Introduction: Sustainable Lifeways

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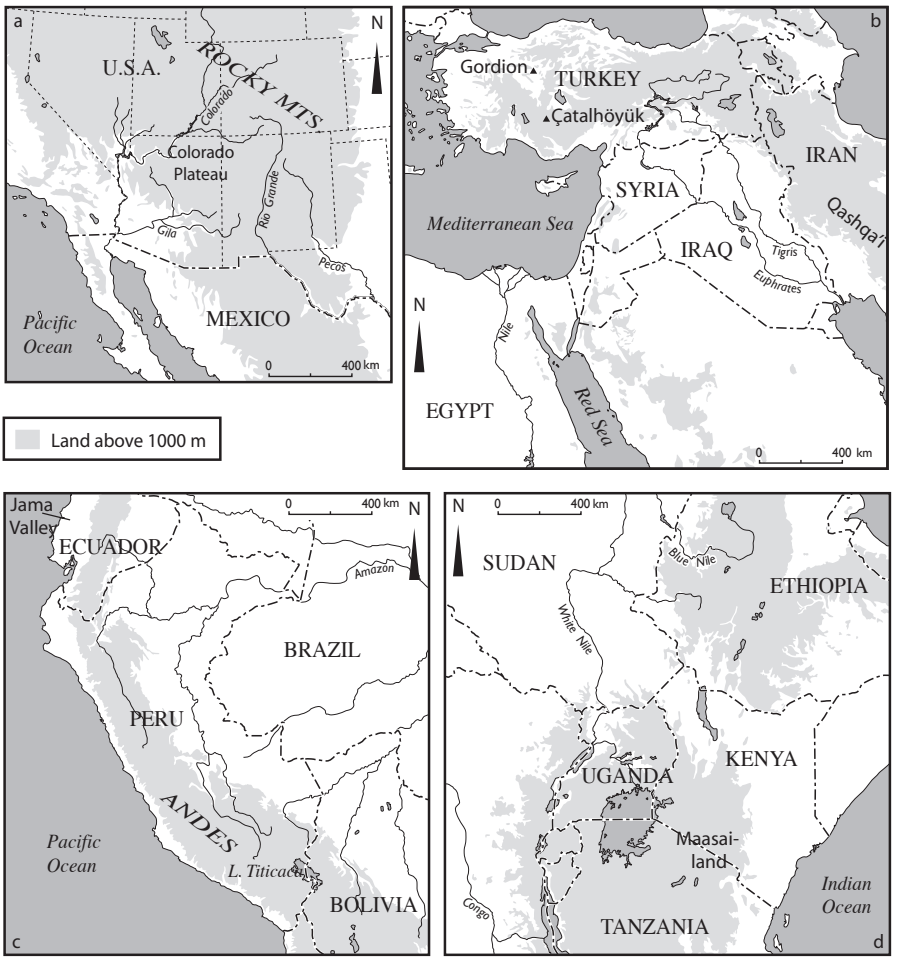
All organisms and species respond to unpredictable variability in their environment. For individual humans and for the societies in which they live, cultural responses to environmental risk are embedded in technology, practice, and ideology. By their collective actions, societies can mitigate or exacerbate immediate and long-term risk in their environment. In addition, all societies, ancient and modern, have to deal with risk on several time scales. The most limited temporal scales concern annual and interannual variability in weather, pests, and other short-term risks. Over decades and longer (referred to here as medium scale), changes in climate, soil conditions, and vegetation cover can be perceived and recorded in intergenerational time. Even longer-term changes in environmental conditions or extremely rare events, like volcanic eruptions, are least likely to be recognized by social groups. Even so, they have a material effect on the ability of those groups to persist. The 2008 Penn Museum International Research Conference "Forces of Nature: Risk and Resilience as Factors of Long-term Cultural Change" addressed these issues. In this volume, we bring the archaeological record to the forefront in understanding the human experience of dynamic environments (Figs. 0.1, 0.2). Even a sustainable system will not be static, because it must respond to changing external conditions and internally generated stresses. But a subtle shift in our

focus occurred in the course of the session's discussions: although societies and individuals confront many uncertainties, success requires continuity of tradition.

The contributors to this volume are aware that the concept of nature in the context of human societies and their traditions is problematic; that even foragers and low-level cultivators manage, and thereby create, their environment (see, for example, Ford and Nigh 2009; Smith 2007; Weiser and Lepofsky 2009). Nevertheless, from the perspective of the individual agent, it is frequently analytically useful to separate certain kinds of conditions,



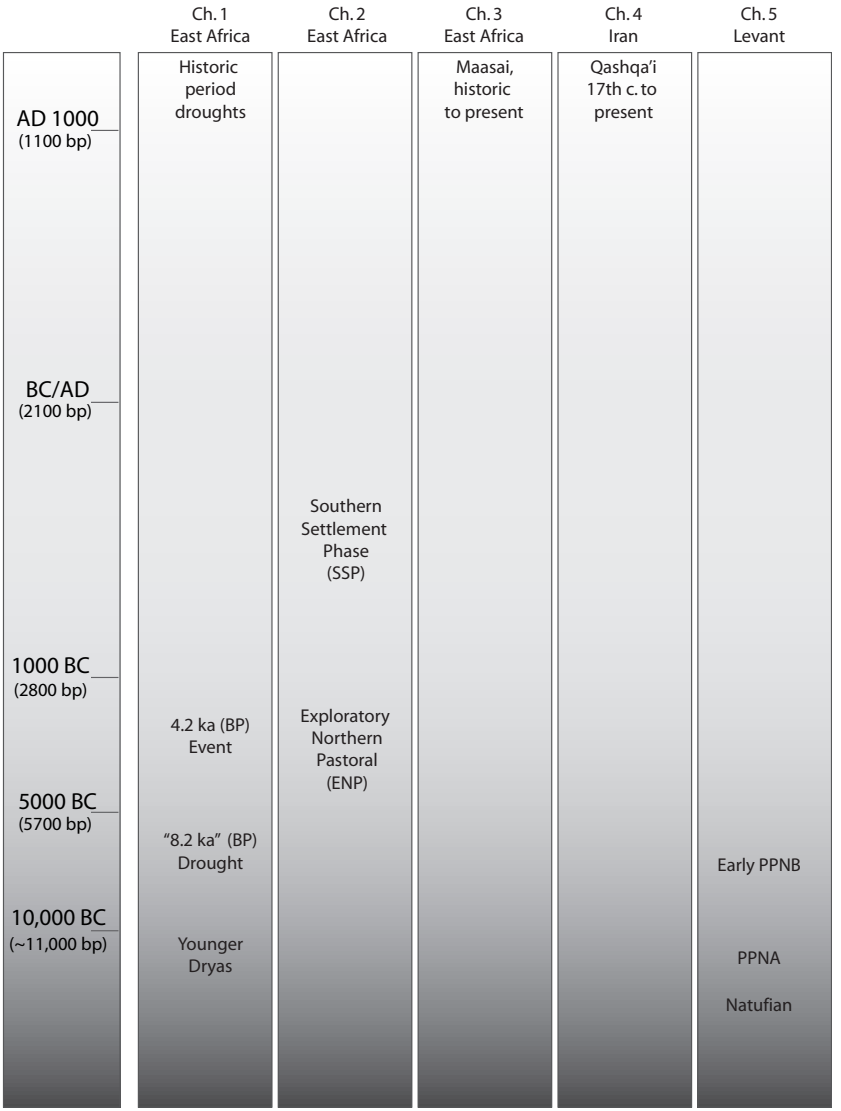
0.1 World areas discussed in the volume. (Base map courtesy of Neil Roberts)

such as climate or volcanism, as independent variables. That said, the chapters in this volume are more concerned with the underlying processes that condition cultural responses to the vagaries of nature.

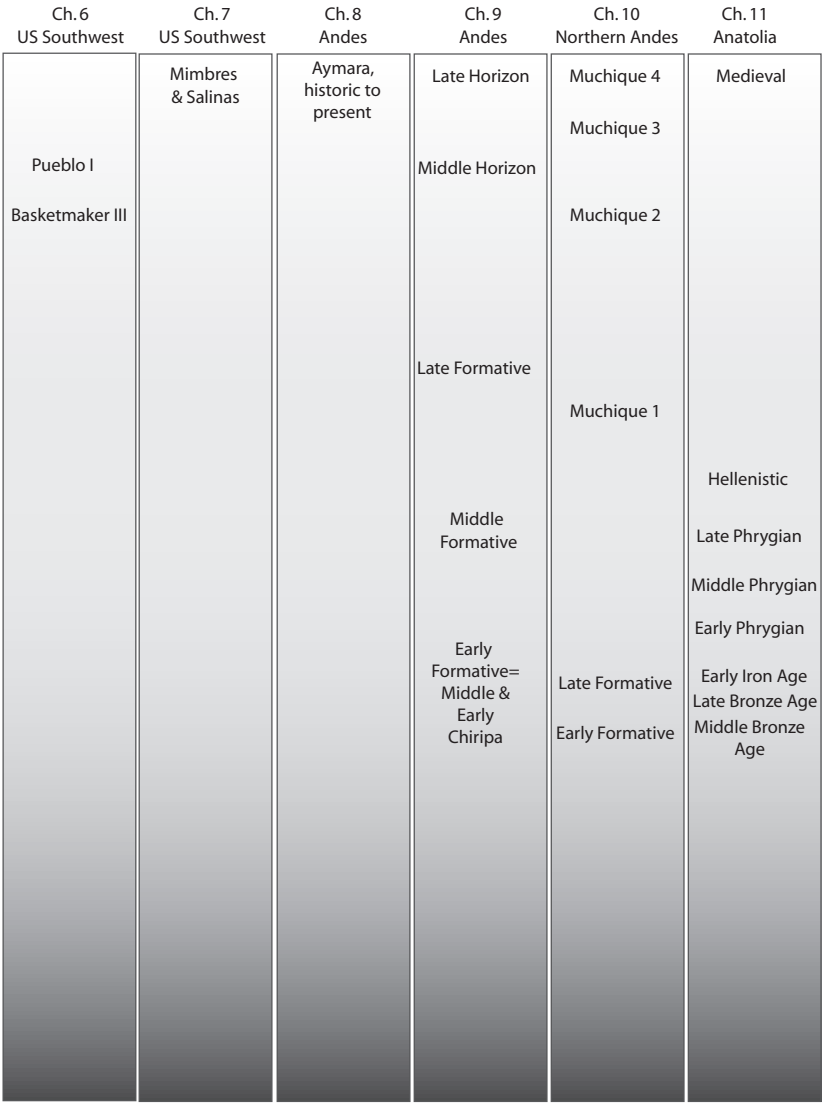
This subject is a perennial one.[1] The 2010 earthquake in Haiti was unprecedented in memory; the Indian Ocean tsunami in 2004 was unusual in the territory it covered, but the affected societies had experienced tsunamis before; in 2005, Hurricane Katrina was an admittedly severe example of an ordinary seasonal climate event that virtually all residents of the region had experienced many times. Thus, we can see that Haiti endured an event predictable only on a long time scale, the tsunami in Asia might have been predicted based on a medium scale record, and Hurricane Katrina, though horrific in its impact, has already been followed by other storms on a short-term, annual cycle. In the past few years, the world has witnessed many such "natural" disasters whose effects were exacerbated by pre-existing interrelated social and environmental conditions (Leroy 2006).

One way that events at these different time scales interact is when the response to a short-term environmental fluctuation results in irrevocable social or environmental changes. For example, British colonial agriculture policy in Kenya was established during a brief phase of favorable climate. It created an unsustainable system when normal drier conditions returned, the results of which are still being felt (Roberts, Chapter 1). If a period of favorable climate is long enough, new technologies may emerge associated with new social structures, as Rosen (Chapter 5) proposes for the Pre-Pottery Neolithic B of the Levant. After a similar short-term climate amelioration permitted a more secure living from farming, agropastoralists at Gordion returned to their prior practices, with lower population densities and a less energy-intensive agricultural system (Miller, Chapter 11). Conversely, volcanic eruptions in the Jama Valley of lowland Ecuador destroyed the original agroecological system by covering the floodplain with tephra. Later-period farmers created a productive, diverse forest mosaic in the uplands that supported larger populations and was less vulnerable to volcanic ashfall (Stahl, Chapter 10).

Periods of perceived stability in the archaeological record may be interpreted as the results of effective risk management in the face of varying conditions. Insofar as these factors relate to the 'natural' environment, these cultural systems have demonstrated their resilience in the face of risks. Archaeological evidence of environment and land use can then help



0.2 Timeline for chapters. (Radiocarbon calibration extrapolated from Stuiver et al. 1998)


Ch. 6
US Southwest
Ch. 7
US Southwest
Ch. 8
Andes
Ch. 9
Andes
Ch. 10
Northern Andes
Ch. 11
Anatolia
Mimbres & Salinas
Aymara, historic to present
Late Horizon
Muchique 4
Medieval
Muchique 3
Pueblo I
Middle Horizon
Basketmaker III
Muchique 2
Late Formative
Muchique 1
Hellenistic
Middle Formative
Late Phrygian
Middle Phrygian
Early Phrygian
Early Formative= Middle & Early Chiripa
Late Formative
Early Iron Age
Late Bronze Age
Early Formative
Middle Bronze Age

us identify long-term developmental processes that allowed ancient societies to persist and change (Redman and Kinzig 2003). Moore (Chapter 9) shows how despite fluctuating water levels, the aquatic richness of Lake Titicaca allowed for flexible responses to climate shifts through the integration of the agropastoral system with the use of fish and birds. In contrast, well-documented periods of rapid change, depopulation, or abandonment may represent cases where risk management strategies were overwhelmed by the magnitude of change (as in the cases of rapid landform changes and floods) or by the cumulative effects of smaller scale changes, such as the abandonment of lower Mesopotamia (see Redman 2005).

The quality of stability in social and ecological contexts arose repeatedly as a methodological issue in conference discussions. The perception of stability that could be inferred from the location of archaeological sites or the record of subsistence practices from deposits in sites appeared to risk an error of circular reasoning: a site's surface would not collect an archaeological record of an adaptation that was no longer possible at that location. This weakness of reading adaptation from the on-site archaeological record is countered here primarily with comparison to off-site deposits such as pollen cores, ice cores, tephra records, tree rings, lake varves, and so on. Yet, how can such records be linked convincingly with site deposits? Each of the chapters addressing archaeological sequences demonstrates careful attention to chronology, and makes intensive use of absolute dating to link site location and contents to specific environmental records. A side effect of this approach is that the location and details of smaller, open, ephemeral sites cannot be linked to the larger, well-dated sites that are the focus of these chapters, even though mobility and dispersal are routinely cited as a response to declining resources. In the case of the effect of volcanic ash falling on sites in the Jama Valley (Stahl), the off-site record does link tightly with the on-site record with ashfalls literally blanketing the sites. In the basin of present-day Lake Titicaca, the off-site record of lake-level change suggests repeated dramatic alterations of the landscape over the period of intensive occupation (Moore). The stability of site location and ecological relationships from the on-site archaeological record contrasts with the picture of climate and vegetation changes from the lake cores, calling the relationship between the two records into question. In other chapters, the off-site record shows slighter amounts of change over time, though the social effects may have been profound. By contrasting the off-site to on-site

relationships between studies in the volume, the range of threshold values that bring about change in economic and ecological systems can be estimated. Even so, we were repeatedly reminded of how multiple aspects of traditional practice combined to dampen the effect of changing rainfall or temperature.

One of the challenges for archaeologists is incorporating the effect of ancient people's knowledge of their environment. Ryan and Karega-Munene's (Chapter 3), Beck and Huang's (Chapter 4), and Bruno's (Chapter 8) case studies point to the kinds of information we may miss in trying to understand ancient practices. Agent-based modeling can provide a virtual link between ethnographic understanding and archaeological inference. For example, in the U.S. Southwest, Kohler and Reed (Chapter 6) create an infinite variety of alternative scenarios for an extended period. While behavioral ecology models would predict site location oriented toward agricultural fields, Kohler and Reed demonstrate that the model with the "best fit" to actual site distribution is one in which the subsistence system favored wild deer over cultivated maize. At Çatalhöyük in Turkey, retention of old ways of subsistence seems like a better explanation for site location in proximity to the fields of this Neolithic site. Roberts and Rosen (2009) suggest that the familiar and diverse resources of the marshland might have secured the transition to full agriculture. Ancient TEK (Traditional Ecological Knowledge) is but one part of the picture. The high value of domesticated cattle among the Maasai (Ryan and Karega-Munene) may give some insight into the cultural significance of deer in the Southwest (Kohler and Reed) and aurochs at Çatalhöyük (Twiss et al. 2009). One reality of traditional agricultural practice to which archaeologists have poor access is the effect of diseases and parasites. Both crop pests (nematodes in potato crops, see Bruno) and animal disease (cattle pests, see Ryan and Karega-Munene) were emphatically identified as central forces in determining the location and nature of settlements. Of course, the distribution of these risks reflects the experience of humans with those plants and animals over time.

Archaeology and long-term ethnographic information provides time depth unavailable in short-term actualistic studies. With the perspective of different chronological and spatial scales within each region, several archaeologically useful parameters of risk and resilience that acted in the past were investigated. Within archaeological assemblages, measures of changing representation of taxa were used as proxies for changing adaptation.

These comparisons included ones where rank orders of important taxa were reversed (Marshall, Grillo, and Arco, Chapter 2) and ones where smaller changes were consistent across a region (Kohler and Reed; Miller; Moore). This use of relatively robust quantitative measures will allow the incorporation of more archaeological sites into such regional studies, particularly sites excavated or analyzed long ago (Amorosi et al. 1996).

Over the four days of the conference, we kept returning to some important concepts. Superficially, adapting to climate is a key variable. Indeed, in choosing the world areas, we considered relatively arid regions of west Asia and Andean South America as supporting societies dependent on domesticated plants and animals; East Africa, with full time pastoralists; and the U.S. Southwest, with societies based on domesticated plants. Arid regions are intrinsically important in studying response to climate change as they are more prone overall to short- and long-term variability in rainfall and are likely to suffer most from the changing climates in the near future compared to regions in more favorable climes (see Solomon et al. 2009:1706). With the exception of Stahl's contribution, therefore, drought is a directly limiting factor, though temperature changes may also have had a key role in bringing cultural change in Kohler and Reed's case in the northern edge of the American Southwest. But it should be understood that climate merely creates conditions. As the "natural" environment changes, humans respond to those changes, thereby creating new conditions. The responses, therefore, are to the conditions, whether of weather, vegetation, soil, or society.

"Climate change" is sometimes used as a shorthand for the whole set of conditions in which people operate and that is not itself stable. Humans and other animals persist by creating circumstances favorable to their survival—"niche construction" (see Smith 2007). "Sustainability" implies "risk minimization," so that "critical thresholds" forcing qualitative systemic changes are not reached. Though change is inevitable, "ecological inheritance" constrains responses. Using Traditional Ecological Knowledge and "management" of the local environment, small-scale societies create the conditions for their own perpetuation. Several other mechanisms of risk reduction also kept recurring in the discussions: mobility (cyclical movement), migration (one-way movement), exchange, cooperation, raiding and warfare, intensification, and subsistence resource diversification.

The broad concept of diversity unites these mechanisms of risk reduction, and thereby helps focus attention on how ancient societies dealt with risk and sustainability. Our discussions revolved around the interconnections among diversity of place, subsistence, and society. In the category of diversity of place, mobility is an important strategy for many foraging societies (see Rosen), as well as transhumant and nomadic pastoral societies (Beck and Huang; Marshall, Grillo, and Arco; Ryan and Karega-Munene). Strategies for movement include using social as well as natural environmental resources (Beck and Huang; Marshall, Grillo, and Arco; Ryan and Karega-Munene). A farming society may be able to survive even sudden, periodic massive devastation of field and forest in place (Stahl). Yet, Spielmann, Nelson, Ingram, and Peeples (Chapter 7) point out that occasional abandonment in the Southwest actually *is* the response to an uncertain environment! Similar histories and abandonment and reorganization are suggested by Marshall, Grillo, and Arco. But even sedentary people take advantage of small-scale spatial diversity, as the Lake Titicaca farmers discussed by Maria Bruno (Chapter 8) take advantage of different soil types.

Diversity of subsistence choices, including technology, is also an important strategy. Moore shows that overall resource productivity may be stable if you are willing to be flexible in your reliance on particular species of plants and animals. As Boserup (1965) pointed out, some technologies may be known long before they are "needed"; irrigation at Gordion is an example of this. Another point where social relationships intersect with technology is in the creation and maintenance of storage. Beyond the obvious cases of storing crops and wild plant foods, we can see examples of social storage in the case of the African pastoralists' history of gift obligations, and we also note the nature of storage of economic value in herds, or even in fisheries and other wild resources. Strategies for manipulating and prolonging the usefulness of stored resources of all kinds have clearly been key for the ancient societies studied in this volume. We also were conscious of memory, a kind of mental and cultural storage, as an essential process in resilient societies: memories of cattle and their donors, memories of where crops had done well and how long ago a certain field had been sown, memories of other ways to manipulate water and to make tools and supplies for long-dormant practices. In the short-term of the contemporary societies in this volume, diversification by the adoption of new crops or new economic roles seems to be a way to buffer a society against further change and loss

of the part of the identity that is held most dear, as Qashaq'i pastoralists tend orchards of fruit and nut trees to support their herds, or as the Aymara farmers adopt European crops to keep working their land. The economic accommodations they are willing to make shows the value they put on fundamental ties to place and way of life.

Cultural and social systems show obvious diversity. Whether through full-time nomadic transhumance or specialized exchange, relationships of individuals and groups to those beyond their immediate subsistence catchment can allow a social group to survive. These practices permit diversity of knowledge and of place to benefit both parties to the exchanges. Yet, exchange is not necessarily to mutual advantage; raiding and warfare always create losers, and sometimes winners. Culturally transmitted TEK is also diversity-enhancing. Successful (i.e., sustainable) systems accumulate wisdom over time that can be applied to recurring or new conditions.

The examples discussed in this volume mostly deal with small-scale rather than expansive societies. In that sense, they are not directly analogous to those of today. Unrestricted mobility as a solution to resource stress has been crippled by the disappearance of open, non-commercial space in modern nations. High population densities constrain movement and the migration of whole populations, despite the fact that the number of individual migrants and length of their journeys is greater now than at any time in the past. Human impacts on the atmosphere, biosphere, and geosphere that are the result of our modern high per capita energy consumption, as well as the high absolute number of people the earth is now expected to support also have no analogy with the past. Perhaps the most profound statement about the limits of resilience comes in Beck and Huang's assessment of the possibility of nomadic life in modern Iran: the Qashaq'i herders know well how to deal with hail, disease, market conditions, and drought, but their flexibility was useless in the face of tight control by an autocratic state. Self-determination and the employment of individual knowledge and experience of the environment is more accessible as a goal in democratic societies than in autocratic ones, and this fact may offer cosmopolitan readers of this volume an avenue for political and social engagement.

Insofar as we are dispassionate scholars, these archaeological, ethnoarchaeological, and ethnographic studies can inform discussion of sustainable practice in the modern world. Yet the contributors to this volume have

long-term commitments to physical and conceptual research areas. The data of archaeology and ethnography demonstrate the many alternative lifeways that have sustained humanity, and it is up to people alive today to use that hard-earned knowledge stored in the memory of peoples, places, and things.

NOTE

1. Recent volumes taking somewhat different perspectives include Bawden and Reycraft (2000), Fisher, Hill, and Feinman (2009); McAnany and Yoffee (2009).

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