly,

the data for environmental decline are limited although the warming episode c. A.D. 400 encourages a greater investigation of dynamic environmental ends".

In their paper Buckley, et al. [1] argued that substantial droughts contributed to the Khmer collapse as they describe two periods, one in the early 13th century and another in the early 14th. However, Khmer methods of agriculture seem to have been less a part the failure to adapt in the region rather it may have been the depletion of resources to building prestige architecture and regional conflict. This may be an area of consonance between several of the theories, of Tainter, Chew, Marcus and Diamond and Caldararo. Here the inputs are too expensive to maintain stability, rather they contribute to increasing inequality and degradation of social capital and internal solidarity that weaken a society and make it victim to external challenge. Therefore, the very symbols of civilization can be seen as costs and elements of social stress which explains why such investments might be timed with exterior stresses as an attempt at compensation that only makes the situation worse by expending scarce resources, as in Diamond's focus [44] on the Bird Man cult in Easter Island. I discuss the economic implications of these factors in more detail in a recent book [58].

Conclusion

While climate must be seen to play a role in the development and demise of civilizations, no single factor usually stands out although single cause theories abound in the history of social science and history, the story is often more complex and frustrating. What is clear is that many societies note environment stress when it takes place in unusual intensity or patterns, but are often unable to respond sufficiently to compensate within the context of their available resources or by modifying their values and cosmology that are often the driving forces behind resource depletion. In his time the Roman historian Polybius, noted that recognition of degradation and having the power to change are quite different aspects of society. This seems especially true today of the global economy and the attitudes denying climate change as caused by human activity. Many societies deny the link; few escape the results, and most suffer the consequences when prudent action might have averted disaster.

What is undeniable, however, as Professor Sing C Chew has shown [41] is that "... human induced changes to the ecology and the climate in turn form barriers to the reproduction" of the natural capital of the world system. One might go further in geological history and note that animal societies are adaptations to environmental changes not under the control of the species, whether cyclical like seasonality or periodic like changes in solar energy due to planetary tilt, reduced radiation or other factors. Insect societies are complex (like bees, wasps and ants) and have evolved to sustain their members over weather conditions where food resources are low and to produce cooperative patterns to exploit food resources when conditions allow. They also have behavior patterns that provide structures to protect them from unusual environmental conditions to a certain extent. Human society has been much like these earlier examples, especially ants and bees. Human society is at the point of reflexivity where it has become aware of itself and has the potential to not only moderate the effects of its own physical presence, but to interfere with the global environment to produce a more comprehensive sustainable adaptation.

Chew [41] argues that collapse and "Dark Ages" have a renewal function given the degradation of the environment resulting from human accumulation of wealth in all its forms, both physical and symbolic. Caldararo has shown elsewhere [13,59], however,

sustainability and stability are possible without collapse dependent on cultural proscriptions against certain levels of accumulation that would lead to degradation and collapse. The Khmer appear to be an example of this variation. The missing element to the other theories of collapse is their failure to account for this variation, especially the role of ideologies. Rostovtzeff [60] suggests that Neo-Pythagoreanism was at the heart of the Roman economic expansion after the Civil Wars and was a central element in rebuilding the stability of the Empire. Reischauer and Fairbank [61] pursue a similar role for Neo-Confucianism in the dynastic form in China and I have argued that a culture that has integrated Shintu, Neo-Confucianism and Buddhism has allowed Japan to produce a resilient response to challenge as well [62]. The Japanese have responded to environmental stress that reduced resource availability (e.g., food) several times by the reduction of population. The country is undergoing a current period of population decline which could reduce its resource extraction to a closer frame of carrying capacity as in the past only with now industrial technology. The rest of the world's current economic system is based on an ideology of capitalism requiring constant growth and consumption and its promise of riches, but it functions on magical thinking and irrationality that also promotes inequality and environmental degradation as Caldararo has shown in a number of publications recently [13,59,63].

Regeneration after collapse is often affected by climate, especially in some cases as in Mayan patterns [64]. Regeneration takes a variety of forms dependant on local environment, extent of collapse, intrusive peoples and type of complexity of the original society and its integration [65]. Stark [37] has emphasized the idea of regeneration and movement in the Khmer example with the idea the continuity of symbols and institutions and an Indic ideology allowed for success. The failure of regeneration in the case of the influx of a powerful new culture and society coupled with efforts to prevent continuity of native symbols and institutions can be seen in the case of Native American complex societies where destruction of Native architecture, writing, learning and institutions of nearly every type created a permanent hiatus concerning Native complex culture [67].

While it is obvious from the fossil record that climate change has occurred in the past, the factors involved, reduced solar radiation, Milankovitch cycles of axis variation in tilt, albedo effect and the influence of life processes, are many. It is clear, nevertheless, that life processes have an effect. The Great Oxidation Event that occurred about 2.3 billion years ago was the result of life processes. Cyanobacteria had been pumping out oxygen for more than a billion years and apparently this accelerated between 2.4 and 2.3 billion years ago dramatically changing the atmosphere of the earth [34] and clearly toxic conditions to anaerobic forms.

Loss of diversity at the end of the Devonian has been explained by a reduction in speciation and invasions of cosmopolitan species, rather than any single event, but each extinction period is associated with anoxic sea conditions that may be the result of volcanic action or biological activity by certain species and their metabolites. While other factors may play more important roles in certain extinctions and changes in climate, for example possible asteroids in the Permian extinction or at the end of the Cretaceous, it is clear that life processes do have a role in climate change.

The question for people today is one of consciousness and what it means to be human. We often pride ourselves by believing we are thinking animals, so one might expect that given past roles "dumb" animals and plants have played in climate change, should not we recognize our own role and behave accordingly? Will we create

conditions that are toxic to our own survival as other life forms have done in the past?

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