

Changing the Atmosphere

Anthropology and Climate Change

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PREFERRED CITATION

Fiske, S.J., Crate, S.A., Crumley, C.L., Galvin, K., Lazrus, H., Lucero, L. Oliver-Smith, A., Orlove, B., Strauss, S., Wilk, R. 2014. Changing the Atmosphere. Anthropology and Climate Change. Final report of the AAA Global Climate Change Task Force, 137 pp. December 2014. Arlington, VA: American Anthropological Association.

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Acknowledgements

The work of the Global Climate Change Task Force (GCCTF), including the development of the final report, was made possible through support by the School for Advanced Research (Santa Fe, New Mexico), the Atlantic Philanthropies (New York City), and the American Anthropological Association. The task force is extremely grateful for this assistance (detailed acknowledgements appear in [Appendix 2](#)).

Additionally, the Global Climate Change Task Force expresses its greatest appreciation for the expert reviewers of the Report's final draft. Reviewers were solicited from within anthropology and from other disciplines. Their thorough and thoughtful comments provided perspectives and insights that improved the report tremendously. They are listed here in alphabetical order:

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Executive Summary

“Changing the Atmosphere: Anthropology and Climate Change” is the final report of the American Anthropological Association’s (AAA) Global Climate Change Task Force. The report’s objectives are: to provide a guiding document on anthropology and climate change in its broadest sense, including anthropology’s contributions to, and concerns about, climate change and climate change policy and discourse; to provide commentary on interdisciplinary research and relationships; and to identify research frontiers for anthropology with respect to climate change. The audiences for the report are the AAA Executive Board and the anthropological discipline; interdisciplinary colleagues, organizations, and institutions; and ultimately and ideally, policymakers, the media, and the general public. This Executive Summary provides readers with a short description of the highlights and sections of the Report, including the Conclusions and Recommendations (both more fully developed over the course of the report and specifically in Sections 7.0 and 8.0, respectively).

The report has the following foci in its approach: (a) human causes and contributions to climate change and the problematizing of human drivers; (b) the identification of lessons learned about human adaptation, survival and change over long time periods; (c) the critique of central concepts used in climate policy on global, state and local levels (adaptation, vulnerability and resilience); (d) the importance of the local and community engagement; and (e) interdisciplinary strengths and opportunities, and research priorities for the future for anthropology and global environmental change. Following are the sections of the report.

Statement on Humanity and Climate Change

The Statement on Humanity and Climate Change presents a number of primary points on climate change and humanity that are based on anthropological research, analysis and expertise. The objectives of the Statement are to raise awareness of anthropological knowledge and concerns about climate change among colleagues within the discipline, the general public, the media, relevant stakeholders and policy-makers; and to cultivate anthropological engagement in climate change issues at multiple levels from research, teaching and training to searching for equitable solutions and sustainable responses to the grand challenges of climate change.

Section 1: Introduction

This section contextualizes the report, providing a brief background of anthropology’s relationship with the climate science and climate change enterprise. The Introduction sets the report in the framework of social-ecological systems and cultural analysis. It introduces crucial highly visible areas of anthropological concern on the landscape of climate change research and engagement.

Section 2: Anthropological Approaches to Drivers of Climate Change

Ultimately all drivers of climate change have roots in human cultural values. Consumption is a complex social product, driven by culturally-specific concepts of “necessity” and “luxury,” divergent morals and values, and grounded in a long human history of using material to mediate

social relationships. Population growth, while a factor in climate change, is not in a simple linear relationship with GHG emissions; this relationship is mediated by education, poverty, and cultural values.

Section 3: Lessons of the Past and What it Can Teach Us

Contributions from archaeology provide insight into how early societies dealt with climatic changes—which types of adaptations succeeded and failed, and at what scale. On the other hand, highly centralized management of an economy and government often leads to instability, and in some places to catastrophe.

Section 4: Adaptation, Vulnerability and Resilience in Climate Change

These three ideas are important policy concepts in the architecture and implementation of global (IPCC, UNFCCC) climate policy and national policies in most nation-states. They have interdisciplinary roots, and anthropological refinements that point to the social and cultural nature of each of them. They have moved from descriptive concepts to normative programs, and they are also anthropological flashpoints of concern. This section problematizes them from the anthropological perspective. Existing top-down programs do not treat the social and economic variables that underpin vulnerability to climate change—poverty, marginalization, lack of education and information, and loss of control over resources. Unless these factors are taken into consideration, efforts to build resilience and decrease vulnerability globally are likely to fall short.

Section 5: Community-centered Approaches to Climate Change

This section sets forth community engagement agenda and guidance for anthropologists. It suggests that much innovation in the face of climate change is coming from local, community or regional activities and initiatives; and it notes that increased stewardship co-occurs with increased agency over one's future.

Section 6: Interdisciplinary Research Frontiers

This section reviews the interdisciplinary projects and programs in which anthropologists have participated, emphasizing engagements with the earth sciences, biology, and other social sciences. It reviews a number of emerging areas of academic and applied research within climate anthropology.

Section 7: Conclusions

The GCCTF report identifies contributions that anthropology makes to the understanding of global climate change science and policy. Anthropologists have traced the diversity of human adaptive responses throughout human history, both before and during the Anthropocene context, with attention to migration, emergence of complex societies, transformation, and collapse. With skills in the cultural, holistic, and contextual domains, anthropologists recognize local-level adaptations across all temporal scales and at the meso- and regional scales, and therefore can contribute to much-needed efforts towards adaptation.

The GCCTF Report comes at a time when the initial promise of science-driven, global approaches to govern the atmospheric commons through GHG emissions reductions has proven politically polarizing and ineffective at reducing emissions. We assert that by shifting the focus of adaptation discussions to sub-state levels, anthropologists can do our part—not only by clarifying how adaptation is decided in local and regional contexts, but also by identifying means to strengthen interaction among various levels. Anthropologists engage with communities to understand how they are affected by local climate change impacts and can thereby identify the path-dependent vectors of vulnerability and be instrumental in facilitating adaptive capacity.

The Report questions the dominant paradigms for climate change, including the trio of policy concepts of adaptation, vulnerability, and resilience. It points to the need for flexibility in climate policy to hear and respond to alternative voices on climate change. It recommends expanding the current focus toward additional goals more inclusive than specific thresholds of greenhouse gas concentrations; and it urges looking to sub-state levels where innovation, flexibility, and ownership are already occurring—as organizations and communities respond to how people see climate change on the ground level.

The report recommends re-thinking climate policy, which has focused on top-down emissions reductions such as emissions trading mechanisms, or national carbon taxes. This re-framing the “problem” of climate change means accepting the issue in all its social and political complexity, as a culturally-driven problem with multiple solutions at different scales—using a holistic anthropological perspective. The report suggests re-thinking incentives for innovation at the local level, seeking adaptations that both reduce emissions and enable communities to build what they see as “resilience” to withstand climate-related disruptions.

The impacts of climate changes are not, and will not be, equally distributed across the globe and will be increasingly differentiated among wealthy and poor populations. Not only will the impacts be different depending on exposure, but the impact experiences by people in their local context will be different, meaning that social aspects of vulnerability and resilience are critical. Anthropology was among the early fields to call attention to the differential impacts of climate change on peoples across the globe and to point out the fundamental environmental injustice of climate change—it has affected the vulnerable, marginal, and otherwise disadvantaged peoples the most, although these are the same peoples who have contributed the least to the accumulation of GHGs.

As anthropologists we understand that a changing climate is one of the many drivers of social change in the set of globalized processes affecting cultures and their interactions with their environment. Climate change is an *intensifier* of existing global environmental changes (degradation/contamination in the hydrosphere, soil, and air that people breathe) in most developing countries, along with social and cultural changes ushered in through forces of globalization. Solving one aspect of the climate problem (emissions) will not deliver a better world for already-stressed populations. If climate change mitigation and adaptation can be incorporated into more immediate needs for employment, economic development, and public health, there is greater likelihood of successful mitigation and adaptation.

Section 8: Recommendations

The task force's recommendations are provided here in condensed form to take our readers straight to the punch:

Recommendations to AAA Executive Board

- Accept and adopt 'Changing the Atmosphere' report from the AAA Global Climate Change task force, and the Statement on Humanity and Climate Change. 2) Publicize the Report broadly and develop enabling mechanisms for anthropological climate change research and knowledge.
- Expand anthropological knowledge and perspectives on climate change into the public domain.
- Provide on-going capacity to monitor and respond to climate change and global environmental change issues affecting humanity world-wide.
- Create places for climate change anthropologists to stay connected to each other.
- Continue aggressively with developments in AAA that reduce the carbon footprint due to association-wide activities.

Recommendations to Catalyze the Discipline and Profession of Anthropology

- Build capacity in anthropology research and engagement to address issues of climate change.

Recommendations to Forge Interdisciplinary and Global Collaborations

- Encourage stronger cross-disciplinary ties with existing professional associations linked with climate change and global environmental change.

Recommendations for Engagement with Policy Community and Media

- Enhance capacity for policy statements, recommendations, and endorsements.
- Develop/expand dissemination strategies for communicating anthropological knowledge with the public, communities, agencies, and NGOs

Before entering into the full exploration and documentation of these conclusions and recommendations, the task force next presents its Statement on Humanity and Climate Change. ■

Statement on Humanity and Climate Change

AAA Global Climate Change Task Force

Recognizing anthropology as the discipline most clearly devoted to the human condition over time and space and across cultural, social, and behavioral domains, this section provides the American Anthropological Association (AAA) with a position statement on the *human nexus* with climate change. The points are founded in anthropological research and analysis, and provide, in a nutshell, the knowledge and anthropology's views on climate change as the members of the Task Force understand it in today's policy context. The main objectives of the Statement are (1) to raise overall awareness of anthropological knowledge and concerns about climate change and other disciplines, and, more broadly, among the general public, the media, and policy-makers; and (2) to cultivate anthropological engagement at multiple levels to promote equitable and sustainable responses to the grand challenges of climate change.

Please Note: The Statement is being finalized at this time (December 2014-January 2015) and will be posted on the AAA website shortly. ■

Background: Charge to GCCTF and Terms Used in Report

Authorization and Charge to GCCTF

In response to its members' concerns, the American Anthropological Association (AAA), established the Global Climate Change Task Force (GCCTF) in November 2010. The charge to the task force was to produce a guiding document to recognize anthropological contributions to global climate change-related issues, articulate new research directions, facilitate interdisciplinary research and provide the AAA with actions and recommendations to support and promote anthropological investigation of these issues. Task force meetings began in the fall of 2011, with the full complement of members appointed in January of 2012.

The goals of the task force are summarized below (see [Appendix 3](#) for full set of objectives):

- Recognize and communicate anthropological roles in and contributions to the study of climate change and climate-related issues, with particular emphasis on representing many diverse voices and narratives, past and present;
- Produce guiding documents to recognize, promote, and develop anthropological contributions to global climate change-related issues;
- Promote engagement of the AAA and anthropologists in general with public policy agendas and the greater public interest, utilizing media and outreach beyond the discipline;
- Engage the analysis of processes, discourses, and institutions associated with climate change science and policy. Communicate and translate local peoples' perceptions and concerns to the media and the general public;
- Support anthropological contributions to interdisciplinary research on climate change through conference panels, workshops, publications, and engagement with publicly accessible websites and databases;
- Articulate new research directions within the discipline and profession, especially to engage students and anthropologists new to the topic area.

The first audience for the “Changing the Atmosphere” final report is the Executive Board and President of the AAA, and the discipline and profession of anthropology as a whole. Our second set of audiences is trans-disciplinary—interdisciplinary colleagues, scientists and anthropologists who want to engage with other disciplines on climate issues. Additionally, we aim our findings towards the public policy community and the greater public, with media, public presentations and other forms of exchange.

We interpreted our objectives broadly: to encourage more anthropologists to engage with climate change discourse, practice, and policy; to identify anthropological knowledge about human interactions with climate change; and to share it more broadly with the public, including

the media. We want to present “what we know”—what anthropologists learned and experienced about global climate change that is worth communicating amongst ourselves, interdisciplinary audiences, the media and the general public.

During its existence from 2010-2014, the task force initiated a large number of activities to gather information from anthropologists about climate change and to enhance outreach to a number of publics about anthropology’s views and concerns about climate change and human activities. In brief, these included a web presence and a monthly column on anthropologists’ work and on their concerns and critical views on climate change. We organized and presented a number of scientific sessions and policy roundtables at meetings of the AAA, the Society for Applied Anthropology, the American Ethnological Society and other venues. We produced commentaries and policy articles on climate change for the media. Task force members met with officers and staff from interdisciplinary groups related to climate change. The task force received support from the School for Advanced Research in Santa Fe, New Mexico, for a short seminar on anthropology and climate change for face-to-face presentations and winnowing of ideas for the final report.

Please see Appendix 2 for the full set of activities and the process by which the task force undertook its work, and the contributions of the many members in AAA and outside of AAA. In addition, please see Appendix 4 for a listing of the columns produced by the task force and published in *Anthropology News*.

Terminology in the Report

A few words about the report’s terminology. The focus of this report is to clarify and promote anthropology’s roles in climate change. We understand ***climate change*** as the diverse ways that global warming, or the overall increase in earth temperature due to heat-trapping gases, is having real-time, on-the-ground effects. These effects, in turn, involve a set of phenomena associated with fossil fuel extraction and use, increasing atmospheric concentrations of greenhouse gases (GHGs), sea level rise, steadily rising earth surface temperatures, changing seasonal timings and increased weather event uncertainty, among others. These aspects of climate change, and the policy, governance, and political aspects involving climate change, occur from the local to the global level, which led to the formation of the task force and its focus on anthropological roles in climate change.

We also use the term ***global environmental change*** in the report, and it is not to be confused with our use of “climate change.” In most cases global environmental change causes a broad set of pressing issues in peoples’ lives—in the immediate time frame, more than climate change—some examples being deforestation, soil erosion, soil contamination, water and air pollution, and changing ecologies of parasites and disease vectors. Climate change can be considered a form of global environmental change; but most affected peoples do not experience “climate change” in the manner put forth by the dominant climate science paradigm. They experience unexpected droughts, eroding shorelines, higher tides, changes in rainfall patterns, etc. We therefore urge anthropologists, social and natural scientists, and the public and policy communities, to engage more broadly with ***global environmental change***. To these ends, we hope this report can serve to engage climate change with the broader issues of global environmental change.

In addition, we provide a guide to other key terms in the report:

Terms Central to the Report

- **Adaptation** among human beings refers to social and cultural changes in belief, knowledge and/or behavior, including the deployment of technology, in response to altered circumstances—to improve living conditions, including a culturally meaningful life.
- **Community** refers to a social unit comprised of individuals who share a location (e.g. place-based communities) or values (e.g. religious communities) or practices (e.g. intentional communities). Individuals may belong to many communities at once or over the course of a lifetime. Communities are comprised of diverse individuals and are therefore intrinsically heterogeneous. Communities possess are capable of acting on their behalf or on behalf of those who have a claim on that identity.
- **Context** refers to the larger historical, political, economic, social and cultural processes across spatial, temporal, and social scales that shape and are shaped by local activities. Context is the sphere in which we lead our lives—the situation, conditions, and circumstances with which we interact directly or indirectly across multiple scales.
- **Culture** is comprised of the shared symbols, meanings, and representations that allow people to coordinate socially and carry out activities. Cultural systems of meaning shape the way that people interpret climate change, and provide an historical and sociocultural context within which impacts are experienced and responses are generated.
- **Holism** is a perspective that directs attention to contextual processes and interactions among entities in systems, rather than seeing them as a static set of components. It the approach to understanding that anchors an anthropological perspective, providing not only understanding of particular social units, but an examination of the relationships among the elements which comprise those units.
- **Resilience** refers to the capacity of a society to withstand impact and recover with little disruption of normal function. It is not the opposite of vulnerability, but is often used as such.
- **Scale** is the set of dimensions that consider the extent and magnitude of the entities which we study. It provides additional explanatory value to our analyses. (1) Temporal scales allow us to understand social and cultural phenomena in historical and archaeological contexts; (2) social scales provide insights into linkages among political and economic structures at the nation-states and global levels, and with communities at the local and regional levels; and (3) spatial scales allow us to understand commonalities and differences across geographically and culturally separate entities.
- **Vulnerability** refers to the relationships between people and the total environment, including the physical setting and the sociopolitical structures that frame the conditions in which people live, and that place them at risk of harm from natural or technological hazard impacts.

1.0 Introduction: Anthropology and Climate Change

Anthropology has engaged with climate and with other disciplines investigating climate throughout its history. Anthropology is making valuable contributions to the understanding of contemporary climate, climate variability, and climate change policy and governance from its unique perspectives of archaeology and ethnography. But anthropology can do much more, both through engagement and scholarship, to contribute to climate research and discourse. This section explores anthropology's relationship with climate issues, highlights the discipline's insights to climate and human interactions and suggests anthropology's important contributions.

Although we forefront examples illustrating real-time impacts of climate change to communicate the urgency of the issue for affected peoples, we recognize that climate change is experienced by people across the globe as climate variability or local environmental change, such as an unexplained drought. Climate change is interpreted, explained and lived in local contexts based on local knowledge, culture, political positioning, and the like. Anthropologists use cultural analysis and theory to understand the diversity of perceptions involving climate change.

1.1 Climate Change Is Affecting Us Now

While US public opinion polls find that a majority (two-thirds of respondents) acknowledge that climate change is occurring, respondents generally do not consider themselves as being vulnerable. They see climate change as a geographically distant threat that will not affect them in their lifetime; they think that will affect primarily people and places far away (see Pew Research Center 2014; Leiserowitz et al. 2006; Leiserowitz et al. 2010). Conversely, a majority of anthropologists understand that climate change affects us now and at home. We present three examples to illustrate.

- The Inuit of Shishmaref and Kivalina, Alaska live in villages previously protected from winter storms by a buffer of hardened, multi-year sea ice. They now must deal with coastal erosion, resulting not only in a reduced ability to cross the ice to hunting grounds, but also the physical destruction of their residences and infrastructures (Shearer 2012; Marino 2012). They now must relocate, a process that will erode community agency as they lose their subsistence base and the practical knowledge that bridges elders with younger generations. They also lose other social ties that make them resilient, including weakening reciprocities during the winter hunt. The gravity of such losses are compounded by a lack of political standing and active participation in the relocation processes (Marino 2012; Marino and Ribot 2012).
- Ioane Teitiota, a resident of Kiribati in the south Pacific, petitioned the New Zealand Supreme Court for refugee status to stay in New Zealand after his visa expired, calling his native Kiribati “uninhabitable” due to rising tides and salt intrusion. He was turned

down, on grounds that he did not meet the conditions of persecution required of a refugee under the UN Refugee Convention. The court stated that if it decided in his favor, the decision would have opened the door to millions of people suffering from the hardships of climate change (BBC News Asia October 13, 2013). More recently (2014) Kiribati president Anote Tong announced on-going negotiations with Fiji in preparation for relocating people from Kiribati islands to other lands in Fiji. Kiribati has already purchased 6,000 acres of land on Fiji's second biggest island, Vanua Levu, to ensure food security as the sea encroaches on its arable land. ([http://www.climate.gov.ki/tag/press-releases-2/ /](http://www.climate.gov.ki/tag/press-releases-2/))

- The residents of Coopersville, Maryland once inhabited a flourishing town, boasting the activities of watermen (crab, oyster and fish harvesters), seafood processors, restaurants, and modest vacation homes. With sea level rise, they now face frequent flooding and preparations for the next big storm. In concert with existing concerns about rolling easements and dwindling real estate values, the changes portended by climate variability and flooding exacerbate an already difficult economic situation for residents—in this case, climate change intensifies the social and economic decline in that part of the state.

1.2 A Brief Look Backward

In 1975 anthropologist Margaret Mead convened a conference with William Kellogg to consider the fate of “the ultimate international commons”—the atmosphere. Though focused on dust, smoke, smog, and other forms of particulate pollution that were the object of public attention at the time, the conference demonstrated concern for the atmospheric commons and highlighted the global nature of the problem prior to public concern about GHGs. In her conference report, Mead foreshadowed the current divisions between scientists and politicians, and between social scientists and decision-makers, which she believed would derail global governance of the atmosphere. (Mead 1980).

Mead's statement came when interest in climate change was building across the US, at research institutes and in academia. The National Center for Atmospheric Research (NCAR), in Boulder, Colorado, established a Societal Impacts workgroup in the social sciences to take on climate and the atmosphere. El Niño and the social impacts of El Niño were an early focus at NCAR, as well as the growing concern of carbon dioxide accumulation.

Anthropologists and other social scientists, including economists, geographers, sociologists, psychologists, and political scientists, were early on tackling global environmental and climate change. Michael Glantz, a political scientist, presaged the difficulty that the US would have politically in dealing with a slow-onset crisis in the atmosphere (Glantz 1979). International interdisciplinary efforts also emerged at this time. The IPCC was formed in 1988 under the United Nations Environmental Program. The US Global Change Research Program (USGCRP) in 1990 authorized a national research program focused on the earth and biogeophysical sciences; but within that umbrella provided for an interagency human dimensions program, as a number of federal agencies had requested funding for social and decision sciences. In addition to the National Science Foundation's early Human Dimensions of Global Change program, other federal agencies established human dimensions programs as part of USGCRP in the 1990s,

including the Department of Energy, working through Battelle Pacific Northwest Laboratories; the US Department of Agriculture, and the National Oceanic and Atmospheric Administration (NOAA), through its grants program on climate change.

During this time, a small number of anthropologists were tackling global change from a cultural and policy perspective (e.g. Gerlach and Rayner 1988; Rayner 1989; Rayner and Malone 1998). Several anthropologists participated in the first IPCC assessment in 1990; and a 4-volume set on social sciences accompanied the largely geophysical and atmospherically-based first Assessment Report (Rayner and Malone 1998). NOAA funded a number of anthropological studies, particularly with respect to the anthropology of climate that resulted in a substantial body of

With anthropology's clear sense of the human-associated nature of climate drivers and impacts, climate change is one of the imminent global issues where anthropologists can and should take a stand on the core substantive underpinnings of the issue.

scholarship that addressed risk perceptions and management, decision making processes, social production of knowledge, and interactions of science, policy,

and politics (Orlove et al. 2000; Broad and Agrawala 2000; Broad et al. 2002; Broad et al. 2007; Roncoli et al. 2009; Lemos et al. 2002; and Peterson et al. 2010; Crane 2010). Anthropological research is prominent in one of the first assessments of research priorities for social sciences in climate change (NRC 1999). Archaeologists began providing definitive accounts of climate and its impacts on the history of civilization (1999, 2004, 2008, 2010). Other anthropologists were engaged with climate change issues through the IHDP (now part of Future Earth), and other research institutes and consortia, government organizations, and non-profits. In 1999, Kathryn Brown, writing in *Science*, concluded that “[c]limate anthropologists appear to be making strides at relating global warming models to everyday lives” (Brown 1999:1141).

As the public discourse of climate change expanded in the late 1990s and into the 21st century, and as the politicization of concepts of climate and global governance gained momentum, anthropologists showed an increased interest in climate-related research and policy. A growing number of anthropologists are examining the climate governance enterprise, taking a critical view of the science-driven hegemony of the Kyoto governance process, focusing on the inability of the current system to draw thoroughly on other cultural perspectives (e.g. Verweij et al. 2006); bringing insights regarding the production of knowledge about climate change (see Lahsen 2007); and raising questions about how participation in knowledge production (or lack of it) shapes the reception of climate knowledge among various publics (Barnes et al. 2013).

Anthropologists are documenting the effects of climate variability and change on human societies, cultural perceptions, the connections of global and local processes, and the contribution of human actions to GHG concentrations. The rapidly-growing body of scholarship in climate and anthropology includes at least a half dozen books and edited volumes from major publishers dealing specifically with the anthropology of climate change (in alphabetical order, Baer and Singer 2009; Crate and Nuttall 2009; Dove 2013; Fagan 2010; McIntosh et al. 2013; Rayner and

Malone 1998; Redman 2004; Strauss and Orlove 2003). The number of high-level syntheses and review articles continues to grow in peer-reviewed journals, both nationally and internationally (deMenocal 2001; Barnes, et al. 2013; Crate 2011a; Hastrup 2013; Palsson et al. 2013; van der Leeuw 2008). Additionally, there are several special issues of journals, guest-edited by anthropologists, including one in a climate science journal over a decade ago and one in the *American Anthropologist* (Magistro et al. 2001; Nelson et al. 2009).

There is an increase in numbers of peer-reviewed articles by anthropologists appearing in cross-disciplinary journals such as *Global Environmental Change*; *Climatic Change*; *Nature Climate Change*; *WIREs Climate Change*; *Climate and Development*; *Climate Risk Management*, and *Weather, Climate and Society*. In an ISSC-commissioned bibliometric report anthropology ranks eighth among 27 sciences in the number of articles published on climate change and environmental change for the 2000-2010 period (Hackmann and St. Clair 2012:10). The increase of anthropological engagement can also be seen in the annual meetings of anthropological associations, and there is concomitant growth in the number of undergraduate and graduate classes on climate change, “the Anthropocene,” and anthropology.

1.3 Roles, Vantage Points, and Contributions

During his 2006 Jack Beale Memorial Lecture on Global Environment, Steve Rayner characterized climate change as a “wicked problem” requiring “clumsy solutions.” Rayner explained that wicked problems have no clear set of alternative solutions, tend to have redistributive implications for entrenched interests, and are symptomatic of other, deeper problems (Rayner 2006). “Clumsy solutions” are characterized by creative and flexible combinations of “organizing, perceiving, and justifying social relations” (Verweij et al. 2006: 818). Clumsy solutions to wicked problems like climate change take advantage of multiple perspectives on reality and a deep understanding of the problem’s integration in social and cultural systems. Framed as such, climate change has multiple causes, pieces and alternative solutions at different scales, requiring the attention of numerous disciplines, addressing both the impacts and the framing(s) of climate change.

Despite increasing confidence in understanding and modeling the future of the earth’s biogeophysical systems (see IPCC Assessment Report 5 Working Group I, 2013 (https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml)), critical questions about integration with human systems remain unanswered. Understanding the complex interactions that underlie and propel climate change involve natural and earth systems disciplines, but they require social sciences as well.

Economists discuss the effects of climate change on national and international economies, and debate the proper frameworks for making trade-offs between expenses in the present (for reducing emissions or for adapting to impacts) and gains in the future (which derive from reduced harm). They consider the effects of different economic instruments—taxes, cap and trade systems, and incentives—in promoting less carbon-intensive energy systems. Political scientists study climate treaties, protocols, and other agreements, whether between nations, provinces, cities or other units, to coordinate their reductions in emissions and to finance adaptation. Sociologists conduct public opinion studies which trace the shifting views of climate

issues, analyze the institutions which seek to influence climate change discussions, and look more broadly at vulnerability, resilience, and risk in social life. Psychologists consider the cognitive and emotional mechanisms that influence the perception of climate change as a risk and which shape the propensity to take action to address it. It is noteworthy that not only do these disciplines contribute generally to the study of climate change, but also that scholars in these disciplines participate with each other and with natural scientists in concrete projects (see [section 6](#)).

Anthropology has an important role to play with respect to climate change, and global environmental change, and contributes critical missing pieces to the puzzle—both from within the dominant interpretive framework, and from perspectives outside representing alternative voices of climate change. Anthropology is well-positioned in the interface between human culture and behavior and the earth sciences to comment on climate and climate change. We have a clear understanding of the human-associated nature of climate drivers and impacts, as well as the culturally-bound framing of international governance regimes such as the Kyoto Protocol. Global climate change is one of the imminent global issues where anthropologists understand the complexity of human-earth interactions and can play a role by showing the complexity of problems in the face of reductionist strategies to set canonical limits on carbon dioxide (e.g. 350ppm).

Anthropology contributes the key temporal dimension of human experience with climate change—historical, archaeological and paleological. Long time frames of hundreds to thousands of years and beyond are important since data from short time spans can lead to spurious causalities and faulty understandings (Crumley 2014). Archaeologists, physical anthropologists, and biological anthropologists comb through the evolutionary trail of hominins, complex societies, and the rise and fall of empires to bring events in the previous geological epoch to bring knowledge to contemporary questions of adaptation. Archaeologists, historic archaeologists and historians have documented limits to and successes of human adaptation under climate stress—how societies responded to episodes of severe climate change in conditions that are analogous to those precipitated by anthropogenic climate change as discussed in Section 3.

Anthropologists link the past with the ethnographic present through historical perspectives based on archival research and oral histories. Ethnographic data from across the globe document with increasing frequency the challenges that humans are facing in a changing climate as well as differing interpretations of climate. Cultural and linguistic anthropologists investigate climate change beliefs and attitudes, and the religious and ontological questions that climate change

No other discipline and profession is better positioned to comment on the human challenges of global environmental change.

provokes. Across all the sub-disciplines, anthropologists have been among the earliest observers to document the drivers of climate change in industrialized nations and less developed states, and the disparate and insidious impacts that climate change is causing. Anthropologists understand how global processes affect local contexts, such as the increasing cash crop production for

markets, the search for wage labor and its effects on gender, families and communities, and increasing economic specialization (see Crate and Nuttall 2009).

As the discipline that has a firm grip on the genesis of the concept of culture, anthropology has important contributions to make from a cultural perspective—such as challenges to the dominant perspectives on climate change. Anthropologists gain insight into alternative systems of thought that do not fit neatly with the Western scientific perspective and theory of climate change, not to mention the global bureaucracy set up to deal with it, through cultural analysis. Alternative ways of thinking about climate change and climate variability are contextually and historically-based interpretations far different from climate sciences’ dominant paradigm of drivers, actors, impacts and action (see Sheridan 2012; Lipset 2013). A unique role for and contribution of anthropologists is to stand outside the climate change system of prescribed beliefs and see alternative perspectives on climate change, not adopting one paradigm or another as our interpretive framework. Anthropology is uniquely placed to question the meaning of climate change, how it is constructed by different parties including science and political actors, and how it is maintained. An important role of anthropology to “problematize the problem” of climate change and to challenge the basic cultural assumptions that underlie IPCC approaches to climate change. Section 4 undertakes that challenge to the key concepts of adaptation, vulnerability and resilience as used in contemporary climate change policy today.

It is a common observation that, particularly in the US, climate change has become a cultural battleground between conservative and liberal worldviews. Anthropologists see the political and public resistance to the science of climate change as part of a cultural and political divide within western, industrialized countries, between believers and deniers of climate change; this in turn is an instance of greater questioning the authority of science and its use in political and policy circles, contestations occurring historically since the development of natural science paradigms. Anthropologists provide insight into alternative climate change beliefs from the perspective that these are systems of thought that offer alternate views of climate change.

1.4 Methodological Tools for Understanding Climate Change: Drivers, Impacts, Engagements

Anthropologists contribute an understanding of climate and environmental change as driven by social, cultural, economic, and political factors at various scales. Climate change affects human well-being in unpredictable ways—for example, through markets, new environmental stresses, multilateral agreements between actors that affect food production, aid and governance history (Bohle et al. 1994). In order to address this complexity, anthropologists employ a broad tool set to link scales of interaction including ethnographies and model building using remote sensing and GIS tools coupled with traditional ecological knowledge. These tools are relevant for studying the drivers of climate change, and all other areas addressed in this report, from impacts to community engagement to interdisciplinary research. The challenge before us is to develop team-based methods integrating anthropology’s strengths of close observation and detailed case study with the survey, statistical, and accounting methods of the sustainable-consumption, energy use, and climate-change communities.

1.4.1 Ethnography

In her review article on climate and culture, Susan Crate highlights the importance of ethnographic methods for climate research, because by “being there” (Geertz 1996) ethnographers can use this “methodological power to bridge local understandings beyond the local to the multitude of stakeholders and on a multitude of scales” (Roncoli et al. 2009:88; Crate 2011a:177). Ethnography is a way of grounding the climate problem by exploring cultural phenomena in the context of social life. Through ethnography anthropologists analyze the embedded linkages between climate beliefs and culture, identity and politics. Ethnographies describe the many ways individuals within a community are capable of responding to climate change depending on wealth, status, gender, etc. The initial promise of science-driven, global scale approaches to govern our atmospheric commons has proven ineffective because of these hidden linkages. Rayner (2003) and Peterson and Broad (2009) have demonstrated the importance of examining climate and weather discourse, while Ogilvie and Palsson (2003) have used Norse sagas to convey perceptions of weather and climate in Iceland. Meltzoff demonstrates the importance of “empathic ethnography” (2013:4-7) for making sense of the varieties of environmental change she encountered up and down the coast of South America. And the use of archaeological data, especially in conjunction with paleobotanical or paleontological approaches, has yielded significant insights into, for example, population shifts during the Holocene in Wyoming (Kelly et al. 2012) and Europe (Shennan et al. 2013) or other diverse manifestations of human responses to a changing climate in various locations around the world (Kirch 2005).

Integrating traditional ecological knowledge (TEK), into climate models represents a significant innovation to environmental research and practice. Individual perspectives and experiences and local ecological knowledge, color how we interpret, analyze and recall weather events, making the integration of this knowledge into climate research challenging. Nevertheless, connecting diverse knowledge systems is being emphasized in many emerging global assessment programs. Anthropologists are at the forefront of co-designing and co-producing research from this approach (Tengö et al. 2014) (see Section 6.3.1).

1.4.2 Models and Other Tools

Anthropologists link processes from individual perceptions to social engagement at the local level and connect them to other components of society (e.g., governance) at various spatial (e.g., linking localities to regions) and temporal scales (e.g., examining current land cover in the context of past land use decisions). One way to link these multi-scalar processes and to better understand the interactions among the economy, the environment and human-wellbeing is to develop models, both conceptual and computer based. Some model building requires significant collaborative efforts from both the natural and social science communities. However, the mainstream social and natural sciences models for climate change research have been for the most part piecemeal, with social scientists and natural scientists working separately to understand and develop solutions for a specific problem. In some cases (e.g. Lahsen 2005), anthropologists have studied the production of models by physical scientists, and demonstrated that the relationship between the modeler’s world and that of empirically knowable reality can be quite dissociated.

In the 1960s to 1980s, several important studies emerged as social science borrowed concepts and analyses from the ecological sciences, including the ecosystem concept, energy flows, and

adaptation (e.g., Vayda and McCay 1975; Thomas 1976). Later, factors such as landscape history (Crumley 1994a), policy and power (e.g., Brosius 1997; Escobar 1999), and cultural meanings (Peet and Watts 1996; Berkes 1999) were integrated into social-ecological studies. The vulnerability analysis and hazards research developed the pressure and release model where risk was defined as a function of the stress plus the vulnerability of the social unit (Blaikie et al. 1994, Turner et al. 2003). Physical hazards and social causes of vulnerability were addressed together and been used to address social groups facing disaster events (see Section 4).

More recently tools such as geographic information systems (GIS), remote sensing and participatory mapping have enhanced integration of increased complexity into studies of SESs (Brondizio and Moran 2012; Rambaldi et al. 2007). Spatial analyses using GIS have helped to bridge social and natural sciences by providing, for example, geographic context to household survey results (e.g., Boone et al. 2000). Remote sensing and land use change science have provided a means to address the effects of human activities across broad spatial and temporal scales. New conceptual models that include micro-cultural processes (e.g., perceptions) and macro-societal processes (e.g., globalization at various scales) are now recognized as important elements of research in human-environment interactions (e.g., Liverman et al. 1998).

Simulation modeling is a tool increasingly used by anthropologists (cf. Galvin et al. 2006; Boone and Galvin in press). Simulation models constitute a class of models that are abstract representations of particular facets of reality that are built for specific purposes. Such models are generally computer-based, and are completely flexible in their underlying structure. A good simulation model operates with input data to produce output data by mimicking particular processes and parts of reality that are of interest to the user (Thornton 2001). Their predictive ability can be used for many purposes, including assessing tradeoffs between multiple stakeholders. A relatively new area of modeling in anthropology is in agent-based models (ABM) that can be used to generate simulations of social and ecological processes. West (2009) has used ABM in relation to climate variability (see [Appendix 6](#) for more on modeling). Anthropology brings a critical eye to its own methods and framing of problems, as well as to those with whom we work. Anthropologists recognize the value of conceptual modeling and scenario generation, but also understand that all models are simplified constructions (“All models are wrong, but some are useful” — Box and Draper 1987), and follow the GIGO (garbage in, garbage out) principle. It is also critical to recognize that, like other kinds of data,

Models can be instruments of power, so the context is always critical. Models can never be used in isolation, but must always be subject to ground-truthing to avoid the easy fall into reification—in which the model takes on its own authority, appearing to be the reality it is, after all, only approximating.

once they are completed, models can be used in ways that are not appropriate, even when inputs have been more inclusive than is typical. Fundamentally, the anthropological perspective supports the critical use and uptake of many different kinds of models, from narrative frameworks to complex coupled social-ecological systems analysis, always ensuring that these representations of reality

are connected with local experiences as well as expert knowledge in other spheres.

1.5 The Anthropocene: An Integrative Opportunity for the Discipline

Many anthropologists embrace an “Anthropology of the Anthropocene” which includes climate and all aspects of global change and which allows every subfield to make a contribution. Biological and medical anthropology are fundamental for understanding future human health issues under changing climate scenarios (e.g. Baer and Singer 2009). Anthropologists use discourse analysis and cultural models, both of which have applications to re-framing the policy dialogues climate change (Lahsen 2013; Kempton 1997).

Every subfield of anthropology has something to contribute to the puzzle of climate change because of its global and cross-cutting nature.

Cultural anthropologists studying climate change communication and knowledge transfer contribute understanding of how people recognize and utilize new information (Brugger et al. 2011). The fields of ethnoclimatology and ethnometeorology focus on how people perceive and understand weather and climate (including climate modelers themselves). Environmental anthropologists study consumerism, consumption chains, energy transitions, and adaptation to climate change

policies (see Lipset 2013) and have spawned the “anthropology of consumption” and behavior, that looks at emissions related issues and also an “anthropology of impacts and adaptation” which is rooted in experiences of climatic variability. Archaeologists make sense of our evolutionary past, as civilizations dealt with changing climate regimes over the millennia; and cultural anthropologists study contemporary experiences as people struggle with the changes brought by changing climate and ecosystems. In many settings around the world, climate change has generated profound disruptions in both sociocultural and ecosystemic contexts. Those affected include both place-based communities who have a direct and daily interaction with their environment, as well as wider communities of faith who recognize that climate changes have altered their ways of orienting to the world. Nearly all belief systems and religions have some notion of a nature as a gift or garden to be sustained or at least honored. Climate change endangers this notion; therefore the issue does not create “fault lines” for us, but instead offers an opportunity to collaborate within the discipline and with other disciplines; and a way to take on “global entanglements” beyond culture and nature (Hastrup 2013).

1.6 Engagement and Policy

Understanding perceptions and responses to change by local communities has long been a strength for anthropologists, and, in the context of contemporary climate change, many anthropologists are undertaking collaborative and participative research where communities experience environmental changes and climate variability. Anthropologists would like to play a greater role in the development of climate policy and in climate discourse. There are multiple

structural reasons and institutional practices that hinder the visibility and effectiveness of anthropological research in climate circles. Nonetheless, anthropologists have provided critical insights into policy processes and climate change policy, as a topic of study, emerging from Science and Technology Studies in particular. An important long-term contribution of anthropology is in helping to re-frame policy discourse and processes from a perspective critical of current approaches. Anthropologists today are active in climate change policy domains, as agents of change, for example, in developing climate change plans of federal agencies; drafting guidelines for Free, Prior and Informed Consent procedures (FPIC); identifying the needs and guidance for historic preservation under conditions of climate change; funding research on public health and community resilience against infectious diseases through public health agencies; developing legislation for national carbon emissions policy (Fiske 2011). Both the National Climate Assessment program, part of the USGCRP, and the IPCC AR5—both out in 2014—have growing involvement of anthropologists. Anthropologists are engaged with climate change and policy at many different levels (see latest special focus issue on climate change in *Anthropology News* <http://www.anthropology-news.org/index.php/category/in-focus/>). ■

2.0 Anthropological Approaches to the Drivers of Climate Change

Humans have entered the Anthropocene, in which we inhabit an increasingly unstable planet and are the dominant species. Decreased water quality and access, reduced biological diversity, and large scale climate change are but some of the symptoms of this epoch. These changes, in turn, affect human social and cultural systems, a feedback cycle that leaves many of the poor, both rural and urban, highly vulnerable. The globalization of markets provides new opportunities, but also creates novel stresses as local production and consumption systems succumb to market conditions. A growing consumer culture enables a global rise in standards of living, increasing demand for electricity and manufactured goods, but also drives greater carbon emissions. While many individuals and communities benefit from economic growth, others subsidize growth through providing cheap labor in oppressive conditions, with degraded local resources and multiple inequalities. In short, we need to understand how GHG concentrations increased so quickly, the causes and the social impacts of that increase and ways to ameliorate the situation.

To these ends, this section looks at the cultural processes driving climate change. Climate change results from the GHGs generated from increased production and consumption of goods and services. Countries with higher standards of living, faster economic growth, and the largest populations contribute the majority of these GHGs. Extraction, transportation, manufacturing, selling, and disposing of a huge volume of consumer goods is directly responsible for the increase in GHG concentrations since the industrial revolution (IPCC 2013). Because of greater global economic integration, the impacts of consumption in one place are often transferred to communities far away (Princen 2002).

Climate change drivers are highly diverse and complex. In order to halt climate change and develop sustainable adaptive strategies for the future, a systems approach linking people, the environment, and the economy is necessary. Systems-thinking forces us to engage with new concepts, methods, and models that bridge many disciplines (see Section 6). Anthropology adds a holistic view of human society to the interdisciplinary toolbox and a substantive record of understanding human-environmental interaction over the long term.

We first look at the major drivers of climate change and ways that anthropology has studied them. Second, we address anthropological perspectives on human-environment interaction. Third, we describe several tools used by anthropologists to address climate change drivers, including ethnography, model-building and other tools.

2.1 Drivers of Climate Change: Consumption, Land Use, Energy, and Population

Political, sociocultural and economic processes and forces are directly and indirectly driving climate change. Here we focus on four of the most important drivers that anthropologists have studied: expanding consumer culture, land use, the sources of energy, and population growth. These are just a few of the ways anthropological knowledge can and should be relevant to finding practical strategies to slow down the engines of growth in GHG emissions. The recent anthropological turn towards research on transnationalism, globalization and neoliberalism has addressed many more drivers, like migration and remittances, growth of mega-cities, and the construction of dams, roads and other capital-intensive infrastructure and energy projects, which in turn are linked to these four key drivers.

2.1.1 Consumption

Burning fossil fuels for electricity, construction and transportation are the largest sources of CO₂ emissions. Deforestation, another source of CO₂ is largely a consequence of increasing food production and the wood products industry (IPCC 2013). Behind these abstractions, though, there is an almost infinite variety of human activities that are generally gathered together under the label of consumption. We are changing the planet, not just to feed growing billions of

Nation-States are the standard unit of analysis for greenhouse gas accounting. But the cultures of consumption play out in very unequal ways across social, economic, and political domains. Purveyors of high-consumption lifestyles in different nations are likely to have more in common with each other than with low-consumption citizens of their own countries, and even those who are living less energy- and consumption-intensive lifestyles may be doing so for radically different reasons.

working poor, but also to support the increasingly opulent lifestyles of the wealthy. In the middle are billions of people who see electricity, motorbikes, cell phones and the comforts of a home as major life goals. Today anthropologists are focusing much more attention on the consumption of this global middle class (e.g. Nelson 2012; O'Dougherty 2002). Although economists tend to treat demand (and the related notions of preferences and utility) as black boxes, demand

is the ultimate driver of all economic growth. Estimates of future growth in greenhouse gasses are also based on models where income serves as a proxy for demand. Anthropologists find, to the contrary, that consumption is a complex social product, and that demand is therefore driven by culturally-specific concepts of “necessity” and “luxury,” divergent morals and values, grounded in a long human history of using material to mediate social relationships (Miller 2013; Trentmann 2009). National data show that across countries people with the same levels of income save and spend in very different ways, consume different bundles of goods and services, and therefore vary greatly in their environmental footprints and greenhouse gas emissions (Durning 1992; Rosa and Deetz 2012).

Anthropologists also question the use of nation-states as the standard unit of analysis for greenhouse-gas accounting. The global divide between over- and under-consumption does not follow regional or state boundaries. Anthropologists of globalization recognize that today each country has its own high-consumers, as well as intermediate and poor classes that consume much

less. The affluent cosmopolitans in different countries can have more in common with each other than with the urban and rural poor in their own country (Hannerz 2002).

Many countries also displace their GHG emissions to other countries by importing energy-intensive goods and outsourcing services such as recycling and data processing. A more accurate depiction of global consumption provided by Redclift (1996) depicts roughly 1.5 billion high-level consumers, a similar number of destitute poor, and a global “middle” who have only precariously entered consumer culture. North Americans already consume 20 to 60 times as much energy and material as a person in a poor agrarian country. Other goods are even more unequally distributed; the richest 20% of the world’s population consume 11 times as much meat as the poorest 20%, and also have much better access to clean water and health care. These imbalances determine environmental impacts of consumption, which far outweigh the effects of population size and growth (Michaelis and Wilk 2005).

Despite a long engagement with material culture, anthropology is making headway on understanding the cultural and social determinants of environmentally significant consumption. Anthropology has recently started to focus on the meaning of consumption in daily life, and reasons for the profusion of consumer products in the marketplace. Anthropologists have studied commodities and products as diverse as sugar, gold and perfume, fair trade coffee, and have valuable insights into the ways that goods are embedded in all of social life (e.g. Douglas and Isherwood 1979; Appadurai 1986; McCracken 1988; West 2012). We also have a sound record of research on global consumer trends like Fair Trade, Slow Food, organic standards, and artisanal handicrafts. The value of these trends is now recognized in marketing and market research where anthropologists have found employment both as teachers and practitioners (Sunderland and Denny 2007; Sherry 1995) (see [Appendix 6](#) for more detail on consumption).

2.1.2 Land Use Change

Globally, carbon dioxide emissions from fossil fuel combustion are overwhelmingly responsible for the increase in atmospheric greenhouse gas concentrations since pre-industrial times. However, land use change is considered the second most significant contributor to climate change (IPCC 2013; Moran et al. 2005; Turner et al. 2007). Humans have changed the land since time immemorial and especially with the dawn of agriculture (circa 10,000 BP). Today agriculture alone occupies approximately 40% of earth’s surface, contributes an estimated 30 to 35% of global greenhouse gas emissions, due primarily to large scale tropical deforestation, livestock and rice cultivation (methane) and fertilization of soils (nitrous oxide) (IPCC 2013;

Land use change is, in large part, caused by policy and economic drivers associated with the demands of increasing numbers of people, global economic trade and trade compacts, and consumption patterns.

Foley et al. 2011)
Urbanization, mining, commercial logging, infrastructure development (e.g., roads, dams) and energy (e.g., oil and natural gas) exploration are also contributing to land change.

Anthropologists have long documented land use changes as humans have made a living from the land and profited from their uses for millennia. Archaeologists have reconstructed the Neolithic transformation of the

earth's surface by agriculture, for example (Ruddiman 2013) (see Section 3). Anthropologists are investigating the drivers of land use change and consequences for peoples around the world, and the interactions that occur between these at multiple scales (cf. Brondizio and Moran 2008; Moran 1993). Some have collaborated with natural scientists to understand the effects of land use change on regional climate patterns (Ojima et al. 1994).

Anthropologists study the processes that turn forests, wetlands, and grasslands into crop land or pasture (Galvin 2009, Moran 1993, Lambin et al. 2001) and how government programs that allow for transnational mining and logging have affected local peoples and their livelihoods (Vasquez-Leon and Liverman 2004; Tsing 2005). Not all land use change derives from global forces; local people shift land use because of increased need for cash, local market forces, or the need to be near social services such as schools, clean water, and health care. Humans also alter the use of lands when responding to conflicts, livelihood insecurity, and disease, for example (e.g., Janes 2010). One of the early refinements to global circulation models came from social scientists, particularly anthropologists and geographers, who argued that land cover alone is not what drives carbon emissions; it is the rate and nature of land use change, which in turn stems from humans' activities that transform the land (National Research Council 1999:12).

Because land use change often has detrimental effects for smallholder households, anthropologists look at solutions to decrease vulnerability and increase resilience to change, especially for the poor. Whether or not the responses of people enhance resilience or adaptive capacity, or cause more vulnerability, depends on the specific local histories and institutions (see [Appendix 6](#) for more detail).

2.1.3 Energy

Energy resources, technologies, and markets have developed over long time periods, and are thoroughly embedded in culture, even at the level of finance and arbitrage (Ho 2009). Anthropology is engaged in addressing ways to promote efficiency, reduce waste, and cut energy use in the US and other developed countries (Henning 2005).

Perhaps the most fundamental contribution of anthropologists is to the underlying issue of why high-energy lifestyles are so attractive, and even seductive to people who had previously followed sustainable, low-energy lifestyles. Anthropology thrives on the details of the often-counter intuitive impacts of increasing incomes, energy use and access to consumer goods on nutrition, well-being, justice and social life. Anthropologists bring their holistic insights further

Comfort and convenience, the crucial motivations of classical consumer research, are embedded in cultural assumptions (Shove 2003).

into engagement with the emerging “sustainable consumption” field, and with concepts like degrowth, steady-state economics, simple living, and food localization (e.g. Cox 2013).

The discipline has long engaged with broader questions about energy and human cultural evolution (e.g. White 1959; Adams 1978). Leslie White was the first anthropologist to focus attention on the ways that cultures harness energy, taking the strong position that cultures evolve as their ability to harness energy

intensifies (1943). His posthumously published work on *The Fuel Revolution* (2008) details the impact of the Industrial Revolution and especially the later fossil fuel revolution, which allowed for enormous shifts in labor management and social institutions. Later anthropologists, especially Laura Nader (Nader 2010; Nader and Beckerman 1978) pushed hard for the recognition of energy studies from a sociocultural perspective, but their efforts went largely unheeded until the recent recognition that climate change and energy were two sides of the same coin.

Some ethnographic work on household energy consumption was prompted by the first “energy crisis,” finding ways for consumers and public utilities to reduce household energy use (e.g. Kempton et al. 1992; Kempton 1986; Wilhite 1996; Wilk & Wilhite 1984). Applied anthropologists have a long track record of studying why some technical innovations and goods are accepted, while others never catch on (e.g. Sharp 1952; Mead 1955; Tax 1957). More recently, the anthropology of energy and its role in climate change has broadened and expanded significantly to include sustainable energy futures, the social aspects of energy infrastructure, and the role of energy in everyday routines (e.g., Strauss et al. 2013; Nader 2010; and Wilhite 1998). The anthropology of energy has contributions to make to climate change science at scales from the household level (Henning 2005; Winther 2008) to the regional (Vandehey 2013; Love & Garwood 2013) and the transnational (Breglia 2013; McGuire and Austin 2013), linking domains from health (Cartwright 2013) to consumption practices (Wilhite 2013; Wilk and Wilhite 1985). Renewable resources like solar and wind (Strauss and Reeser 2013), as well as nuclear energy (Gusterson 1996) and fossil fuels, from coal (Rolston 2013) to oil (Weszkalnys 2013; Sawyer 2004, Bank 1997) and natural gas, each present specific concerns and opportunities with respect to behaviors, values, and environmental concerns.

2.1.4 Population

The impacts of consumption reflect both the levels of individual consumption and the number of individual consumers, so the growth in population and the growth of consumption have jointly contributed to a human predicament of threatened collapse (Ehrlich and Ehrlich 2013). Population growth and increasing environmental degradation are often seen as a one-to-one correlation. However, the relationship between population growth, land use changes, and gas emissions is extremely complex: the deceleration of population growth directly leads to fewer emissions but in the same time accelerates economic growth and therefore increases per capita emissions. Anthropological studies have also shown that there is no simple linear relationship between population growth and environmental degradation (i.e., Caldwell 1984; Blaikie and Brookfield 1987).

We have generally followed Esther Boserup’s argument that population pressure drives continuing social and technological innovation, and is not itself a cause of poverty or collapse (Boserup 2005 [1965]). We also question the over-general application of demographic transition theory, pointing to diverse fertility rates in similar societies (Polger 1972). While some societies have managed to achieve demographic stability, others have entered cycles of increasing poverty and immiseration that drives further population growth, often pushed along by government policies that inhibit local adaptation (Netting 1995).

Changing gender roles, particularly the education of girls and young women, has proven a key issue in understanding population growth. There is a strong inverse relationship between female education and fertility. At a more general level, family and household organization also effect

energy use and emissions; per capita energy use goes up as households get smaller and single-adult households proliferate. Gender is deeply implicated in the origin and growth of contemporary consumer culture as well; romance and sexuality drive vast industries (e.g. marriage, tourism, entertainment, sports), while extractive and heavy industries depend on heroic forms of masculinity. Gender also presents some dramatic obstacles to sustainable development, in that improving education, diets, and medical care all lower total fertility, and therefore population growth. At the same time they also tend to increase consumption.

Anthropological studies show this complexity of gender relationships and defy taking a universal approach to lowering population numbers (i.e., Arizpe et al. 1994; McCallister et al. 2012; Foley 2007). For example, the global revolution that would need to take place to change cultural and social norms towards contraceptives and family planning could only happen if all societies had the same economic and social incentives, which they do not. An anthropological focus on gender has shown that curbing population growth is associated with women's health and is only achieved with access to other basic needs such as education, secure livelihoods, good nutrition and clean water. Approaches to family planning are insufficient when these needs are not accessible to both women and men.

As populations rise, demand for food increases. Agriculture is often touted as the solution to meeting demands and increasing food security across the globe, but agriculture is paradoxically also a major contributor to carbon emissions, broad-scale land use change, loss of biodiversity and climate disruption (Foley et al. 2011). It is also a paradox that affluence and decreasing fertility are associated with increasing carbon emissions and a warming planet (see [Appendix 6](#) on global policies that add to this paradox). Population growth is indeed a factor in growing carbon emissions, but it is by no means a direct one-to-one relationship (Gallagher 2004; Shrybman 2000; Smith et al. 2007).

2.2 Anthropological Approaches to Human-Environment Interactions

Current research on human-environment interactions began in the 1940s and 1950s, though some would argue for a much earlier start. Julian Steward (1955) building on the work of his mentor, Franz Boas, developed the concept of cultural ecology as a way of understanding the relationship between cultural and environmental change. Steward examined environmentally-induced adaptation to describe the adjustment of “cultural cores”, that is, a society's subsistence strategies in relation to its environment (Steward 1955). Steward's methodology was an effort to make sense of human subsistence variability across a wide range of environmental conditions. Anthropologist Mary Douglas was first known for her work on pollution (1966), and later for her work with political scientist Aaron Wildavsky (1982) on the Cultural Theory of risk, developed in opposition to economic and psychological risk theories that were prevalent at the time. This approach demonstrated the significance of competing cultural values of risk perception that were related to differing groups in human societies, and has gained broad respect in anthropology and in other fields, including political science, environmental policy analysis and risk analysis. The notion of a “risk society,” proposed simultaneously by sociologists Ulrich Beck (1992 [1986]) and Anthony Giddens (1990, 1999), has become very popular with anthropologists; though not

identical, these two theorists consider late modern societies to be defined by their preoccupation with the management of risk in general, but especially with environmental risk. All of these approaches continue to serve as a basis for many social science engagements with climate and environmental change risks today (Nagle 2010; Rudiak-Gould 2013) (see [Appendix 6](#) for other examples of human-environment interactions).

Additional approaches to understanding human-environment interactions have emerged recently where research is focused on linked social-ecological system (SES) dynamics and change (Brondizio and Moran 2012). At least three factors in the development of a SES framework were particularly relevant to the study of climate change. First, adaptation as a fundamental concept in human studies was explored in the context of coping mechanisms, biobehavioral adjustments to stress (e.g., ecological, social, economic, political), or behavioral, institutional or societal flexibility (Little 1995) (see Section 4). Second, a systems approach provided the conceptual models of the components and interrelations of an ecosystem that included humans as an integral part of the ecosystem (Stepp et al. 2003). This approach led to the testing of hypotheses about cultural, institutional, demographic and societal behavior and human biology in an environmental context. Finally, the emergence of sustainability science (Kates et al. 2001) and sustainability frameworks called for a solution-oriented science with dual objectives of meeting the needs of society and sustaining the life support systems of the planet (Raven 2002).

Adaptation and resilience encompass the ways in which humans proactively and retroactively respond to forces of change and are often portrayed as positive goals. But normative goals, no matter how well intended, are necessarily prescriptive in nature, establishing a set of rules for policy and implementation efforts. Anthropologists understand that particular rules affect how benefits and risks are distributed thereby making some groups vulnerable; there are always winners and losers as a result of making group decisions and acting on them. Orlove (2005) uses cases from the archaeological and historical record to give a nuanced discussion of the limits of adaptation, importantly noting that people are differentially affected by such decisions. Anthropologists study people from all over the world, across different socio-economic and ethnic groups producing a wealth of information on local adaptations and local knowledge systems that can contribute to effective solutions that increase resilience and adaptive capacity and reduce vulnerability to climate change (see Section 4 for an in-depth discussion of these terms).

In summary, anthropologists are making major contributions to new frameworks, methods, and models for understanding the complex connections between the economy, the environment and human well-being under climate change, while also ensuring that these processes incorporate environmental and social realities at various scales. Because anthropologists understand the development of various drivers and impacts of environmental change on all aspects of society, we offer crucial insights for collaboration across disciplines on problems of environmental change. Anthropology's holistic framework and set of eclectic tools span research and practice. Increased understanding on the ways that anthropologists approach the study of climate change, in terms of its strengths in understanding local problems, the context of the problems and integrative methods, provides a productive pathway for collaborative problem solving. ■

3.0 Lessons of the Past and What it Can Teach Us

Anthropologists have found numerous analogs for the behavior of the human species under extraordinary conditions, which provide important insights to humanity's contemporary predicament with climate change. Although some researchers (Williams et al. 2011) have suggested that the Anthropocene may have ushered in "no analog" environmental conditions for the planet—in the sense of ecosystem conditions that are without precedent in the past, anthropologists have found numerous analogs for the behavior of the human species under extraordinary conditions. For more than two million years humans (including other species closely related to *Homo sapiens*) have modified, and been in turn modified by their environments, developed successful and unsuccessful ways to adapt, and learned a great deal about their surroundings. Archaeology, biological and medical anthropology, and disciplines outside of anthropology (geography, history, environmental studies, etc.) have pieced together an

In over 2.5 million years of human existence, we have proven ourselves at adapting to changing conditions. However, what we face today is unprecedented.

integrated history of humans and their environments over a remarkably long time span.

The question remains, What can the past teach us? Humanity is now at a turning point. In order to land safely in the future, we must change outdated and

destructive habits and replace them with new, future-oriented solutions. In over 2.5 million years of hominin existence, we have proven our ability to adapt to changing conditions. However, what we face today is unprecedented in both pace and scope. One important lesson of the past is that the human species is not invariably *homo devastans*, ruining every environment it occupies (Balée 2006). Further, humans are not inalterably and uniformly "consumptive machines" driving environmental degradation and climate change. To understand past and future changes, we must look to the cultural frameworks and human systems within which human activity occurs. Some popular writers have characterized our human past as a series of societal collapses and failures, and indeed there have been failures; clearly some more recent human activities are not contributing to a sustainable future. But the lessons of the past tell us that human systems are enormously diverse and are not explained by only a few variables. We are obliged to pay high-resolution attention to the nature of the changes in the past, melding archaeology, anthropology, and history with other ways of perceiving the past such as environmental studies, language and literature, and ancient DNA. A complex systems approach, which can accommodate changes in many variables and their interrelationships, can tease out the lessons for social change, resilience and adaptation (see, e.g., McAnany and Yoffee 2009), and address the enormous challenges of the future.

Critical to enduring ecosystems and the species inhabiting them is diversity, both biological and cultural. The latter, based upon the uniquely human trait of culture, shares a similar dynamic with biological diversity in that individual and collective innovations are tempered both by the

environment in which they are produced and by frameworks of rules and norms. Cultural change over the long term entails the constant re-shaping of traditions, values, memories, and experiences. The cultural diversity found in past and present human societies is thus a rich source of new ideas for a rapidly changing world.

For example, language is far more than a mere communicative tool. It is a symbolic system that represents accumulated knowledge of the ecosystems, societies, and cultural contexts its speakers inhabit. Linguistic diversity and traditional ecological knowledge are dynamic and evolving storehouses of human environmental understandings. Further, the world's many religions and belief systems transmit values, ethics, and place-based stewardship across generations. Many are now arguing that cultural, linguistic, and biological diversity tend to co-vary in environmentally threatened regions and advocate the recognition of how these "biocultural memories" retain hard-won insights and offer useful information for the future (Barthel et al. 2013; Maffi and Woodley 2010; Nazarea 1998).

Humanity's rich cultural diversity and extensive knowledge of sustenance (animal husbandry, fishing, agriculture, etc.), often deftly practiced in marginal environments, is increasingly useful in our efforts to feed a rapidly changing world. Additionally, the many ways people can and do govern themselves successfully remind us that humans continue to craft viable political systems in the absence of distant authorities. Conversely, inequality, in all its forms (economic, political, social, health, etc.) reminds us that the unequal distribution of resources often leads to suffering and strife.

Political flexibility offers important ways to address challenges. For example, ancient Egypt illustrates how political systems which are rigid and unable to adjust to changing conditions in a timely manner are more likely to fail. The political structure in ancient Egypt was based on the Pharaoh's ability to ensure that the country reaped great bounty from the annual Nile floods. Inadequate flooding during dry years spelled trouble for pharaohs when famine and plagues spread throughout the land and resulted in periods of political instability when dynasties were weakened or failed altogether (Hassan 1994). Egyptologists refer to these periods as intermediate periods. Whether or not political systems were flexible, farmers

Social Diversity on Banks of the Nile

The banks of the Nile in Egypt have been continuously occupied for over 5,000 years. This longevity is not just due to the Nile's rich yearly floods, but also the diverse means by which fishermen, farmers, political and religious elites, merchants, and others reaped its benefits. Each of these groups relied on distinct water management strategies to grow crops, transport goods and people, and fish the waters—made possible in large part by the diversity of ways that water has been collected over the millennia, from *shadufs* to canals. From the scale of the household to that of the state, each group interacted (through domestic exchange, market sales, long-distance trade) but also maintained considerable independence, thus promoting economic stability. ♦

adapted by relying on diverse strategies (see sidebar) to obtain and use water. This example and many show how political flexibility—defined as a willingness to abandon dysfunctional practices and infrastructure and modify social forms—offers important ways to address challenges.

3.1 Climate Change and Society

Events of the past, if not forgotten, are teachings about the future.
—*Ssu-ma Ch'ien, 2nd century B.C.E.*

The past is a critical resource for understanding how complex systems operate. Complex systems have many parts or aspects, each operating with different parameters with unknown outcomes to their interactions. The Human/Earth system is a classic example. Climate and climate change have played a major role in human history, from the evolution of the human species (deMenocal 2011) to the advent of agriculture and the subsequent exponential growth of the human population and social complexity. One example is that a warm and wet period in the steppes, along with other factors, provided ideal conditions for the rise of Genghis Khan (Hvistendahl 2012). Half the world away in the American Southwest, increasing drought had distinct impacts on three societies—Mimbres, Mesa Verde, and Hohokam (Hegmon et al. 2008). Thus the relationship between climate and society is multi-dimensional, multi-directional, and produces varying results.

Diversity in the Past: Ancient Peru

The Moche people of Peru (c. 100-800 C.E.) were not able to withstand torrential rains and destructive floods resulting from several El Niño events and long-term droughts, due to their inflexible system of government and an overly elaborate irrigation technology (Fagan 1999:119-138). The El Niño events repeatedly damaged their irrigation systems in the late 600s C.E., ultimately resulting in Moche leaders' loss of power. The Chimú of northern Peru followed the Moche ca. 800 C.E. and became a powerful state, centered at the capital of Chan Chan; it reached its political peak ca. 1200 C.E.

Chan Chan is located in a region where river valleys meet the arid coastal area. The region's Chimú population relied on diverse water management and subsistence strategies—including storage reservoirs, aqueducts, c. 400 km of canals, stone breaches, and wells (Dillehay and Kolata 2004). They seem to have learned from the past that diversifying types of water management was key to survival. They applied this principle to conquered lands, which allowed them to manage water resources in a variety of environments and subsistence systems. Their demise came at the hands of the Inka c. 1470 C.E. when, in the throes of a two centuries' long drought, Chimú authorities took a command and control approach that failed to respond to the dual social and environmental crises. ◆

Climate changed continuously throughout the geological and paleontological past. In the distant past, climate change was a result of natural causes such as sun-energy variation, volcanic

eruptions, variations in earth's orbit, and other causes (deMenocal 2001). Since the Pleistocene, subsequent Holocene and contemporary Anthropocene epochs, human contributions to changing climate have increased, from at least as early as the development of agriculture (12,000 B.C.E.) but perhaps even earlier (Ruddiman 2013; Ruddiman and Ellis 2009; Ruddiman et al. 2011).

In the Anthropocene, the effects of climate change on human groups will be broader in scale and intensity compared with the past, because of our greater numbers and cumulative imprint. As a recent editorial in *Science* posits, we are living in a different world, one dealing with global, simultaneous, and cumulative impacts: “[t]ackling problems of cumulative dimensions is a priority if we are to find viable solutions to the real environmental crises of the coming decades. There is a need for all scientists to rise to this challenge” (McNutt 2013:435).

In the past, the impacts of change and people's options and responses were both varied and localized across the globe (Hassan 2007). Populations were smaller and people had access to more diverse subsistence resources and more options (such as migration) in the face of changing conditions. The industrial age brought more widespread and eventually global repercussions; Margaret Mead wrote that pollution knows no borders (Mead 1980). Climate change has brought and will bring an array of disasters such as flooding, drought, extreme heat and cold; these future disasters will be delivered with greater intensity and more widespread secondary impacts (e.g., disease, conflict, famine).

The effects of climate change on human groups will be broader in scale and intensity compared with the past, because of our greater numbers and cumulative imprint.

Here again the past provides lessons. The Medieval Warm Period (MWP) (800/900/1000-1300 C.E.) had different repercussions worldwide. Although the rise in temperature in the northern hemisphere was only 0.5°, it enabled the rise of Cahokia in the Midwestern United States (Benson et al. 2009), and fostered the expansion of the Toltecs in Central Mexico, the Normans and the Vikings into various parts of

Western Europe, and Hinduism outside of India. Simultaneously, the Maya witnessed several droughts (Gunn 1994), as did people living in western North America (Fagan 2008:141). Today, in an increasingly warming and populous world, we lack such ability to migrate across political borders or to more promising ecosystems; we have fewer options than our ancestors had in the past. Instead, we are seeing increasingly unacceptable responses such as increasing conflict (see Scheffran et al. 2012; Zhang et al. 2007, 2011).

Climate change presents clear challenges now and into the future for human health, food production, water accessibility and water quality, to name a few sectors affecting the human species (see Kaniewski et al. 2013; Wood 2008, 2014). Anthony J. McMichael, a scientist at the National Centre for Epidemiology and Population Health, Australian National University, reviewed the pre-modern cases which span the world and involve climatic events of varied durations from acute events to multiyear to multi-century events. He shows that the relationship between climate change and health, although quite complex, resulted in three major kinds of health risks: direct impacts, impacts due to “changes in ecological or biophysical systems,” and impacts “arising from social and economic disruptions and hardships” (McMichael 2012: 4731).

He states “[c]limate change poses threats to human health, safety, and survival via weather extremes and climatic impacts on food yields, fresh water, infectious diseases, conflict, and displacement. Historical experiences of diverse societies experiencing climatic changes, spanning multi-century to single-year duration, provide insights into population health vulnerability—even though most climatic changes were considerably less than those anticipated this century and beyond....The drought–famine–starvation nexus has been the main, recurring, serious threat to health....Modern societies, although larger, better resourced, and more interconnected than past societies, are less flexible, more infrastructure-dependent, densely populated, and hence equally vulnerable. Adverse historical climate-related health experiences underscore the case for abating human-induced climate change” (McMichael 2012:4730). See also section 5 for contemporary health examples.

A recent article on the relationship between climate change and human crises in Europe between 1500 and 1800 C.E. further highlights the intricate relationship between climate change and society (Zhang et al. 2011); the article shows how climate change intersects with bio-productivity, agricultural production, food supply, famine, nutritional status, social disturbance, war, migration, epidemics, and population. But might the past contribute to creating a viable human future? Two case studies, one from the Old World and one from the New, provide clues.

3.2 The Relation of Climate to Other Factors in the Collapse of the Western Roman Empire

A central challenge today is how to change from a dependence on unsustainable sources of energy and food to more sustainable ones. Fossil fuels are finite; and our mainstream agrobiodiversity globally is narrow with only a handful of foods (wheat, maize, and rice) feeding the world. Of them, wheat is the most important, as it is grown on more land area and its consumption leads all others.

Diverse and renewable energy sources are needed for a sustainable future. But our present trends are not unprecedented and again, history provides lessons. By 52 B.C.E., and after the conquest of most of Western Europe, Roman administrators fed Imperial cities with the agricultural bounty of conquered regions. Diverse, multi-species systems were replaced with the exclusive production of wheat, grapes, and olives. Powered by slave labor and linked to market conditions, the Roman cultivation system was profitable in the short term, but did not match conquered peoples’ more sustainable practices.

Additionally, the long, stable warm period that accompanied Roman expansion began to deteriorate in the late 200s C.E. (Crumley 1994b; Tainter and Crumley 2007). The subsequent cool, wet period lasted more than 500 years and challenged the low diversity of the Roman system. Wheat, unlike rye, oats, and spelt, was not adapted to the new conditions. Crops and taxes—both essential for maintaining the garrisons protecting the Empire from unconquered peoples beyond the Rhine—declined.

As the Empire ceased to expand, the government was forced to debase the currency, leading to inflation. Fiscal crises coincided with political and military crises. In this period there were

constant foreign and civil wars; cities were sacked and frontiers devastated. Emperors ruled for short periods. For a time, reforms saved the Empire. The size of the army was doubled; the size of the civil service also increased, and many new administrative centers were established. Essential services, such as the military, were frozen into hereditary occupations and farmers were tied to their land. Cities across the Empire built new walls.

Taxes were increased to pay for the greater size and complexity of the government and army. Across the Empire, every unit of production was assessed for taxes, which had to be paid regardless of yield. Farmers who could not pay their taxes abandoned their lands and went to work for wealthy landowners, creating the conditions that would lead to feudalism. Further, the population could not recover from plagues. The Empire survived the crisis in the 200s C.E. by consuming its capital and human resources—productive lands and the peasant workforce.

By the early 400s C.E. in the Western Empire, epidemics were common, urban centers crumbled, farms and villas were abandoned, and a new religion, Christianity, took hold. Rich bottomlands became waterlogged and forests retook the countryside. Climatic conditions improved only after 800 C.E.

The Roman Empire is one of history's great successes, and also a spectacular failure. It has many parallels with contemporary societies: a reliance on a handful of vulnerable staples, growing differences in wealth and access to land and other resources, a changing climate that affects the ability to respond to problems, diminishing state income (trade and taxation) and increasing expenditures (wars, rebellions), and failure to invest in infrastructure and its maintenance. Clearly, as the past shows, multiple shocks and system-wide impacts beyond temporary instability can render great societies fatally vulnerable.

3.3 The Relation of Climate to Other Factors in the Collapse of Classic Maya Kingship

Because forty percent of the world's contemporary population lives in the tropics, understanding how people thrived there for millennia can provide concrete approaches to dealing with present-day climate change in such environments and elsewhere. The Classic Maya (c. 250-950 C.E.) accomplished all of their renowned feats in a tropical environment without beasts of burden, the wheel, or metal implements. They lived in a setting with seasonal and annual variation that impacted agricultural schedules, settlement patterns (size and density), water quality, political power, exchange systems, and transportation.

Maya kings rose to varying degrees of power in centers throughout the southern Maya lowlands because of what they provided their subjects materially (e.g., in some regions providing water from artificial reservoirs during annual droughts) and socially (e.g., sponsoring public ceremonies, games, festivals, feasts, and so on) (Lucero 2002, 2006; Lucero et al. 2011). Royal power lasted a millennium, from c. 100 B.C.E. to the 900s C.E.; the dissolution of Mayan kingship was related to several multi-year droughts between 800 and 930 C.E. and this change is thought to have precipitated extensive warfare along with other critical social and political changes that led to the eventual downfall of the classic kingships (Kennett et al. 2012; Medina-

Elizalde et al. 2010; 2012; Turner and Sabloff 2012). The impact of the droughts depended on regional conditions, resulting in strong local expressions; these can be understood by looking at social, political, and environmental changes as an interacting system. In the southern lowlands, kings lost their ultimate power, abandoning their royal ceremonial centers while farmers remained in the area and continued to farm, and do so to this day.

The Classic period of the southern Maya lowlands could offer a glimpse into what occurred. One hypothesis is that when drought extended beyond a few seasons, Maya kings expended dwindling resources on increasingly ornate feasts and ceremonies to supplicate ancestors and gods. Kings would have sponsored such events because they always had worked in the past, but in so doing, they would have depleted the stores of food and water needed for seeds to plant and water for daily needs. Royal ceremonies that once highlighted kings' successes would then only emphasize their failures. We know that ordinary people relied on diverse subsistence strategies to feed their families, and that kings and their political institutions would have been less flexible. Maya farmers in the southern lowlands appear to have abandoned ceremonial centers between 850 and 950 C.E., re-organized at the community level and moved to areas near lakes and rivers.

It is useful to note that other parts of the Maya system had a different trajectory, especially in the northern lowlands with its thinner soils, but higher water tables. The drought hypothesis for the collapse runs in to evidentiary problems in northern Yucatán, where some of the first cities to be abandoned were located on permanent sources of water and many of those that stayed strong (or grew) through the Terminal Classic period, were located in areas that are very vulnerable to water stress. Postclassic codices and the Books of Chilam Balam indicate a keen awareness of cycles of drought, at least in the northern lowlands. As these writings come from literati rather

These cases show that political systems fluctuate much more dramatically than smaller social systems, such as farming families and communities. When political systems are not flexible enough to adjust to changing conditions, they fail.

than humble farmers, they suggest that coping with local variation in rainfall was very much on the minds of some rulers. The diversity of regional resources and historic trajectories, and the interwoven nature of social life, politics, and rainfall patterns throughout the

Preclassic and Classic periods underscore the need for a complex systems framework (Iannone 2014) that treats the many Maya regions together but does not apply a single cause-and-effect scenario across the entire Maya area.

These cases show how the success of far-flung political systems in managing dire conditions fluctuates much more dramatically than does local-scale governance. Big political systems have huge investments in infrastructure and elite networks of exchange. When political leadership is not able to re-structure to manage changing conditions, it fails. In contrast, households and communities must often make adjustments and are more flexible and resilient. Monolithic strategies (e.g., mono-cropping, or relying primarily on single subsistence sources), often emblematic of large political systems, are not as sustainable as diversified ones (see Crumley 2003; van der Leeuw 2008). History has also shown that in a changing climate, stress contributes

to the rigidity and intensification of top down approaches, which in turn creates unstable systems (Fagan 2008).

Future adaptations are more sustainable if linked with fundamental lessons of sustainability from the past. For example, although Maya kings eventually lost power, their leadership lasted for nearly a thousand years. One element of their success over the long period was their role as water managers (see Lucero et al. 2011). In some Maya areas, water was collected in reservoirs during the rainy season for dry season use. A concern, especially as the dry season wore on, would have been keeping the reservoirs clean from excessive levels of algae, toxins and water-borne disease vectors. The historic and archaeological records leave little doubt that the Maya successfully survived the annual dry season for centuries. They maintained clean water stores by constructing wetlands for filtering and transforming waste using plants and naturally occurring microbes. Their near thousand-year history is evidence of this kind of practice and knowledge of its effectiveness. Today, wetlands are once again being integrated into municipal and regional waste management systems, not only to treat the water but also to produce grey water for non-human use (e.g., Horne 1995; Scarborough et al. 2012).

There are other examples of pre-industrial/traditional techniques informing contemporary land management. Guttman-Bond (2010) illustrates past successes in desert environments to show how agricultural and engineering techniques (e.g., for irrigation and retaining water) are sustainable and resilient, especially in developing countries and marginal environments. Other examples come from the American Southwest acequia systems of the Spanish, and from Mesopotamia, Ancient Egypt, the prehispanic city of Cahokia in the central United States, Harappan society, the pre-modern city of Angkor in Cambodia, and Andean South America. The lessons we draw from the Roman Empire, the Classic Maya, and other examples highlight basic and enduring environmental and social relationships.

3.4 Using the Past as Guidance for the Future

Several current initiatives use knowledge from the past and apply it to the future. One is the Integrated History and Future of People on Earth (IHOPE), a global network of researchers and research projects using collaborative and interdisciplinary frameworks to combine human and Earth system history to ensure our common future. IHOPE unites Earth system science with the social sciences, the humanities, and communities of practice (<http://ihopenet.org>) (see Costanza et al. 2007, 2012; van der Leeuw et al. 2011).

The history of coupled human and environmental change combines the social sciences and the humanities: the archaeological record, documentary history, human knowledge and memories, languages and literatures, and much more in conjunction with the environmental, biological, and information sciences. Comprehensive regional histories contain information about how people in those places and specific circumstances responded to climate extremes. This knowledge allows managers to anticipate changes in their region (e.g., ground water levels, impacts on particular species, or successful strategies adopted in the past) (Sandweiss and Kelley 2012).

IHOPE's long-term, human-scale perspective is intended to improve models based on earth system sciences that often exclude knowledge drawn from the social sciences, humanities, and

from communities of practice. Global-scale models of change are incomplete without comprehending human history and cognition and incorporating regional diversity. IHOPE aims to critically evaluate earth sciences models' portrayal of past human activities, demonstrate the contemporary relevance of the past, and find useful paths into our future by focusing on the human scale of landscapes and regions.

Many archaeologists now focus on the infrastructure of ancient agglomerations in an effort to learn about place-based management solutions that are sturdy, inexpensive, relatively easy to maintain, and applicable to contemporary problems. IHOPE demonstrates the contemporary relevance of the past to the future of landscapes and regions by examining the history of linked human-environment systems that lead to societal resilience or vulnerability (e.g., Chase and Scarborough in press).

Past decisions shape and constrain subsequent ones, even though past circumstances themselves may no longer be relevant. Small initial differences disproportionately shape later conditions; this is called "path dependence" and can lead to what has been termed a "rigidity trap" that impedes finding solutions to problems (Brondizio 2008; Hegmon et al. 2008). Knowledge of the histories of management strategies can help avoid systemic vulnerability and offer viable alternatives to similar contemporary challenges. For example, the failure of the Green Revolution in Bali led the government to revert to the traditional water temple system for crop rotation and water management (Lansing 1991, 2006).

These "old-and-new" solutions stimulate "tinkering" to arrive at hybrid innovations that may yield sustainable development efforts. They have many advantages: low-cost, low-impact, locally available materials, a local and motivated work force, and a source of local pride that strengthens community.

In conclusion, we can avoid repeating mistakes of the past by informing the public, politicians, and policy makers about the abiding importance of sustainable practices (Mead 1980). We need to merge top-down and bottom-up approaches in dealing with both large, global problems and local environmental and social conditions. In the face of worsening problems, our responses increasingly are to "trade up on the scale of vulnerability," producing detrimental, unintended consequences for peoples far away from the end users and the unsustainable use of Earth's natural resources (Fagan 2004: xv). Short-term responses typically have short-term benefits, often with unintended consequences, such as expending precious resources in a futile attempt to prevent the inevitable (Fagan 1999, 2008). The necessary longer-term responses, however, are not a first priority for family economics, community needs, corporations' shareholders, and politicians' political survival.

Anthropologists assessing long-term change in human behavior and society have proposed that conformist behaviors rather than innovation have been the downfall for many societies (Whitehead and Richerson 2009). This point is a salient one for the Maya kings, who used the same rituals that had served them in the past in the hope that conditions would change.

History has shown that migration, conflict, and a reliance on technological solutions have been common responses to drastic change (deMenocal 2001; Hassan 1994; Scheffran et al. 2012).

Most of these options are no longer viable or desirable. Migration is less of an option due to protected or militarized borders and territorial issues. Conflict does not allay problems, but rather perpetuates them, since most crises today are no longer local, but have become global. Political change, while viable, often does not address the problem at hand. Developed countries often rely on technological innovations and inventions to address challenges, as innovations have worked in the past (such as increasing food production through use of plows, fertilizers, genetic engineering, more drought-resistant crop seeds, and so forth). However, an over-reliance on technology derails the human ability to cognitively adapt to change.

Our final comments highlight the lessons of past human engagement with climate instability to inform current global challenges. We have shown how the past helps us to understand relationships among various drivers, including climate instability, and what strategies people used to deal with challenges. The linked human-environmental history of a region contains information about how both humans and specific environments respond to extremes in climate, and allows managers today to anticipate changes in many aspects of the region.

A critical element that ensures resilience to systemic shocks is diversity, not just of living organisms but also of thought and practice. History shows us that societies with more diverse practices (see sidebar on the Chimú of Peru) withstood climatic changes compared to those societies that largely relied on one type of subsistence strategy (such as intensive agriculture).

Knowledge of past management strategies can help us avoid mistakes and offer viable alternatives to contemporary challenges. We have the tools needed to map risk and vulnerability in both past and present circumstances, and they must be used to assess future scenarios. Not all (pre)historic techniques are sustainable, but their longevity is one witness to their efficacy.

The history of humans in their environments can inform critical issues, such as the role of biological and cultural diversity in food security, or revisiting the successes of ancient architecture and engineering practices. To identify useful past strategies that are relevant today, we need more comparative work across continents and timescales to draw out commonalities on how societies dealt with changing climates. For example, in tropical low-density urban societies,

Diversity and flexibility are critical components of enduring societies.

evidence shows that while political systems fluctuated dramatically, sustainable farming practices remained largely unchanged for millennia (Lucero et al. n.d.); for the Sinhalese in South Asia, the

Khmer in Southeast Asia, and the southern lowland Maya, their presence in environments with high biodiversity is crucial in understanding how farmers adapted (dispersed and diversified), how political leaders integrated people for centuries (seasonal water in centers via sophisticated, intricate and large-scale water systems, protection, markets, ceremonies, etc.), and how each sector responded when climate noticeably changed. The result was political transformation and urban diaspora (Lucero et al. n.d.). What has endured for millennia, however, is peoples' reliance on diversified agricultural techniques and local networks (Barthel et al. 2013). Top-down

approaches are not often successful, while bottom-up approaches enjoy much greater success, for both social and economic reasons.

Over forty percent of today's global population lives in the tropics, areas that particularly will be hard hit by global climate change (Mora et al. 2013). It is thus critical to appreciate the long history of human-environment interaction in such regions to highlight useful strategies from the past. Archaeologists focus beyond kings, collapse and the exotic and by means of extensive comparative research they can tell stories from the past of how people adapted to changes in climate over time. Given that some modern analysts predict large-scale conflict as food and water likely become scarcer in some regions, it is important to review parallel instances of past climate-driven scarcity and competition, as well as sustainability, to see how the past can directly inform the present (e.g. Turner and Sabloff 2012). Archaeologists' work in the reconstruction of mobility patterns, population estimates and land use analysis, settlement patterns, multi-scalar excavations (house to palace), and much more, provide us the means to tell the story of our past with an eye to our future. Today's archaeologists highlight successful strategies from the past that have been successfully used by many societies at all scales (household, community, local and national governments) and can demonstrate the utility of concepts (e.g., flexible vs. inflexible political systems and subsistence strategies). While the same strategies may not apply precisely to current conditions, careful examination of previously successful efforts can form the basis of new approaches. ■

4.0 Adaptation, Vulnerability, and Resilience in Climate Change

Three concepts have emerged over the last four decades that today frame the challenges presented by climate change and humanity’s responses to it: adaptation, vulnerability, and resilience. Adaptation, initially borrowed from biology, now is broadly defined as the process of developing characteristics that improve chances for survival in a given environment. Resilience and vulnerability serve as measures or indices of the effectiveness, or lack thereof, of adaptive strategies. Although these concepts are widely accepted for understanding and addressing climate change, definitions vary across disciplines and user groups, sometimes distorting or obscuring important questions, especially of a social science nature. Nonetheless, all three concepts are now ensconced in both academic and policy domains and are deployed as policy instruments, serving a variety of purposes and agendas across a spectrum of social and political interests.

4.1 The Concept of Adaptation in Anthropology

Adaptation is and has been a core concept of anthropology since the emergence of the field in the 19th century with its focus on human biological and cultural evolution (Harris 1980). Human beings interact with nature to survive and reproduce through a set of material practices that are socially constituted and culturally meaningful (Patterson 1994:223). Socially constructed meanings create frameworks through which alternative material and social practices, including

In effect, the problems of the poor and vulnerable do not begin with climate change. They may be made substantially worse by climate change, but limiting interventions to dealing with climate effects fails to address systemically imposed social vulnerability.

food production, shelter, and, at the most fundamental level, security, are analyzed, evaluated and prioritized (Crane 2010). The premises upon which humans make basic productive decisions are multiple. They emerge from direct environmental stimuli, social organizational forms, and ideological mandates.

There is broad acceptance within anthropology that populations around the world have an intimate knowledge of their environments and possess a number of elements—knowledge systems, technologies, forms of work organizations, and the like—which allow them to make use of the resources in the environment for social reproduction and physical sustenance. Today, when anthropologists use adaptation, the term generally refers to changes in beliefs or behaviors in response to altered circumstances to improve living conditions (see sidebar). Humans adapt to their dynamic natural, socio-cultural (including institutional) and built environments through a cultural lens of individually and collectively interpreted knowledge and meaning, to make decisions and respond. However, human adaptation is not a simple function of technical solutions (Crate and Nuttall 2009; Roncoli 2006), but also involves the need to frame responses

within social and cultural parameters. Outside of the current climate change policy frameworks, adaptation is an evolutionary process which, because it transpires over varying lengths of time, can only be apprehended in hindsight (Thornton and Manasfi 2010). Inside the current climate context, adaptive processes can be both anticipatory, as in mitigation efforts, and reactive. They can vary over spatial and temporal dimensions and in form (technological or social). Adaptive processes include mobility (migration), exchange, rationing, pooling, diversification, intensification, innovation and revitalization (Thornton and Manasfi 2010).

The term “adaptive capacity” refers to the ability of social institutions (households, communities, organizations, networks) to use knowledge and experience to foster flexibility in problem solving and to enable reconfigurations without losing functionality (Folke et al. 2002). Human adaptations to environmental change generally involve social organization and technology and can occur and be analyzed at multiple levels of organization (household, community, and institutional).

Climate change has the potential to undermine primary adaptive strategies by diminishing the environmental conditions supporting them. Crate’s work with northeastern Russia’s indigenous populations demonstrates how mobility, a primary adaptive strategy, is challenged by the local effects of climate change in the context of ongoing industrial contamination, economic transformation, and the alienation of youth from traditional practices (2008). For this reason, local institutions must play key roles in the way adaptation programs and practices are and will be developed and applied (Agrawal 2010).

4.1.1 Critical Perspectives on Adaptation in Anthropological Climate Change Research

Many anthropologists argue that although adaptation is a key concept in climate change policy, it fails to accurately capture the complexity of how humans perceive, understand, and respond within the range of alternatives open to them (Orlove 2009). The lack of such a holistic approach begs the question, “Are adaptation projects truly adaptive, or are they merely coping strategies that fail to address the core issues of a systemic vulnerability based on socially structured inequality in access to resources?” (Pelling 2011). In other words, what is being adapted to—climate change itself, or a system of structural disadvantage exacerbated by climate change? A distinction should be drawn between adaptation and coping. Adaptations are part of cultural knowledge and practice, evolved over time; in effect, part of the overall toolkit for life. Coping refers to decision-making in novel situations for which there is no ready culturally integrated

Adaptation

Adaptation generally refers to changes in beliefs or behaviors in response to altered circumstances to improve living conditions, including a culturally meaningful life; this includes adaptation to natural, socio-cultural and institutional (political, economic, and civil society) circumstances. Human beings perceive and adapt to such changes consciously, through a cultural lens of individually and collectively interpreted knowledge and meaning, to make decisions and respond, including the deployment of technology.

institutionalized response. Both adaptation and coping involve problem solving and decision making but coping involves improvisation for immediate versus long term goals. Outcomes of both adaptation and coping may be replete with winners and losers, and may have unanticipated results.

Adaptation among human beings is not a simple function of technical solutions, but involves deliberate decision-making and implementation at various scales. Further, the complexity of human societies means that outcomes are equally complex, replete with winners and losers, and have unanticipated results.

Such issues are further complicated by temporal and spatial variability. Natural and social processes unfold at different time scales and allow for trial and error in the process of societal adaptation (Holling 1994). Adaptations, highly effective in one context, often have extremely negative effects either up or down spatial scales. Adapting to deglaciation-driven

water scarcity in the Peruvian Andes involves dams and water storage, creating long-term risks of water scarcity for fully half the national population on the coast. In other words, short term success may turn into long term risk. In addition, an over-reliance on one resource or practice can lead to an inability to adapt in the face of change. Consider, for example, the case at the end of the western Roman Empire (Crumley 1994b, 2003), or the case in the southern Maya lowlands at the end of the Classic period c. 850 through 950 C.E. (Lucero 2002, 2006; Lucero et al. 2011), both discussed in more detail in Section 3.

Local, regional, and international programs to promote adaptation attract public interest, support of policy-makers, and funding. Nonetheless, both conceptual and practical deficiencies remain in all of these.

In sum, anthropological insights indicate that flexible systems are less vulnerable, more resilient, and better able to adapt, much along the lines of the aforementioned “clumsy solutions” to complex problems suggested by Verweij (Verweij et al. 2006). In addition, diversity is key to having the options that are critical in determining the success or failure of

systems, especially political ones. Third, that long-term solutions, although requiring more upfront investment of resources and innovation, are key to survival. Lastly, adaptation efforts must comprehensively explore the advantages and disadvantages of action, mitigating any harmful consequences that may appear at different geopolitical or temporal scales.

4.1.2 Adaptation in Climate Change Frameworks

The IPCC Fifth Assessment Report (2014) defines adaptation as “the process of adjustment to actual or expected climate and its effects in human systems, adaptation seeks to moderate harm or exploit beneficial opportunities (IPCC 2014:2). The UNFCCC has developed programs and language to promote national-level adaptation planning, especially among the countries believed to be poorest and most vulnerable. Though early adaptation planning focused at the national level, activities at other scales soon grew to promote adaptation in specific sectors including

agriculture, water, and health, and at a variety of scales, from international programs to regions, watersheds, and communities.

Over time, the term has shifted from referring to a basic and omnipresent process of change in life, to a policy-driven set of formal strategies and projects (Nelson et al. 2007). Adaptation projects cover a wide spectrum of issues and are supported by international organizations and

Adaptation efforts must recognize the advantages and disadvantages of action, taking precautions to mitigate harmful consequences that may appear at different geopolitical or temporal scales, as far as they can be known in advance.

national governments and domestic agencies. Projects address adaptive strategies for disaster risk reduction, drought and desertification, water management, disease vector expansions, agricultural diversification, river basin management, seasonal forecasting, flooding, sea level rise, and conservation (Rosenzweig et al. 2010; Bulkeley 2010). Nonetheless, there is concern that the focus in national adaptation plans is mostly on technical and infrastructural interventions with little, if any, attention to social and institutional issues (Thornton and

Manasfi 2010).

Such efforts illuminate key issues. First, that the long-time scales and uncertainties associated with climate change allow other problems, more immediate or certain, to receive preferential political attention, funding commitments and other resource allocations. Second, due to the complex interconnections between climate change adaptation and other concerns, successful climate change adaptation is difficult, if not impossible, to measure. Third, discerning the relative importance of different adaptation needs and projects remains problematic. Lastly, efforts to promote adaptation funding operate at different scales that are most often weakly coordinated (Orlove 2009; Pelling 2011).

4.2 The Concept of Vulnerability

Vulnerability refers to the relationship between people and their environment, including economic and sociopolitical structures that can render them vulnerable to hazard impact. The concept of vulnerability emerged in the 1970s work of geographers to explain why disasters were so much worse in the global south by positing that it was necessary to take “the naturalness out of natural disasters” (O’Keefe et al. 1976). To these ends, they began to focus on the multiple, scaled social causes that imposed risk selectively and increased disaster impacts (Hewitt 1983). As a result, the notion of vulnerability encompasses many complex and interconnected social, economic, demographic, environmental, and political processes that make it problematic to define succinctly (Thywissen 2006).

Anthropologists have adopted various approaches to vulnerability. Wisner et al. (2004) understand vulnerability as generated through the interactions of a social system’s historical and contemporary ideological, social, and economic features with dynamic demographic, socio-economic or ecological pressures that produce unsafe conditions. Spatial, temporal and hierarchical scales of analysis establish the links from root causes to the actual disaster, showing

how vulnerability may be produced over long time frames and by inclusion in broader, non-local systems. Other models, like Turner et al. (2003) reduce the temporal and spatial scope of analysis and focus on exposure, susceptibility, coping impact response, capacity, adaptive capacity and interactions with perturbations and stressors as elements of vulnerability.

Despite the variety of approaches, there is agreement that vulnerability, at its most basic level, is a necessary pre-condition for disasters to create harm, and that it includes the social characteristics that place a people at risk in terms of their abilities to anticipate, respond to and recover from impacts (Wisner et al. 2004). All social contexts have some level of vulnerability, making it an intrinsic, but dynamic, multi-dimensional aspect of every society, independent of the magnitude of any particular hazard.

4.2.1 Vulnerability in Anthropological Research

The variety of approaches to vulnerability has had broad applications in anthropology. The political economic approach of Wisner et al. (2004) broadens spatial scales and deepens temporal scales of analysis, supporting anthropological analysis of local to global linkages (Oliver-Smith 1995; Ensor 2009). The multi-faceted perspective of Cannon et al. (2004) enables the disclosure of the role of

misguided development processes in the construction of vulnerability (Barrios 2011; Button 2010; Schuller and Morales 2012). The multi-structured approaches to vulnerability, which include coping and adaptive capacity, suggest an analytical interface between vulnerability and

In the final analysis, vulnerability explicitly ties environmental hazard and climate change impacts to the structure and organization of society.

Vulnerability

Vulnerability links the relationship that people have with their environment with social forces and institutions and the cultural values that sustain or contest them to understand how basic conditions such as poverty or racism produce susceptibilities to specific environmental hazards. ◆

the related concepts of resilience and adaptation. In final analysis, the concept of vulnerability in anthropological research explicitly ties environmental hazards and specifically climate change, and its effects to the structure and organization of society.

While vulnerability has been adopted as a critical concept in the assessment of risks, some researchers argue that the concept may obscure the existence and exposure to specific hazards (Birkmann 2011). Others criticize the conflation of vulnerability with poverty, pointing out that many poor communities have high levels of social organizational adaptive capacity for dealing

with environmental threats (Laska and Peterson 2013). Others see vulnerability as a profoundly disempowering concept for local populations (Cameron 2012; Cannon 2008); defining a community as vulnerable and characterizing it as helpless in the face of environmental forces can mask social forms of agency. Ultimately, the widespread acceptance and use of the concept has led to its dilution in some policy contexts; where it was once a critical concept, it is now in danger of becoming simply a term to describe a set of immutable conditions.

4.2.2 Vulnerability and Climate Change

Although originating in disaster studies, vulnerability now plays a significant role in global climate change research for framing both scientific analysis and policy options. Crafting policy-relevant vulnerability research is challenging because it requires combining global projections, their local and regional manifestations, and local patterns of socially constructed vulnerability. The IPCC (2014) definition is considerably restricted as compared with that of disaster research and is concerned with “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and the lack of capacity to cope and adjust” (2014: 28).

Although the probability of more extreme events is high, most of the effects of climate change will be gradual, incrementally affecting communities that are already dealing with high levels of social vulnerability, thus turning creeping, chronic disasters into rapid onset ones (Lavell 2011). Climate change will tend to exaggerate frequencies and effects of existing hazards most of which are manifested through local social vulnerabilities. Interventions need to assist people by reducing vulnerability and enhancing resilience in the face of changing environmental conditions.

4.3 The Concept of Resilience

In ecology, “resilience” means the capacity of an ecosystem to respond to disturbance by resisting damage and recovering quickly (Holling 1973). Derived from a framework known as the adaptive cycle (exploitation, conservation, release and reorganization), resilience is now integral to the discourse on understanding the character and dynamics of environmental change at various stages (Gunderson and Holling 2002). In the 1990s, systems ecologists began to explore this process using the term *social-ecological system (SES)* (Folke et al. 2002, 2004). Walker and Salt (2012) identify a number of features of a resilient socio-ecological system: diversity, ecological variability, modularity, slow variables, tight feedbacks, social capital, innovation, overlapping governance, ecosystem services, fairness and humility. This array of characteristics reveals the challenge of articulating natural science and social science variables making up a socio-ecological system, much less developing policy that addresses them comprehensively.

Despite a general reluctance to accept biological models for human behavior, many social scientists and policy makers apply the concept to society, defining resilience as the ability of social groups or individuals to bear or absorb sudden or slow changes and variation without collapsing (Holling and Meffe 1996). As noted in section 2.2, there has been a call for a more developed “adaptation science” in which the adaptive state of a system is determined in part by

the resilience of the system, which is a property inherent to the society. The resilience framework recognizes the importance of dynamics, scale and the linkages between nested sub-systems; and it is used to understand the role of change in SESs (Walker et al. 2004). Social resilience is often defined as the ability of groups to tolerate and respond to environmental and socioeconomic constraints through adaptive strategies (Bradley and Grainger 2004). Therefore, adaptations can occur at various social levels, wherever negotiation occurs, though there may be impacts for the system at other scales.

4.3.1 Resilience in Anthropological Research

In archeology, the resilience perspective has proved useful at least at the heuristic level in conceptualizing social-ecological processes over longer time frames. For example, as detailed in section 3, resilience is helpful to understand how Classic Maya kingship successfully met environmental challenges for approximately 1000 years, but succumbed to several multi-year droughts in the 800s CE, because traditional ritual methods failed to ameliorate the harsh drought conditions. (Lucero et al. 2011; see also Hegmon et al. 2008). However, not yet incorporated into resilience thinking, for example, is the archaeological attention to scales of time and space with attention not only to rapid variables, but also slower, more obscure features of what would appear to be stable systems (Crumley 2014).

Currently, there is an anthropological focus on the examination of building community resilience—that is, how communities can reduce risk and losses from climate change (Nelson et al 2007). In this context, building resilience involves continual feedbacks to preparedness and risk mitigation activities, through social learning that may enhance adaptive capacity over longer periods of time (Cutter et al. 2008). Robust—resilient—local and regional management requires a comprehensive grasp of the social, historical, cultural, and political aspects of people in their environments.

4.3.2 Resilience in Climate Change

Resilience, now a central theme in climate change research and policy, has largely dispensed with the notion of the adaptive cycle and is focused on the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events (National Research Council 2012). From a policy perspective, resilience is generally framed as a function of the levels of internal coherence, social solidarity, and the capacity of a social unit to organize and work on its own behalf, rather than as a feature of a social-ecological system. Hastrup posits that resilience is an emergent quality of all responsible social action; in fact, it is a fundamental feature of all societies that persist in the face of hazards and stressors of many types (2009:28). Resilience, however, is not always adaptive since many systems that are erosive to both social

Resilience

Resilience in communities is embedded in the historical, social, and cultural constructions that govern social interactions and the material development of communities and the attendant institutions pertaining to management and growth. ◆

and environmental sustainability have shown themselves remarkably resistant to change. Indeed, a cogent criticism of resilience pertains to its lack of attention to political factors, essentially power, that can affect local vulnerabilities and capacities.

This breadth, generality and abstraction which characterize the discussions of resilience have led to debate about the goals of resilience thinking: specifically, is resilience about stability or about change? If resilience is about the capacity to absorb disruption without loss of function, for human communities, it would seem to be resistance to change, particularly of a structural nature. Nonetheless, Nelson et al. (2007) assert that resilience promotes the capacity to deal with future change rather than replicating the present. Resilience, in this sense, is oriented toward maintaining flexibility and adaptive capacity to handle future stressors. Adaptation and resilience building approaches range from centralized, top-down projects that focus on specific biophysical climate change effects to efforts framed as adaptive governance that also draw on science but stress engagement with community building, multi-level politics, and ethical issues such as indigenous rights (Brunner and Lynch 2010; Cote and Nightingale 2012; Doubleday 2007; Hatt 2012; Nadasdy 2007; Welsh 2014). To be politically feasible and equitable, planning must engage diverse stakeholders and its implementation must adapt to changing conditions.

Discussions of resilience face challenges when they seek to integrate the more general universal features of the concept with the specific features of any particular social-ecological system (Crane 2010). Resilience at the local level is culturally defined and socially enacted. Social constructions of meaning (culture) need to be integrated with material analyses of adaptive social-ecological processes. While climate change practitioners can promote resilience to the physical/material components of a socio-ecological system, such changes for local people may be profound if local values and beliefs are devalued (Crane 2010). Disruption to the social, economic, and environmental determinants of health by climate change may cause an increase in mental health issues, such as family stress, drug and alcohol abuse and potential for suicide ideation (Willox et al. 2013). In effect, the cultural side of resilience requires that livelihoods that fulfill material, moral, and spiritual needs in the context of major environmental, social, cultural, economic or political changes be maintained for a sense of continuity of meaning and coherence (Marris 1975; Crane 2010).

4.4 The Articulation of Adaptation, Vulnerability, and Resilience for Policy

Adaptation, vulnerability, and resilience, despite the inconsistencies in definitions and applications, are articulated with and involved in the formulation and application of each other.

Current adaptation practices and policies focus on adapting to climate change itself, rather than to challenging the causes and drivers of climate change.

The concepts of vulnerability and resilience address the degree to which a society is adapted to the hazards and risks of its environment, including the effects of climate change. Both vulnerability and resilience refer to the conditions

in which people live that render them either susceptible or resistant to environmental hazards, and therefore, which address the concept of adaptation. An aspect of vulnerability is the inability to recover from environmental impact, in other words, a lack of resilience (Wisner et al 2004). However, the relationship between vulnerability and resilience is not linear, but dialectical (Aguirre 2007). That is, lowering vulnerability may or may not increase resilience, but it also may create other forms of vulnerability. For example, adaptations based on technology or resettlement may create risks, exposure and vulnerability through their malfunction or failure. Indeed, changes in conditions of vulnerability and/or resilience are leading to situations that exceed capacities to adapt, bringing about irrevocable and permanent losses. The recent climate talks in Doha and Warsaw have focused on policy responses to the limits of adaptation (Dow et al. 2013).

Adaptation requires change, but the direction and purpose of that change must be defined. In one context, adaptation as currently deployed may foster approaches that more deeply embed local vulnerabilities (Felli and Castree 2012). Vulnerability analysis therefore becomes a virtual requirement prior to any adaptation intervention if it is to have any transformational potential (Ribot 2011). Is transformational adaptation possible, in the sense of “a change in the

Effective mitigation and adaptation actions are likely to be complex, since they involve diverse world views and forms of organization on local, national and global scales.

fundamental attributes of a system based on altered paradigms, goal or values” (IPCC 2014: 27)? As currently practiced, much climate change adaptation today does not address the real adaptive challenge which requires questioning the beliefs, values,

commitments, loyalties and interests that have created and perpetuated the structures, systems, and behaviors that drive climate change (O’Brien 2012). Indeed, current definitions of climate change adaptation are positioned far more to accommodate change rather than to challenge the causes and drivers, leaving current development approaches essentially unchallenged (Pelling 2012). From their various points of genesis, the concepts of adaptation, vulnerability, and resilience have been brought to bear on climate change along similar, if not exactly parallel, policy-relevant paths. They foregrounded the social roots of environmental risk. They internalized and routinized risk and disturbance, emphasized the centrality of socio-ecological processes across temporal and spatial scales, and underscored the importance of historical analysis in assessing current conditions and trends.

These concepts are also intertwined with the questions of adaptation and development. All three concepts have proved important in our understanding climate change effects, but as yet have failed to produce widely adopted policies or practices that have significantly reduced GHG emissions, or resulting risk, or losses from climate change in much of the world. The reasons for our lack of progress toward such goals reside in the fact that climate change is a “wicked” problem, requiring “clumsy solutions” involving the articulation of diverse world views, forms of social organization, interests, knowledge systems and meanings of populations within their dynamic physical settings and socio-cultural circumstances including the interactions of local to global decision-making processes (Verweij et al 2006). Such “clumsy solutions” must generate

policies that creatively articulate multiple perspectives on the causes, effects, adaptations, resiliencies and vulnerabilities associated with climate change that are embedded in global, national and local priorities and practices of development. ■

5.0 Community-Centered Approaches to Climate Change

Humans perceive, understand and respond to change based on their individual and community-shared cultural predilections. Anthropologists tend to work at community levels and a major focus of investigation and facilitation in climate change research is centered on impacts from and responses to climate change at the community scale. Historically, anthropologists were among the first to document the extensive nature of climate change in communities, particularly in northern latitudes and the Arctic. Elders, residents with the longest history of observation, reported changes in caribou, insects, sea mammals, and ice conditions directly affecting their subsistence (ACIA 2004; Krupnik and Jolly 2002; Nuttall 1998).

Understanding how climate change is affecting communities requires community-level engagement.

Climate change poses a diverse set of impacts and challenges for communities, as discussed throughout this report. These impacts range from the direct effects of weather and climate fluctuations, either just outside the ecosystem’s “normal” ranges or to extremes that push the human adaptive capacity to its limits, and to the large scale

transformations in the biosphere that threaten critical ecosystem services and functions upon which all life depends. One of the defining characteristics of climate change impacts on communities is the impacts of climate change are place-specific and path-dependent (Hess et al. 2008). In other words, the biophysical impacts, and a community’s vulnerability to those impacts, will vary significantly from one location to another. Communities will be differentially impacted depending on their relationship to the environment and contextual political and socioeconomic conditions, as detailed in Section 4. In other words, efforts to reduce vulnerability and adapt to impacts of a changing climate should be centered on communities as place-based or locally-organized social entities. This section underscores the importance of community-centered approaches to climate change-related research and action. Here, we highlight why the place-specific and path-dependent nature of climate impacts necessitate community-centered approaches, and review why anthropology is particularly well-suited to engage with communities and facilitate community agency.

Currently anthropologists work with a wide array of types of communities, from small, rural, isolated villages to larger, urban virtual ones. As indicated previously, anthropologists define community as a social unit comprised of individuals who share a location (e.g. place-based communities) or values (e.g. religious communities) or practices (e.g. intentional communities). Individuals may belong to many communities at once or over the course of a lifetime. Communities are comprised of diverse individuals and are therefore intrinsically heterogeneous and are commonly divided according to demographic and socioeconomic characteristics, such as gender, economic status, education, or ethnicity. Anthropologists engaging in climate research recognize the diversity within communities of different perspectives on and approaches to climate change (Agrawal 2010). Thus, there are multiple, overlapping “communities” that are

relevant to engaging communities in climate. Anthropologists also examine the cross-scale links that run through communities, from individuals and households on up to international NGOs, and among communities that may be widely dispersed across the globe such as the Alliance of Small Island States.

5.1 Place-Based Impacts

Communities are affected by climate change through their relationship to the environment, to specific places (e.g., urban centers, high latitudes or low elevations along coastlines), to natural resources (e.g., presence of glaciers and glacial melt, tidal estuaries, or narrow peninsulas), and other environmental characteristics. Observational evidence has revealed that the rate and magnitude of change experienced by key climate parameters (temperature and precipitation)

There are multiple and overlapping ideas of community that are relevant to engaging communities in climate adaptation, from communities of practice such as natural resource managers or ranchers to place-based communities, whether urban or rural, such as those towns or villages in high latitudes or low-lying islands. While anthropologists often work among community members, we also examine the cross-scale links that run through communities, from individuals and households on up to international NGOs, and among communities that may be widely dispersed across the globe such as the Alliance of Small Island States.

differ significantly by region, making climate impacts highly place-specific. Future projections based on climate models also show this place-specificity (IPCC 2013). For example, although high latitudes have experienced the greatest amount of warming, there is great diversity of warming and precipitation within the high latitudes.

Other factors also bring about locality-specific differences. Stone and colleagues found that the rate and magnitude of temperature increases in the US is pronounced in urban areas,

due to the combined effect of climate change warming as a backdrop, enhanced by a urban heat island (UHI) effect (2010). Looking at still finer spatial resolution, there is substantial heterogeneity even within the UHI, where pockets of high temperatures are found where there exists a concentration of engineered materials (concrete, blacktop, dark surfaces) (Johnson et al. 2012). Conversely, urban areas with high amounts of vegetation, tree canopy and shade, are typically cooler. Furthermore, the combination of these characteristics, vegetative land cover, impermeable surface, and urban heat islands, tend to amplify a variety of climate change-related exposures ranging from temperature extremes to heavy precipitation events, placing urban populations at increased risk (Luber and McGeehin 2008).

Sea-level rise (SLR) is a climate-related phenomenon receiving a great deal of attention due to its impacts on communities located along coastlines and on islands. Worldwide, 100 million people live within three feet of sea level. Again, local conditions, such as magnitude of tidal influences, geologic subsidence (or lack of), historic storm surge conditions, and overall island size and relief determine the extent to which communities will be impacted. Regarding the latter,

the impacts for the low-lying island communities of Tuvalu entail very different adaptation responses than the impacts for coastal communities on higher islands who have the option to relocate within their island. In Tuvalu, Kirabati, and other low-lying nations, this is not the case, and international migration is under discussion (Lazrus 2012).

5.2 Path-Dependent Impacts

Climate change affects communities through specific pathways. Vulnerability to climate change varies significantly based on sharing socio-economic, demographic, gender, race and other factors. To illustrate this point with the example of urban heat, Harlan and colleagues found that differences in neighborhood microclimates often co-vary with vulnerability to heat stress (age, health, etc.), and adaptive capacity (access to air conditioning, swimming pools, etc.). Lower socioeconomic and ethnic minority groups were more likely to live in warmer neighborhoods with both greater exposure to extreme heat and fewer resources to cope with it, making them more vulnerable due to greater exposure and fewer social and material resources (Harlan et al. 2006).

Understanding how these pathways of risk and vulnerability are configured differently in every community, reflecting unique histories and contexts, is key. To these ends, expanding the concept of community to include non-place-based communities—such as Lave’s “communities of practice” (1991) and virtual and intentional communities—can provide a useful lens to view vulnerability. For example, in the developing world, where women are more frequently involved in natural resource-dependent activities, such as the collection of water, fuel wood and agricultural production, gender plays an important role in determining vulnerability to climate change (Davison 1988). As critical resources, including clean water and arable land, become scarcer and weather extremes amplify due to climate change, disproportionate impacts will, again, fall on women (Fordham 2003). However, in some contexts these gendered norms have become more fluid and even advantageous under climate stresses. In a Bolivian case study, women’s expertise in emergency management has empowered them in the realm of community governance and decision making (Wutich 2012).

5.3 Facilitating Community Agency

The place-specific/pathway-dependent nature of climate impacts results in uneven exposure to environmental threats among and within communities, in part as a function of their relationship to the environment as well as ethnicity, race, socioeconomic status, history, education, access to information, and local to national policies. Such inequity is a central tenet of environmental justice (Shepherd and Corbin-Mark 2009), which provides the foundation for climate justice efforts, seeking to reduce these disparities through engagement and advocacy of policies and rights. Climate justice addresses the inequity those least responsible for greenhouse emissions are often the most impacted by climate change’s adverse effects (Shepherd and Corbin-Mark 2009).

Climate justice involves empowering affected communities by facilitating a community’s agency to self-identify adaptation possibilities, preferences and priorities. Such activities demonstrate

how vulnerability need not mean a lack of initiative, voice, or strength. In Tuvalu, for example, community members contest global narratives of “climate refugees,” a designation that posits them as helpless victims. Rather than accept a seemingly inevitable fate as a nation displaced from its land and forced to lose their culture, many Tuvaluans discuss *in situ* adaptation, their history of mobility as seafarers, and the contemporary diasporas around the world in which

Anthropologists are well-positioned to work with communities to examine how climate change is understood and responded to, helping to identify and promote adaptation strategies that maintain cultural preferences and ensure equity.

Tuvaluans maintain identity and cultural practices (Farbotko and Lazrus 2012; Stratford et al. 2013).

Anthropologists work with communities to examine how climate change is understood and responded to, helping to identify and promote adaptation

strategies that maintain cultural preferences and ensure equity. In place-based communities, most adaptation to climate change happens at the local level through autonomous activities.

Furthermore, because communities operate relative to regional, or even global, cross-scale linkages, these larger relationships must also be factored in. For example, urban populations’ food security is founded on food produce in rural areas. The ways climate affects these distant regions directly impacts urban survival. Anthropologists also see the implications of the complexity of both climate change impacts and the policies designed to address them, another disparity exacerbated by cross-scale interactions. As noted in Section 4, unanticipated interactions across scales can inadvertently further entrench structural inequalities thereby increasing vulnerabilities or reducing adaptive capacity. Facilitating community decision-making and negotiation reduces negative outcomes for communities and gives the community ownership of their future.

Anthropologists act as translators, mediators, and facilitators when communities design, plan, and implement climate solutions (Moser and Dilling 2004). Engaging key individuals and leaders can scale up individual and household efforts to mitigate climate impacts to community levels and beyond. Likewise, adaptation efforts identified externally by an international NGO or other party, will be adopted by a community more readily if ‘championed’ by community leaders. Anthropologists can mediate this process, translating outside recommendations into the vernacular so communities can understand and decide themselves.

Because anthropology is uniquely positioned to interpret cultural meaning and cultural priorities, facilitating community-coherent adaptation strategies is a paramount role for anthropologists. For example, working with communities to develop options when climate change renders their main subsistence source either unavailable (range changes of animals and plants) or unattainable (inability to travel, harvest, etc. due to changes in land/water resources). If areas are still inhabitable, some communities may desire to remain in their homeland and develop other forms of subsistence while some may want to relocate to maintain their subsistence practices. Anthropologists can help discern these alternatives through participatory methods. If their homeland has changed to such an extent that inhabitation is not possible, anthropologists can

facilitate community understanding and discussion (Crate and Fedorov 2013; Farbotko and Lazrus 2012; Marino 2012; Kingston & Marino 2012).

5.4 Community Engagement

As climate science becomes better able to downscale and discern how the global phenomenon of climate change is affecting specific places and communities, it provides an opportunity to engage

Founded in relationships of trust with affected communities, anthropologists can be reliable community interlocutors and can connect communities with the resources they may need to create new understandings, practices and infrastructure in the face of climate change.

more directly not only with climate impacts and adaptations but also with systemic vulnerabilities and consumptive practices that drive climate-changing emissions. Founded in relationships of trust with affected communities, anthropologists can be reliable community interlocutors and can connect communities with the resources they may need to

create new understandings, practices and infrastructure in the face of climate change.

Anthropologists use their expertise in local languages to choose appropriate words for changes in the local environment and use their knowledge of culturally appropriate contexts in which such discussions take place.

Local knowledge, understandings and terminology used to refer to climate change effects rarely reflects the scientific discourse (e.g., Tengö et al. 2014). Languages often reflect more global understandings and cosmologies of a culture. In the Republic of the Marshall Islands, the word used to describe climate in the local language connotes not only climate but also nature, the cosmos and society. Local communication about climate change often conveys something very different than what adaptation planners anticipate (Rudiak-Gould 2012). In this way, engaged with communities and familiar with their priorities and practices, anthropologists serve as “culture brokers,” translating within, across and between communities and with external actors.

Anthropologists can identify local and scientific experts to collaborate. All parties benefit here—local communities can discern what the global process of climate change is, and which of the changes they are observing and affected by are linked to global processes; local or regional experts can gain a greater appreciation of how global phenomena are having very different effects at local scales. “Dialoguing Local and Scientific Knowledge in Northeast Siberia”⁴ shows how one such collaboration between an anthropologist and a permafrost specialist resulted in increased understanding about the local effects of climate change for the local affected communities, the scientists (social and natural), local, regional and republic organization and policy-makers (Crate and Fedorov 2013). The project began with the anthropological investigation of local observations about unprecedented changes in annual and seasonal weather and climate. The anthropologist, in collaboration with a regional permafrost specialist, corroborated this local knowledge with scientific data. Once this corroboration made clear that: 1) much of what local communities were observing was due to global climate change; 2) local

communities did not recognize the local effects of climate change, due mostly to lack of relevant information; and 3) local observations provided highly detailed information pertaining to the particulars of place and global climate change effects; the communities participated in ‘knowledge exchange’ events to test ways to corroborate observations and data in an interactive dialogue. Involving a team of local and regional specialists, the eight events aroused enthusiastic local interest and initiated the writing and publication of a book, written in the native language and in an easily accessible format to reach all affected communities. In the process, the Ministry of Ecology has taken a more proactive role in understanding the local effects of climate change in the Republic and in educating communities about it.

Anthropological engagement with communities to understand climate impacts and identify adaptation strategies addresses the unique challenges of specific places and pathways of vulnerability. Because climate change is having very different “on-the-ground” effects from

Anthropologists know that co-production of knowledge on climate change is critical to ensure transformative adaptive change.

place to place, and communities have developed site-specific adaptations to the places they inhabit, it follows that basing a preliminary understanding of how climate change is affecting communities on their knowledge is fundamental. Communities know local

adaptations to their pre-anthropogenic climate change environment and can often build upon those adaptations in response to unprecedented change. Anthropologists can investigate epistemology, in its most basic form: the ways that the communities they collaborate with make sense of their worlds and articulate what they know. Here anthropologists can take an inter-epistemological approach, contemplating the “upstream” questions related to understanding the foundations of the knowledge system(s) being considered and focusing on how things are known rather than what is known (Murphy, 2011: 492; Bartels et al. 2013).

In conclusion, communities worldwide are affected by both the place-specific effects of climate change and the path-dependent vectors of vulnerability. As communities negotiate the impacts of a changing climate and the policies designed to address those impacts, anthropologists must play a role in understanding how communities are affected and how they demonstrate their agency. We think broadly about the idea of community and understand communities to be united by place, practices and values. Furthermore, communities are made of diverse individuals who will each interact with climate change in unique ways. Anthropologists’ attention to similarities and differences within communities and between communities and other groups—from scientists to policy makers and resource managers—can help identify how communities are embedded within larger contexts. In this way, anthropologists provide insight on how communities have been affected by climate change in the past (Section 3), how communities are rendered vulnerable or are able to adapt to contemporary climate change impacts (Section 4), and how communities participate within and resist the institutions that drive climate change (see Section 2). In community engagement, anthropologists can contribute to community goals through projects that go beyond research and into practice. ■

6.0 Interdisciplinary Research Frontiers

This section examines interdisciplinary aspects of the engagement of anthropology in activities connected to climate change, particularly academic and applied research, and also includes a discussion of research frontiers. The activities we consider as interdisciplinary are those in which anthropologists participate as members of teams or groups along with professionals of other disciplines and professions. We focus on the active presence of anthropologists in these settings. We distinguish two roles for anthropologists—as collaborators in the production of interdisciplinary research objects, methods, evidence and analysis, and as embedded ethnographers in the worlds of climate science, policy and politics.

6.1. Interdisciplinary Research

6.1.1 Interdisciplinarity and Climate Change

Much of the work in the climate change field has been interdisciplinary, whether it consists of academic research, applied research, or direct participation in policy and programs. One could argue that the work of climate change is innately an interdisciplinary endeavor, since it stems from two crucial insights: First, that societies have affected the natural world via unprecedented greenhouse gas production and land use practices which alter Earth’s climate; and, second, that nature has affected societies via the altered climate creating shifts in temperature and precipitation, in turn changing food production, natural hazards, health risks, water availability and other aspects of human life. Inevitably climate change research involves specialists from a number of natural and social sciences. (See section 1 for fuller discussion of other social sciences represented)

Not only do other social science scholars, in economics, political science, sociology and

A key contribution of anthropology to interdisciplinary efforts to reduce vulnerability has been the discipline’s attention to the broad basis in the historic and contemporary diversity of culture, values, and beliefs.

psychology, contribute to the study of climate change, they also participate across social and natural science in interdisciplinary research projects. Among their ranks anthropologists are also firmly engaged.

The interdisciplinarity of climate change is also reflected in the core concepts, with their roots in different disciplines and interdisciplinary fields. Take the concepts of vulnerability and resilience. As discussed more fully in Section 4, the concept of vulnerability is drawn from geography, particularly the work on natural hazards; and the idea of resilience stems from models of ecosystem dynamics within the field of ecology (Janssen et al. 2006). Within climate change, the cross-disciplinary development of the core concepts of vulnerability and resilience has broadened the arena of their application. Furthermore, spanning the social and natural sciences, the interdisciplinary fields of risk analysis and disaster studies combine social, cultural, and cognitive elements with the geosciences, materials science, engineering, and related natural science fields. Anthropology contributes

importantly in these interdisciplinary activities. With its broad basis in the historic and contemporary diversity of culture, values, and beliefs, anthropology is central to interdisciplinary efforts to reduce vulnerability around the world (Roncoli et al. 2002; Crate and Nuttall 2009; Barnes et al. 2013).

6.1.2 Collaborating Disciplines

The engagement of anthropologists in interdisciplinary work on climate change includes working in groups with natural scientists, other social sciences and the humanities. These projects link anthropologists to other social sciences, both those closest to anthropology, such as sociology and geography, and those more distinct, such as economics and psychology. As an example, social processes within collectivities interact with individual perceptions, making anthropology

The engagement of anthropologists in interdisciplinary work on climate change is often understood to be synonymous with the participation of anthropologists in groups that also contain natural scientists. Nonetheless, interdisciplinary research is broader, including the other social sciences and the humanities.

and psychology strong partners for adapting to threats associated with climate change (Swim, et al. 2011).

Interdisciplinary research can also link anthropologists to researchers in the humanities.

Culture is embedded in social representations, shared assumptions, and

understandings about the social and physical world. The arts (including literature, film, and

other forms of creative expression) coupled with an understanding of culture (the purview of anthropology) inform how representations of climate change provide communities ways to live with uncertain futures (Yusoff 2011; Hulme 2011). For example, the Cape Farewell Project (<http://www.capefarewell.com/>) working in partnership with scientific and cultural institutions, delivers an innovative climate program of public engagement by looking at the physical, social and economic realities that lead to climate events to catalyze the creation of climate-focused art.

One of anthropology's most significant contributions to climate change research is discerning how narrative frames information to sustain public dialogue about climate change (Broad and Orlove 2007, Galvin 2013, Orlove et al. 2014). In this way, anthropology reinforces the integration of science and politics, to show how climate change impacts cannot be separated from the social, political and economic conditions in which communities are embedded (Bravo 2009).

6.1.3 Foci and Products

Interdisciplinary climate research includes both academic and applied activities, each with

Four important anthropological concepts in interdisciplinary climate research are culture, context and holism, and scale.

specific institutional forms, including organizations which support academic and applied research, journals, reports and other media in which research is published, and colleges and universities in which

anthropologists participate in educational programs. A number of examples are contained in the body of this section. To name a few, interdisciplinary research involving anthropologists is supported by the National Science Foundation (programs include Dynamics of Coupled Natural-Human Systems, Arctic Systems Science, Arctic Social Science, Decision Making Under Uncertainty, Human and Social Dynamics, and Long-Term Ecological Research).

Anthropologists have participated as mentors and as scholars in DISCCRS, (DISsertations Initiative for the advancement of Climate Change ReSearch), a program funded by NSF and NASA to promote young scholars to engage in interdisciplinary efforts in climate change research. A major area of support within NOAA is the Regional Integrated Sciences and Assessments program, which falls under the Climate Program Office. NOAA's National Hurricane Center has also drawn extensively on anthropological research. Anthropologists have participated in the National Climate Assessment. Other interdisciplinary activities include collaboration between universities and environmental NGOs, for example, the Natural Capital Project or the Resilience Alliance, the latter which bridges universities, bilateral aid organizations, and national research agencies. Anthropologists are also active within intergovernmental organizations, for example, the UN International Human Dimensions Programme on Global Environmental Change (to be subsumed under Future Earth later in 2014).

6.2 Key Elements of Anthropology within Interdisciplinary Activities

As introduced in [Section 1.0](#), the four most important anthropological concepts in interdisciplinary climate research are culture, context, holism, and scale. Culture—the cultural system of meaning—is intertwined with the values through which a people perceive and interpret the past, present, and possible future effects of climate change and variability, and direct their responses. Social and historical context influence the distribution of resources and power within

Anthropological methods, both quantitative and qualitative, are characterized by a long time depth of implementation and an integrated holistic orientation to their subjects.

and between societies, and shape the institutions in which responses to climate change are made. Holism views systems as entities with interacting parts, rather than as sets or assemblages of their components, and thereby directs attention to processes of

interactions among these parts. Finally, *scale* takes us from a sub-individual level of human-environment interaction (such as epigenetics), through to the individual, community, regional, national, and global domains, in both spatial and temporal dimensions.

Anthropologists engage both qualitative methods (including participant observation, oral histories, interviews, focus groups, archival work and linguistic analysis), and quantitative methods (such as surveys, structured, modeling of various sorts, time allocation and archaeological excavation). These methods are characterized by a long time depth of implementation and an integrated holistic orientation to their subjects. They are generally time-intensive in nature, resting on the establishment of close social ties (whether in single-sited or

multi-sited ethnographies) and on familiarity with one or more cultural and/or archaeological sites. Anthropologists do use more rapid assessments (e.g., archaeological site surveys, general ethnographic reconnaissance), but these are the exception and most often serve as an early stage to develop more intensive projects. Anthropologists need to articulate the in-depth and longitudinal aspects of the discipline's methods and their inherent value at a time when more rapid methods, such as Participatory Rural Appraisal, are promoted in interdisciplinary projects as a means of obtaining social data.

Some anthropological participation in interdisciplinary research engages complexity science, the study of complex adaptive systems (also termed dynamic or non-linear systems), that are out of equilibrium and unpredictable. With no overarching hierarchy of dominant/determining “stimulators” and subordinate “responders,” these systems are considered “heterarchies”—sets of interacting elements, each of which may sometimes dominate the system and at other times may

It is an important task for anthropologists to demonstrate the value of the discipline's methods through use of general accounts articulating the value of the data that these methods generate, and through specific studies that illustrate the power of insight brought forward by these data.

be subordinate to it (Scarborough et al. 2003). Furthermore, complex systems generate new features, known as “emergence.” Both heterarchy and emergence distinguish contemporary complex systems thinking from earlier systems theory, which assumed that natural systems could be modeled with a few key

variables and would return to equilibrium after being disturbed.

While the systems theory of the mid-twentieth century (roughly the 1930s through the 1970s) and the new complex systems thinking both address the organization of information, there is yet another important contrast between them. The earlier paradigm held (for many prominent scholars including Margaret Mead and Gregory Bateson) the tantalizing but largely unrealized possibility that a predictive science of human behavior could be framed in the language of mathematics, philosophy, and the nascent fields of artificial intelligence and computer science (Hofstadter 1979). Parallel trends developed simultaneously in ecology and other of the biological sciences (see Ellen 1982). In contrast, contemporary complex systems research is not a single theory, but a highly interdisciplinary aggregate and rich amalgam of several strands of investigation (e.g. chaos and network theory, computation science), and applied in the biological, physical, and social sciences. Contemporary complex systems research brings concepts such as nonlinearity, initial conditions, emergence, basins of attraction, and path dependence to the analysis of systems; this places a new focus on the importance of a system's history to discern its future state (colloquially termed the “butterfly effect”). These ideas, applied to human societies, can broaden the study of change across time and space and into the future, and seem particularly useful for the examination of resilience (see section 4). It is not surprising, then, that many anthropologists, whether studying the present through ethnography or the past through archaeology, have found complex systems particularly useful in efforts to understand social-ecological systems over time and space, and at different scales.

We detail below two key areas to which anthropology has contributed in interdisciplinary research: Ethnography and Local Knowledge; and, the Integration of Human and Natural Systems. We also defer to discussions of interdisciplinarity elsewhere in this report: in [section 2.0](#), of anthropological engagement in interdisciplinary efforts to study consumption and energy use; in [section 3](#), of collaborations between anthropologists and natural scientists in studying past

Since global climate change has strikingly different effects from one locale to the next, anthropologists are well-positioned to be the interlocutors of human-environment observations, perceptions, understandings and responses.

cultures; and in [section 4](#), of the interdisciplinary nature needed to articulate, specify and apply certain core concepts in the climate change field.

Additionally, [section 5](#) provides extensive discussion of interdisciplinary efforts documenting how anthropologists act as

interlocutors of community perceptions and scientific data about local change.

6.2.1 Ethnography and Local Knowledge

Climate change is a global process having diverse effects across ecosystems and cultures. Herein lies a critical role for anthropology. Much anthropological research is carried out on scales that attend to the local, whether centering on local processes or locating them in relation to wider social and historical contexts. Anthropology is unique among the social sciences in its stress on extensive and longitudinal fieldwork, its use of multiple methods and its close attention to the everyday lives of local people (Agar 2004; Hastrup 2013). For example, local communities' knowledge of changes of weather and wind is more than ample (e.g., Strauss 2007; Galvin 2013). Ethnography shows how global connections and local facts are interconnected, reflecting the anthropological commitment to understand and engage several scales of interaction simultaneously (Crate 2011a, 2011b; Galvin 2007).

Since global climate change has strikingly different effects from one locale to the next, anthropologists involved in interdisciplinary endeavors can link the perceptions and understandings of local and expert groups. The reporting of observations by local peoples living in the world's more climate sensitive areas was one of the seminal entries into anthropological research on climate change (Krupnik and Jolly 2002; Orlove et al. 2010). As anthropologists shared this experience and as other anthropologists' sensitivities to similar observations and witness by their field collaborators increased, the possibilities of knowing how a global process can result in a diversity of realities on the ground became increasingly clear. In these ways anthropological investigations could work as a type of "ground-truthing" for global and regional models, and point to the importance of down-scaling these models.

Prior to such down-scaling, local observations must be understood through the local cultural and institutional context. Anthropologists often conduct research with populations that consider most of the natural world to be sentient, embodied by spirits who are active agents:

If rainfall is a divine gift, then solving the problems related to drought must involve dealings with the supernatural in the form of pleasing the deity responsible. Failure to

adjust to environmental stress is as much a social and cosmological problem as an environmental one (Rosen 2007:10).

This recognition creates both challenges and opportunities for anthropologists. On the one hand, anthropologists can corroborate the observations and perceptions of the populations they study with evidence from the physical sciences. For example, an anthropologist can document their collaborators' observation that there is "too much rain" when scientific instruments show that annual precipitation rates have remained the same. Anthropological insight interprets what appears an incongruity as a sound contextualized observation. In this case, the affected communities depend on harvesting substantial amounts of hay in the brief sub-arctic summer to fodder their herds through the winter. For the past ten years, the timing of major rainfall has shifted from spring to late summer, exactly the time of the hay harvest. Because this is such a critical time for their hay harvest, inhabitants perceive it as too much rain based on their essential human-environment subsistence strategy. Or, phrased alternatively, the phrase "too much" may refer to an excess, calibrated to a qualitative metric of human needs rather than to a quantitative metric of precipitation totals (Crate and Fedorov 2013). In a related fashion, research drawing on anthropology and other social sciences has shown that the concept of drought itself is social and cultural, since it is influenced by specific forms of resource management and governance (Wilhite and Pulwarty 2005).

Anthropologists also show that discussions of climatic and other environmental changes are not merely about natural phenomena, but also about social, political, moral and religious systems, as shown in Lipset's analysis of Papua New Guinea communities who raise issues about political legitimacy and supernatural order in response to coastal erosion (2011). Similarly, Tanzanian farmers say that "the rain is different now," and blame declining rainfall on a changing post-colonial social order and changing power relationships, linking rainfall with politics of the 20th century (Sheridan 2012:230). Medical anthropologists gained such insights long ago of how non-Western healing systems contained understandings that could be explained in scientific terms and adopted elsewhere, but also addressed wider issues of human well-being that could not be immediately reducible to scientific frameworks. More broadly, these cases show the importance of grasping the widely different understandings about the entities which exist, interact and act in the world, in recent years termed "ontological" (see also section 1.3 in Introduction).

This issue of multiple forms of interpretation comes to the fore when anthropologists encounter non-Western accounts of causality, again making anthropological engagement key to for interfacing local communities' understandings of change and its sources. Here again our appreciation of and attention to different forms of knowledge within non-Western cultures and science are critical. For example, whereas a non-anthropologist might write off community members' explanation of changes in their local environment as due to "too much technology," an anthropologist has insights to understand such a response (Crate 2011b). First, it is relevant that the sector of the population explaining local change in this way is elderly. Second, it is critical to know that many contemporary elders were born and spent their early years in a lifestyle powered either by humans or animals—there was no mechanization for the first few decades of their lives. In short, that over their lifetimes, they have witnessed the introduction and full development of modern technology. With these contextual pieces, the explanation of "too much technology" makes sense. Additionally, they are in part "true." In one sense, it is true that modern

technologies, usually involving fossil fuels, do contribute to climate change. In another sense, new technologies can be associated with disruption of long-established lifeways, of inter-generational transmission of environmental knowledge, and of ritually-mediated relations between humans and the environment (Aporta and Higgs 2005).

As these cases show, anthropologists have contributed to the study of climate change by bringing forward the issue of cultural difference which lie between Western and non-Western cultures, particularly indigenous cultures, since anthropologists have been particularly interested in working with populations in remote vulnerable areas such as the Arctic and low-lying islands (Lazrus 2012). However, anthropologists also engage cultural differences within Western cultures or within non-Western cultures. (We are sensitive to Trouillot's [1991] critique of anthropology as falling into a "savage slot" of constructing cultural difference as otherness and hierarchy.) As examples later in this section indicate, anthropologists also study the cultural frameworks of residents of coastal New Jersey or of scientists employed by federal agencies. Anthropologists have also productively examined the debates over climate change in Western societies, including positions ranging from climate deniers and skeptics to activists who oppose coal-fired power plants (Connor 2010, 2012). Moreover, anthropologists study social inequality, whether based on ethnic, class or other divisions and show, for example, that climate policies themselves can be tools in political conflicts, favoring some groups at the expense of others (Hughes 2013).

6.2.2 Integration of Human and Natural Systems

Together with colleagues in the natural sciences, anthropologists have made great strides to clarify the entanglements of natural and social realities, without simplifying the causal links (Hastrup 2013; Crate 2011a; Barnes et al. 2013: 541).

Anthropologists study a number of linkages between human and natural systems. Of particular

Anthropologists study a number of linkages between human and natural systems. Of particular importance are the human activities that generate greenhouse gases; the ways in which different groups perceive and understand climate change; the varying impacts of climate change on people around the world; and the diverse societal mechanisms that drive adaptation and mitigation.

importance are the human activities that generate greenhouse gases, the ways in which different groups perceive and understand climate change, the varying impacts of climate change on people around the world, and the diverse societal mechanisms that drive adaptation and mitigation.

Anthropologists can integrate human and natural systems with an understanding of the history

of society-environment interactions to produce a broad holistic view of climate change. Anthropologists who work on environmental issues conduct research that represents a wide range of theoretical and methodological approaches, but that all underscores the relevance of anthropological approaches for study of complex social-ecological systems. There is a growing recognition among natural scientists that they need to contend with the human impacts on ecosystems, since all places of the planet now have a human imprint. Ecologists study ecosystem

processes at the micro-scale and at the global macro-scale. They have tended to view humans as external drivers of natural systems, rather than as agents acting within social-ecological systems (Grimm et al. 2000). Similarly, ecologists do not discern the local, regional, and national scales at which human activities more directly affect ecosystem processes. This and other examples offer opportunities for anthropologists who study complex social-ecological systems using a holistic approach and making linkages across spatiotemporal scales (Moritz et al. 2012).

While there are social science activities in many projects within environmental science, they are often carried out on an ad hoc and inconsistent basis. Such interdisciplinary research is usually difficult because of the mismatch of conceptual models, theories, methods, and scopes and units of analysis in ecology and anthropology (Mooney et al. 2013). Anthropologists' primary goal is describing and explaining cross-cultural variation across all human societies and over time. Furthermore, ecologists rarely understand the iterative approach of ethnographic research strategies, as described by Agar (1996). There remains resistance to the integration of social sciences in ecosystem research and also stereotypes of anthropologists as inferior scientists with few quantitative skills. However, the field-based research that is at the heart of anthropology and many natural science disciplines is a strong bridging factor that makes integration achievable. This bridge provides the basis for the many successful interdisciplinary collaborations between environmental scientists and anthropologists, such as the South Turkana Ecosystem Project.

Interdisciplinary climate science has developed tools to identify the entanglements of social and natural systems and the cascade of other changes to a system prompted by climate change. Beyond that, such ecosystem effects exist in the context of other non-climate-related change, a phenomenon termed "double exposure" (O'Brien and Leichenko 2000) and "multiple-stressors" (McCarthy and Martello 2005). Some attempts to account for this complexity of change involve nascent efforts to develop models (Pielke et al. 2012). The challenge comes when trying to simulate evolving social responses and interactions to change, with attempts to do so disappointingly mechanical (Fuessel 2009).

As anthropologists are increasingly called to collaborate with interdisciplinary teams, they are developing more human-inclusive approaches to understanding change. For example, Hastrup and her colleagues in the Waterworlds project strive to humanize the concept of resilience, addressing the need to consider and account for what they call "bottom-up complexity" or the on-the-ground complexity of social and cultural systems ". . . resilience is an emergent quality of all responsible social action; it is the rule and not the exception of social life, given that all

In short, we need to use qualitative approaches to understand fully how humans interact with a complexity of change in the contemporary world.

societies must demonstrate a degree of flexibility to operate and ultimately to survive . . . Resilience, therefore, is not simply a question of systemic (social and cultural) adaptation to external factors, but a constitutive element of any working society" (2009:28). In

short, anthropologists have tools such as qualitative approaches to understand fully how humans interact with the complexity of change in our contemporary world. These points are illustrated

with a set of case studies of anthropological engagement in interdisciplinary research, contained in [Appendix 7](#).

6.3 Research Frontiers

In this section we describe a set of research frontiers, the academic and applied research opportunities that climate change provides anthropologists. Anthropological theories and methods engage different human populations (residents of different regions of the world; natural and social scientists; policy-makers, officials, and other members of state and civil society institutions) who engage with changing environments and who draw on systems of representations and meanings (different cultures; science; legal and political discourses) to understand and act upon these environments. We arranged these frontiers to start with those most directly participating in the major international climate change frameworks, moving next to those that engage more critically with the politics of such frameworks, and closing with those that question the assumptions of the same frameworks.

6.3.1 Frontier 1: Models

Climate scientists use global and regional climate models to make projections about climate in the future. These models are based on assumptions about physical climate, effects of biological environments, effects on humans and human systems, and effects of mitigation efforts and policies – all at different levels and which result in a number of scenarios. Data related to human activities is usually economic, or quantifications of emissions levels. Anthropologists familiar with the process have lamented the lack of non-economic data that inform the human dimensions of models (Crate 2011a). Human societies and human interactions and behaviors are notoriously difficult to model and to design, especially given the variability in practices and cultures globally. Nonetheless, anthropologists can work at an incipient level, to review and utilize new and grounded assumptions about the types of data and the relationships between them that go into the human modeling and how the human information interfaces with biogeophysical modeling and climate modeling. Anthropologists are taking initial steps, using agent-based modeling (ABM) (Boone and Galvin, n.d.; Axtell et al. 2002; Lansing and Kremer 1993) and statistical modeling to inform climate models. Anthropologists also continue to work with physical scientists and modelers to guide the development and interpretation of model outputs. These efforts can all lead to building more relevant and meaningful models, and to fully integrated interdisciplinary studies (see also modeling discussion in Section 2.0).

6.3.2 Frontier 2: Resilience

Anthropologists can add to interdisciplinary climate studies using a resiliency framework based largely on ecological constructs (Berkes et al. 2000) by showing how cultural factors play a role in adaptive success (see Nelson et al. 2009; Nelson and Finan 2009; Vásquez-León 2009), and highlighting the dynamism of adaptation, based in a web of reciprocities, obligations, and assets (Crane et al. 2010; Roncoli et al. 2009; Hastrup and other researchers in the Waterworlds project (see section 6.2.2) developed qualitative anthropological approaches, including the longitudinal engagement of ethnography, a grounding in the biophysical and the cultural of local contexts, and an understanding and appreciation of cultural representation and relationships, to understand

how humans interact with a complexity of change in the contemporary world. This is an important research frontier that begs for more investigators not only to flesh out these anthropological approaches to resilience, but also to find ways to effectively integrate those approaches with the resiliency frameworks of climate science and/or to strengthen and prove the case to create alternative ways to understanding resilience.

6.3.3 Frontier 3: Adaptation Discourses

Anthropologists contribute to the understanding of global economic and political systems by showing the pervasive effects of frameworks that appear to be universal, technical and neutral. Following examples such as Ferguson's discussion of economic development, focused in Lesotho (1990) and West's examination of biodiversity conservation, centered on Papua New Guinea (2006), anthropologists are beginning to conduct studies which trace the effects of adaptation frameworks as they move from international conferences and national governments to wider social spheres (Orlove et al. 2014). For example, Farbotko and Lazrus (2012) show that residents of atolls in the Pacific articulate their longstanding patterns of movements between islands (including those of lower and higher topography) in ways that are quite distinct from global discourses of adaptation and of refugee populations. In a related vein, Weisser et al. (2013) trace the ways in which efforts by national governments to promote adaptation programs were contested and reshaped by local populations in different ways in Tanzania, Uganda, Ethiopia, and Rwanda. Through studies such as these, anthropologists can contribute to the debates over adaptation programs and policies, and can demonstrate that the idea of adaptation is shaped by many sectors of society rather than by experts alone.

6.3.4 Frontier 4: Habitability

The concept of habitability draws on several strands of research, including the study of the natural parameters that allow human life on earth (Rockstrom et al. 2009) and the examination of international environmental discourses and institutions that underscore the threats that climate change brings to the continued suitability of specific regions, such as the Arctic and low-lying islands, for human settlements (Orlove et al. 2014). The concept of habitability is suggested by debates about strategic retreat from coastal zones and to discussions of climate refugees. It extends the notion of vulnerability by looking at harm so severe as to preclude human settlements, but focuses on the spatial zones of uninhabitability, unlike vulnerability, which is generally associated with populations and individuals. It relates as well to the idea of sustainability, but points to the possible failures of sustainability. The interactions of scientific, political and cultural notions of habitability are a fertile area for anthropological research.

6.3.5 Frontier 5: The Cultural Politics of Decarbonization

The cultural politics of decarbonization is another critical area for anthropologists to engage. What will decarbonization, now addressed primarily from the perspective of economics and global- to national-level politics (Edenhofer et al. 2009; Bernstein et al 2013), mean for everyday practice, future imaginaries, forms of resistance and co-optation by ordinary people in local communities, as they begin to respond to the need to transition to low carbon cultures? Reshaping the relationship between people and their carbon-intensive lifeways entails a shift in habitus, and anthropology is the appropriate discipline to both document and support such transitions. We need more integrated understandings of how people use carbon in its many manifestations, from fuel to plastics. These would include studies of how people differentially

value different forms of energy, from fossil fuels to wind or solar, or use traditional stove fuels and technologies versus newer systems that produce less black carbon; make decisions about transportation options, like walking or cycling instead of driving (and such decisions also have implications for health); engage in other kinds of family and institutional level consumer behaviors, such as choices about local or organic food options (see section 6.3.6); consider strategies for housing that include improving insulation, changing habits with regard to household energy use, developing different forms of green roofing; participate in policy debates about the siting of energy facilities and national choices of energy systems, and many other possibilities. Although such research exists to some degree in the marketing world (e.g. Avallone et al. 2012), it has not been sufficiently linked to broader social and cultural understandings of everyday practice, particularly in the context of the deep shifts in values and strategies that will be required for a rapidly decarbonizing world.

6.3.6 Frontier 6: Alternative Consumption Patterns

Anthropologists also have a long and distinguished record of studying alternative and utopian communities such as eco-villages, slow cities, transition towns, and local currencies, and popular movements like vegetarianism, simple living, food sovereignty, slow food, survivalism, the Occupy movement, and environmentalism of all stripes. We need to bring together this scattered scholarship into a careful assessment of the potential for this activism to have a major effect on consumption and production, and therefore on greenhouse gas emissions (see section 6.3.5). How can this knowledge be used to advise on public policies and laws to encourage and promote low-impact lifestyles? Can we find practical ways of slowing the spread of high-consumer lifestyles, reducing consumption among the rich, reducing economic inequality and rethinking the ideologies of growth and welfare? This will require that we forge connections with researchers in other disciplines who are working on projects on topics like degrowth, the sharing economy, post-autistic economics, industrial ecology, decarbonization, energy cultures, culture hacking, and anti-consumerism.

6.3.7 Frontier 7: Political Realignments and Migration

The rise of mitigation and adaptation frameworks in policy circles has created substantial shifts regarding livelihoods, resource management and patterns of residence, favoring some agendas and actors and displacing others. These processes represent opportunities for anthropologists to conduct research and to engage with a variety of groups. One striking example is the growth of REDD, Reducing Emissions from Deforestation and Degradation, a way of promoting mitigation of greenhouse gases by encouraging the storage of carbon as biomass in forests. The anthropologists who have conducted field research among local and indigenous populations in tropical forests have noted that the rise of climate change as an issue has meant a decline in the importance of biodiversity as an issue. When biodiversity held center stage in global environmental discussions, it was possible to put forward coalitions of forest peoples and environmental organizations at different scales to protect forests against such threats as the rise of plantations of oil palm and other commercial species. The rise of carbon accounting and REDD has encouraged plantations, displacing local populations, encouraging transnational ownership and control of forests (Brosius and Campbell 2010; Hirsch et al. 2011; Howell 2014). A second example is the use of climate projections by certain political actors to reorient water governance within Egypt, diminishing the voices of certain organizations, which represent small farmers and urban consumers (Barnes 2014). Perhaps most significantly, studies can examine the

ways in which actors seek to locate climate-influenced population movements within the established frameworks developed to describe migrants and refugees.

6.3.8 Frontier 8: Anthropology of Science

Drawing on longstanding engagements of anthropology with Science and Technology Studies, a number of anthropologists have begun to study the natural scientists who engage in climate change research, tracing the interactions within scientific communities and between scientific communities and other institutions; a number of opportunities exist for further work in this area. These studies include the integration of different types of data and the handling of uncertainty within major international efforts, such as the assessment reports of the IPCC (O'Reilly et al. 2012), national monitoring programs (Lahsen and Nobre 2007; Lahsen 2009), and the position of scientists at the science/policy interface (Moore 2012). Other research has focused on the recent growth of interest in establishing the current era as a new geological epoch, named the Anthropocene, characterized by visible evidence worldwide of human impacts on earth's physical and chemical processes (Sayre 2012). This research within the anthropology of science seeks to examine the influence of social, cultural, and political contexts on the production of scientific knowledge, including the analytical frameworks, research methods, and circulation of results; it can serve to deepen the understanding of the reception and use of climate science within policy and social settings.

6.3.9 Frontier 9: The Ontological Turn

In recent years, a number of anthropologists—drawing on earlier work within the discipline on animism, cultural models, and epistemology—have used the word “ontology” to indicate the radical differences between modern Western science and other cultural systems. Though the word “ontology” refers broadly to philosophical questions of existence and the status and categories of objects, anthropologists often employ it to indicate that other cultures attribute sentience, purposiveness, intentionality and morality to animals, natural phenomena, and other entities unrecognized by Western science. Within environmental anthropology, a number of researchers on biodiversity conservation have shown that many protected areas contain resident populations who view their relations with animals in terms very different from the ways that biologists and policy-makers do (Blaser 2009). Cruikshank's prizewinning book *Do Glaciers Listen?* (2005) brings this approach to climate anthropology, discussing the ways that geoscientists and local indigenous people in the Canadian Yukon understand glacial processes very differently. Rudiak-Gould (2011) examines a similar contrast between local and scientific understandings of climate in the Marshall Islands, and refers to such inquiries as “reception studies” (see also Bravo 2009). In related ways, Nuttall (2009) discusses the ways that indigenous populations in Greenland place climate-driven environmental change within a framework of relations between fully conscious human and non-human actors, Orlove and Kabugo (2005) locate customary Ugandan forecasts of climate, medical and other hazards within local understandings of a world filled with significance, and Lipset (2011) shows that coastal villagers in Papua New Guinea explain sea level rise and seek solutions to the problems it causes in ways that are profoundly different from the science- and policy-based accounts of national and international actors. This area offers possibilities for future anthropological research. ■

7.0 Conclusions

The GCCTF report comes at a time when the initial promise of science-driven, global scale approaches to govern our atmospheric commons has failed. Although the IPCC process has generated increasingly high-confidence reports documenting the urgency of the earth's predicament, and has shown that the anthropogenic cause of that predicament is undeniable, international actions in response by the UNFCCC and Council of Parties (COP) are entrenched in a deep-seated political impasse. In the process of years of international deliberations, it is clear that long-lasting solutions require actions beyond global, top-down solutions to include local, bottom-up ones.

This creates both opportunities and responsibilities for anthropology and for the social sciences overall. We suggest a transfer of the focus of climate-related science and policy attention to meso- and regional scales in an effort to re-orient adaptation strategies in place, where they happen—grounded in the localities, communities, societies and settings where they are needed.

The GCCTF report identifies multiple contributions that anthropology makes to the understanding of global climate change science and policy and offers the following conclusions:

Anthropologists have traced the diversity of human adaptive responses throughout human history, both before and during the Anthropocene context, with attention to migration, emergence of complex societies, transformation, and collapse. Anthropological analysis of past climate change is based on the discipline's emphasis on holism and context, and a search for the relationship between social and environmental diversity. Early and highly visible contributions from archaeology continue to provide insight into how early societies dealt with climatic changes—which types of adaptations succeeded and failed, at what scale, and how some societies developed institutions that managed a long-term. Cases from archaeology and ethnography show that two universally critical components of enduring societies are diversity (e.g., subsistence strategies, scale of adaptation, etc.) and flexibility. On the other hand highly centralized management of economy and government often leads to instability, and in some places catastrophe. The relationship between climate change and human conflict is an important research topic that is likely to expand in anthropology in the future.

With skills in the cultural, holistic, and contextual domains, anthropologists recognize local-level adaptations across all temporal scales and at the meso- and regional scales, and therefore can contribute to much-needed efforts towards adaptation. Although climate scientists, from the beginning, have recognized that greenhouse gas production is a consequence of human activity, anthropologists were among the first of the social sciences to elaborate on the breadth and cultural nature of climate “drivers,” pointing out that land cover change is essentially driven by human choices. The ultimate causes of GHG production are all cultural, having been produced over the history of human existence; they are not a product only of the present. The discipline has been at the forefront of studies of contemporary drivers, such as the expansion of consumer culture, making significant contributions to understanding the history and global spread of major agricultural commodities. Production and consumption patterns have widespread

impacts both on producers' environments and on people and, through the use of energy, on the production of greenhouse gases.

Prescriptions for adaptation, and to a lesser degree vulnerability and resilience, are primary pillars of international and national climate change policy. Adaptation is often negotiated and debated on the level of nation-states. **We assert that by refocusing adaptation discussions on sub-state levels, anthropologists can do our part—not only by clarifying how adaptation is decided in local and regional contexts, but also by identifying means to strengthen interactions among various levels.** Discussions of adaptation are proceeding in many places and at different scales, including international climate accords, national planning agencies, municipal governments and local communities; these disparate efforts are often not integrated and weakly coordinated.

Existing top-down adaptation programs do not treat the social and economic variables that underpin vulnerability: poverty, marginalization, lack of education and information, ineffective local governance, and loss of control over resources. Anthropologists use collaborative models in working with communities—to understand and develop approaches that are locally generated, owned and perpetuated, whether they are among the Sakha in Siberia or community leaders in Chicago.

Anthropological analysis shows how vulnerability and resilience have morphed from being technical, descriptive concepts into broad political slogans to promote action without the needed assessment, application, monitoring and evaluation needed to be effective. **Anthropology was among the early observers to call attention to the differential impacts of climate change on people across the globe and to point out the fundamental environmental injustice of climate change—that it has affected the vulnerable, marginal, and otherwise disadvantaged peoples the most, though these are the same peoples who have contributed the least to the accumulation of GHGs.**

By contributing insight into climate policy processes at national and international levels, anthropology has demonstrated the distributional and unintended consequences of policy on communities and people, the weaknesses in dealing with adaptation without addressing underlying vulnerabilities, and the frailties pervading climate change communication. These contributions help to re-frame the policy discourse about climate change especially around concepts of adaptation, vulnerability, and resilience.

As anthropologists we understand that a changing climate is one of the many drivers of social change in the set of globalized processes affecting cultures and their interactions with their environments. At the ground level, people experience the local effects of climate change through increased variability and unpredictability of weather, altered seasonal timings, and changing water regimes. However, affected communities' lives are also challenged by the cumulative effects of environmental degradation, poverty, political upheaval, changes in land tenure, demographic shifts, etc. Furthermore, these other sources of change often are the most urgent and pressing in daily life. Anthropological investigation requires a holistic perspective that can connect the many processes and drivers of socio-cultural change. This anthropological

attention to the entanglement of changes affecting human communities and the obstacles to global sustainability are crucial in crafting effective action on global environmental change.

Anthropologists engage with communities to understand how they are affected by local climate change impacts; anthropologists work to identify the path-dependent vectors of vulnerability which are instrumental in facilitating adaptive capacity. Anthropologists are well positioned to engage with communities as they evolve capacities and the agency to deal with climate change. We think of community broadly, including communities of place, practice, and beliefs. Anthropological investigation—observing shifts in technology, consumption, and changes in land use, etc., draws attention to the processes and structures of adaptation in regions, communities, and households. We recognize that local knowledge is a key way of perceiving, understanding and responding to local changes, which expands our understanding of human interactions with climate and climate change.

Recent anthropological work points to the need to focus attention on the ethics, practices, and policies/politics of transitioning to a low-carbon society, including the resistance these changes will inevitably entail. The study of consumption and cultural change has a long history in anthropology and, while little research has been carried out on decarbonization transitions to date, this new direction follows directly from our long engagement with technological change as both cause and consequence of environmental change. The risks and opportunities associated with a changing climate, from the health effects of a changing climate to new technological innovations, are reaching the awareness of all, from those most economically and/or geographically marginalized to the most privileged people on the planet. By studying the shifting discourses of climate change, as well as the values and practices that generated it and the material effects and resulting transformations it entails, anthropologists contribute significantly to our understandings of both the drivers and the impacts of a changing climate. Anthropologists excel in understanding how individuals and cultures make sense of novel technologies and threats, and so we are well-suited to help promote change from within.

The task force concludes, in summary, that anthropology has made numerous contributions to climate change science, discourse, and policy; but that it needs to do more to bring to the forefront the methods and insights from our discipline to address the complex challenges that lie before us. The increasing number of publications articulating the contributions of anthropology, as well as the increasing engagement of individual anthropologists—at scales from communities and island states, to national policy and global interdisciplinary initiatives—all point to a very positive set of signals. Anthropology itself is flexible and highly adaptable, giving the discipline a unique talent for finding and studying the most current and novel developments and innovations.

In our review, we focus on selected high points in the anthropology of climate change. We take on the problematic nature of once descriptive terms now being used as policy frameworks at the global level—and how we can re-think and re-align those concepts to allow the intended beneficiaries to participate in effective and fair solutions at the local level. We highlight the lessons from the past with respect to the ways that complex societies change under direct and indirect climate stress, and how social structures transform and morph, leading to generalizations about the nature of resilience in social systems. We address the critical role of drivers as seen

through the anthropological lens; and the nuances of impacts at the regional and community level. Anthropologists have long recognized what has now become common knowledge: that all adaptation is local and that climate change and other environmental changes will be experienced locally. However, because of the other global forces in addition to climate change, acting upon the local, including globalization of financial markets, the increasing dependence of every community on international trade, etc., anthropology must collaborate with interdisciplinary and transdisciplinary efforts towards resolution, sometimes at the national or global level. As the focal point sharpens on mesoscale and community level social-ecological systems, anthropologists are working with communities as they develop capacity and agency to deal with climate change threats to their existence and livelihoods, promising new and more effective models of adaptation and resilience. ■

8.0 Recommendations to the AAA Executive Board

8.1 Recommendations for AAA

Please note: the Recommendations are in the process of being reviewed by the AAA Executive Board and AAA staff prior to being finalized and/or adopted. The general categories and sense of the recommendations are provided here without the details.

- 1) Accept and adopt 'Changing the Atmosphere' report from the AAA Global Climate Change task force, and the Statement on Humanity and Climate Change.
- 2) Publicize the Report broadly and develop enabling mechanisms for anthropological climate change research and knowledge.
- 3) Expand anthropological knowledge and perspectives on climate change into the public domain.
- 4) Provide on-going capacity to monitor and respond to climate change and global environmental change issues affecting humanity world-wide.
- 5) Continue aggressively with developments in AAA that reduce the carbon footprint due to association-wide activities.

8.2 Recommendations to Catalyze the Discipline and Profession of Anthropology

- 1) Build capacity in anthropology research and engagement to address issues of climate change.

8.3 Recommendations to Forge Interdisciplinary and Global Collaborations

- 1) Encourage stronger cross-disciplinary ties with existing professional associations linked with climate change and global environmental change.

8.4 Recommendations for Engagement with Policy Community and Media

- 1) Enhance capacity for policy statements, recommendations, and endorsements.
- 2) Develop/expand dissemination strategies for communicating anthropological knowledge with the public, communities, agencies, and NGOs. ■

Appendix 1: List of AAA Global Climate Change Task Force Members (2011–14)

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Appendix 2: GCCTF Activities, Process and Products 2011-2014

How Did the AAA GCCTF Come to be Authorized?

As more and more anthropologists in all four of its subfields sensed the widespread import and impact of global climate change, particularly in communities within which they worked, members of the American Anthropological Association (AAA) believed that the association should take an active role in issues of climate change. Heather Lazrus, an anthropologist working in Tuvalu on climate change issues and a member of the Environment and Anthropology Society, drafted a resolution to form a task force to comment on climate change for the discipline and profession. The resolution was brought forward and passed in a Section Assembly; and the Executive Board approved a resolution authorizing the AAA's Global Climate Change Task Force in November 2010. With this effort, the AAA joins the American Association for the Advancement of Science, the American Meteorological Society, the American Sociological Association and the American Psychological Association, among other professional and scholarly organizations, that have convened working groups, commissions, workshops, and reports on climate change.

The resolution urged the AAA to take action in the face of increasingly widespread and directional environmental shifts linked to climate change—glaciers retreating, increasing rain, higher temperatures, rising sea levels and ocean acidification, and increasing desertification, to name but a few changes. While geophysical and biological scientists and governmental bodies often focus on the physical and ecological effects of climate change, anthropologists' sociocultural and archaeological knowledge and perspectives on the relationship between culture and climate are less well-known. Anthropologists interpret humanity from multiple scales and perspectives—from ethnographic and archaeological understandings of effects on livelihoods, identities and culture, to the asymmetries in global power dynamics and inequities associated with global climate change policies and responses.

The members of the GCCTF were appointed by AAA Presidents Virginia R. Dominguez and Leith Mullings over a period that spanned both their presidencies. The members were selected based on responses to an initial call for participants by the president, recommendations from departments, and recommendations by the task force where there were gaps in theory and knowledge base. The eleven members of the Task Force are, in alphabetical order, Susan A Crate, Carole Crumley, Shirley J Fiske (Chair), Kathleen Galvin, Heather Lazrus, George Luber, Lisa Lucero, Anthony Oliver-Smith, Ben S Orlove, Sarah Strauss, and Richard Wilk (see [Appendix 1](#) for details).

The Charge to the Task Force

The initial charge to the task force was the following:

“The charge of the GCCTF is to facilitate anthropological contributions to interdisciplinary research on climate change. We are especially interested in contributions that can be made without sacrificing disciplinary rigor and those that promote engagement with an array of policy issues. In addition, the GCCTF is tasked to produce a guiding document to recognize anthropological contributions to global climate change-related issues, articulate new research directions, and provide the AAA with actions and recommendations to support and promote anthropological investigation of these issues. These should include the development of course curricula and the application of anthropological theory and methods to the issues.”

The highlights of the charge for the GCCTF, as elaborated by the task force, are listed below. The full set of objectives can be found in [Appendix 3](#).

- Recognize and communicate anthropological roles in and contributions to the study of climate change and climate-related issues, with particular emphasis on representing many diverse voices and narratives, past and present;
- Produce guiding documents to recognize, promote, and develop anthropological contributions to global climate change-related issues;
- Promote engagement of the AAA and anthropologists in general with public policy agendas and the greater public interest, utilizing media and outreach beyond the discipline;
- Promote analysis of processes, discourses, and institutions associated with climate change science and policy. Communicate and translate local peoples’ perceptions and concerns to the media and general public;
- Support anthropological contributions to interdisciplinary research on climate change through panels, workshops, publications, engagement with publicly accessible websites and databases, and participation at conferences;
- Articulate new research directions within the discipline and profession, especially for students and anthropologists new to the topic area;
- By focusing on the complementary intra-disciplinary approaches to climate change, bring about recognition, respect, and exchange among the different perspectives within anthropology.

How Did the Task Force Go about its Work?

The task force began its work at the 2011 AAA annual meeting in Montreal where we met for the first time face-to-face as a task force. The four primary items on our agenda were to establish working relationships within the group; to continue to refine our mission statement and objectives based on the original guidance from the Executive Board; to hold an Open Meeting to solicit input and interest from attendees in the meeting; and to start planning for our sessions and outreach for the upcoming calendar year.

The initial meetings and formation of the task force appeared in *Anthropology News (AN)* of November, 2011; and the Open Meeting was publicized through Anthropology and Environment list serve in advance. The results from the Open Meeting confirmed the deep interest that anthropologists have in climate change. The small conference room was packed, and we heard from students, young professionals, researchers, faculty, and task force members about their concerns and frustrations in helping communities deal with challenges of climate variability and climate change. We came away impressed by the breadth of interest and the great desire to know what other anthropologists are doing in climate change; this became a mandate for information sharing and the nurturing of an informal network and resulted in setting up a list serve for anthropologists devoted to climate change related issues, discussed more below.

The major initiatives undertaken by the GCCTF to meet its objectives, are listed below in fairly chronological fashion.

Outreach and Information Gathering within Anthropology

The GCCTF created a page on the AAA website to provide a publicly accessible web presence where people can access general information about the GCCTF and links to specific activities;

Changing the Atmosphere Columns

Please see [Appendix 4](#) for complete listing and link.

February 2012: **Tales from the AAA Task Force on Global Climate Change**

March 2012: **Of Cows, Corn, and Climate**

April 2012: **Listening to Locals, Recognizing Risks, Reframing Discourse**

May 2012: **Of Aquifers and Islands**

June 2012: **“Experiencing Rio+20”**

Summer 2012: **Communication, Consultation, Collaboration**

Sept 2012: **Climate Change Impacts across the Americas**

Oct 2012: **Agriculture and Adaptation from Africa to the Andes**

Nov 2012: **A Snapshot of Climate Change in Rural Tanzania, 2010-2011**

January 2013: **Landscape, Climate, and Social Memory**

February 2013: **Of Climate, Kings, and Cenotes**

May 2013: **Variability and Change in the Drylands of Kenya**

December 2013: **From Sweden to China**

March 2014: **“Sagas for Sustainability”** ◆

see <http://www.aaanet.org/cmtes/commissions/CCTF/gcctf.cfm>, Our staff liaison, Dr. Amy

Goldenberg, organized our work, publications, and outreach so that individuals could find links to the list serve, the political commentaries, the “Changing the Atmosphere” columns, and the other activities.

We learned at the outset that anthropologists want to know who is out there and what they are doing—particularly graduate students and faculty. In response, we initiated “Changing the Atmosphere,” an on-going column in the electronic *AN*, accessible to the public, with Sarah Strauss as Contributing Editor. The column is a periodic series of interviews with anthropologists engaged in climate change research and activity world-wide, including both task force members and others; sometimes including news from international meetings such as Rio + 20, the United Nations Conference on Sustainable Development. Columns are posted on the GCCTF webpage after they go off the *AN* website. “Changing the Atmosphere” became a way to communicate with a large network of anthropologists and others and to share the work of anthropologists working in climate and climate change. It provides anthropologists the opportunity to comment on their work, see how their work articulates with the general topic, and identify the concerns and critiques they may have of climate change anthropology; people were widely solicited to participate, and to date has profiled 21 anthropologists from a variety of subfields of anthropology (for full list see Appendix 4).

As part of its information-gathering phases, the GCCTF reached out to anthropologists and colleagues through a series of AAA Open Forums and web-based exchanges, including queries and information over EANTH’s substantial list. The task force members traveled to annual meetings of other organizations and conducted panels and discussions to have feedback and get insights to the concerns and views of other anthropologists. Within the first year we held sessions at American Ethnological Society (AES) in New York City, organized by Ben Orlove and a session for the Society for Applied Anthropology (SfAA) in Baltimore, MD, led by Susan Crate and Shirley Fiske.

The task force used the extensive reach of *Anthropology News* to AAA members to alert them and to engage with the task force, in addition to producing period blogs for the AAA site and even a twitter or two. The task force provided three articles to *AN*—one to announce it in November 2011, one in February 2012 arguing for greater involvement in climate change and articulating our professional responsibility to be involved, and a third to appear in 2013 to provide a preview of the task force’s findings and conclusions. See Appendix 4 for links.

Community Building among Anthropologists

Community building is a natural outgrowth of several objectives to “recognize and communicate anthropological roles in and contributions to the study of climate change” and “support anthropologists and anthropology students who are interested and engaged in climate research across all sub-disciplines of anthropology” (Task Force Objectives, Appendix 3).

In order for climate change anthropologists to exchange ideas and build networks, and to conduct task force business, we established a climate change anthropology list serve that is accessible to climate change anthropologists globally, “climate-change-anth” <https://lists.capalon.com/lists/listinfo/climate-change-anth>. We were assisted by staff

liaison Amy Goldenberg and then-AAA web services assistant manager Travis Raup, who created the listserv. We were fortunate to recruit a colleague L. Jen Shaffer at University of Maryland to take on the role of moderator, and we thank her immensely. Her help enabled us to keep the list serve going for the duration of our existence, at which point it will be absorbed into EANTH. The list served us all well and allowed us to circulate ideas and publications and draw attention to the task force activities and sessions of climate change interest at meetings.

Although AAA task forces are not allotted any sessions at the annual AAA meetings at present, the task force believed that sponsoring scientific and policy sessions at meetings is very important tool to build a network of scholars and practitioners working in climate change, and to receive feedback on our approaches and research undertaken by members of the task force. The GCCTF was successful in getting support from sections of the AAA in order to sponsor sessions in the AAA program. At the annual meetings in 2012 and 2013, we presented both scientific panels and interactive policy roundtables that were very successful in terms of participation and attendance (see sidebar).

The GCCTF would like to thank the leadership of the Anthropology and Environment Society (A&E), the AAA Public Policy Committee, National Association for the Practice of Anthropology (NAPA), and the Program Committees of both the San Francisco and Chicago annual meetings, for elevating our sessions to Executive Session status and for helping us with waivers for non-anthropologists who we invited to participate on our roundtables. The support and coordination among all these groups made these sessions possible and contributed to the community building among anthropologists; the support of the Program Chairs and Co-Chairs made a huge difference in our abilities to carry out our mission and is greatly appreciated.

In addition to organizing sessions for the AAA annual meetings, the task force organized two additional sessions at the Society for Applied Anthropology (SfAA) annual meetings in Baltimore (2012) and Denver (2013). In 2012, Susan Crate organized

AAA Annual Meeting Sessions

2012, in San Francisco

Scientific Session

The View from Grassroots and Grids: Insights on Global Climate Change from Below

Organized by Sarah Strauss, Heather Lazrus, and Werner Kraus. Presenters: Lisa Lucero, Kathleen Galvin, L. Jen Shaffer, Heather Lazrus. Discussant: Rick Wilk

Policy Roundtable

Climate Change Policy and Anthropology: Crossing Multiple Borders and Scales

Organized by Shirley Fiske. Chaired and moderated by Carole L Crumley and Shirley Fiske. Panelists: Kristie L. Ebi, Anthony Oliver-Smith, Kathleen Galvin, and Susan A Crate

2013, in Chicago

Scientific Session

Understanding Present and Future Engagements: The Nature of Anthropological Knowledge in a World of Global Environmental Change

Organized by Shirley Fiske and Kathleen Galvin. Chaired by Susan Crate and Anthony Oliver-Smith. Presenters: Sarah Strauss, Anthony Oliver-Smith, Susan Crate, Heather Lazrus. Discussants: Rick Wilk and Ben Orlove

Policy Roundtable

Evolving Adaptation to Climate Change

Organized by Heather Lazrus and Susan Crate. Chaired/moderated by Carole Crumley and Shirley Fiske. Panelists: Arun Agrawal, Shannon McNeeley, Julie Maldonado, Werner Krauss. ♦

and chaired a double session “Pushing the Borders and Boundaries of Anthropology in Climate Change Research,” which included papers by Kelly D. Alley, Julie Maldonado, Susan Charnley, L. Jen Shaffer, Susan Crate, Julie Brugger, Sara Alexander, Peter Rudiak-Gold, Sarah Strauss, and Shirley J. Fiske. These presentations and discussions all pertained to and supported the GCCTF objective to “Support anthropologists and anthropology students who are interested and engaged in climate research across all sub-disciplines of anthropology, by promoting public and professional exchange of ideas and networks, providing forums to listen and learn, and producing guidance documents on human dimensions of climate and climate change.”

In an effort to generate interest and discussion around the challenges of teaching climate change and anthropology the GCCTF endorsed a session on that topic for the 2013 SfAA meetings in Denver. The session, titled “Teaching the Anthropology of Climate Change in the 21st Century,” was organized and led by L. Jen Shaffer and Patricia Hammer. Presenters were solicited through the GCCTF list serve and other professional channels. The presenters were Peter Rudiak-Gold, Christine Miller Hesed, Janet Chernela, and L. Jen Shaffer. The session was well-attended and there was lively discussion and interest in the topic.

In order to promote teaching of anthropology and climate topics and coursework, the GCCTF opted to utilize the AAA platform recently made available for that purpose on the website. The *Teaching Materials Exchange* provides an accessible and easy location to upload syllabi and teaching materials. Working with AAA Director of Publishing Oona Schmidt, we were able to add an additional keyword of “climate” and “climate change” to help visitors locate syllabi dedicated to that purpose. At last count there were about 8-10 syllabi posted, after appeals to faculty nationally and internationally through EANTH and the climate change list serve. We hope to use it to upload discrete modules of learning activities in the future; and example syllabi are presented in [Appendix 9](#).

Outreach to Other Disciplines and Broader Public

The task force objectives included encouraging anthropologists to reach a broader audience than our disciplinary circles and particularly the public and policy makers in a general sense. Anthropologists in the US, in particular, tend to lament our lack of traction on policy and political issues and the lack of visibility of our research and work outside our disciplinary circles. To promote our broader engagement, the GCCTF has made a start by fostering interactions between anthropology and the science community, between academia and practice, and between anthropology and the media. Our goals were to foster a conversation and cross-fertilization; but this work as a discipline is just beginning and will need continual attention.

To bring our views and findings to a wider public, largely the media, the task force undertook a series of political commentaries aimed at the general public and decision-makers through the media. They are oriented towards editorial or op-ed material and lengths. “Why Climate Matters” provides anthropologists’ views on climate-related issues capitalizing on our field experiences, research and writings, that is aimed at the general public and articulates why they should care about climate, bringing it home by telling personal stories.

Superstorm Sandy (2012) was the platform for the first of the commentaries, calling attention to the need to take climate change seriously in our policy and planning in part because of the costly damage that sea level rise in particular will cause to public infrastructure; and the social equity issues caused when we do not build into our planning and legal statutes the authorities for agencies to assist coastal communities from Louisiana to Alaska. This was picked up by *Counterpunch* and was followed with a timely commentary by Rick Wilk on the necessity of living with less, thinking about consumerism and its ill-distributed costs globally. Anthony Oliver-Smith called attention to the uncomfortable fact of forced migration for millions of people; Kathleen Galvin reflects on the lessons from peoples’ in Mongolia and East Africa who already are dealing with sustained drought and are adapting in successful and carbon-sensitive ways—why can’t we learn from pastoralists? Rick Wilk calls attention to the chimera of green consumerism. All of these were published by *Huffington Post* in the AAA blogosphere. We appreciate very much the guidance from Damon Dozier and the invaluable assistance of Joslyn Osten at the AAA for their assistance in placing these. There are still more to come at this publication time.

Interdisciplinary Outreach

To broaden our base of working relationships with other disciplines, and to promote anthropological approaches to climate change research, the task force spoke with a number of professional organizations to explore mutual interests and approaches. In 2013, we met with the president of

“Why Climate Matters” Commentaries

Open Letter to the Candidates:
SuperStorm Sandy and Her
Lessons

<http://www.counterpunch.org/2012/11/02/why-climate-matters/>

Thinking Big About
Consumerism

http://www.huffingtonpost.com/american-anthropological-association/thinking-big-about-consum_b_2317917.html

Forced Migration? Facing an
Uncomfortable Future

http://www.huffingtonpost.com/american-anthropological-association/forced-migration-facing_b_2980482.html

Green Consumerism is no
Solution

http://www.huffingtonpost.com/american-anthropological-association/green-consumerism-is-no-solution_b_3437457.html

An Arid World? Can We Learn
from Other Nations?

http://www.huffingtonpost.com/american-anthropological-association/an-arid-world-can-we-lear_b_3768175.html ♦

Ecological Society of America (ESA), Jill Baron, along with their policy and education staff, and the executive director of AAA, where we explored mutual interests and possible joint programming for the future. We also met with the communications staff of AAAS, and found welcoming conversations which we will continue with the editor-in-chief, who also wants to understand the nature of climate impacts more fully (McNutt 2013). Once the report is accepted by the Executive Board, we aspire to publish the findings of the task force in an interdisciplinary forum such as *Science*, or a similar venue.

Most of the scholarly social science associations and interdisciplinary organizations have undertaken assessments similar to that of the GCCTF—concerning their role in and perspectives on global climate change. As the discipline most clearly devoted to the human condition over time, across cultural, social, and behavioral elements, and across geopolitical space, the task force believes it is appropriate and important for the AAA to join other professional bodies by adopting an association statement on climate change—specifically what we as anthropologists know about the *human nexus* with climate change. To that end, the task force has drafted a Statement of Climate Change and Humanity that it hopes the Board will consider and adopt. The statement is presented in section 9.

The work of the GCCTF is enriched by the extended network of its members, who are members in and participate in national and international efforts. We support the participation of GCCTF members on the science advisory boards of other associations, such as the American Meteorological Association (AMS) Societal Impacts Board (Heather Lazrus). Task force member Lisa J. Lucero was elected to serve on the nominating committee of American Association for the Advancement of Sciences (AAAS). Susan Crate serves on the international task force of the Study of Arctic Change (SEARCH) as one of two social scientists. Task force members Susan Crate and Sarah Strauss were both invited to be mentors for an ongoing NSF sponsored interdisciplinary climate change research network, DISCCRS (see <http://discrs.org/home>). Ben Orlove is the Editor for *Weather, Climate, and Society*, a new journal of the AMS. Tony Oliver-Smith co-authored United Nations University policy briefs for the COP meetings. He was lead author on a UN University Policy Brief on Social Vulnerability and Climate change that was distributed to the delegates at the Doha talks in 2012 and co-author of another UN University policy brief on Non-economic loss and damage that was distributed to the delegates in Warsaw in 2013. Carole Crumley is the Executive Director for the UN project on the Integrated History and Future of People on Earth (IHOPE). George Luber is lead author of a chapter on public health for the US National Climate Assessment, and a contributing author on one of the IPCC chapters.

The annual meeting provides another space and place to integrate interdisciplinarity. The task force invites scientists from outside the anthropological discipline to comment, present, and engage on ideas of adaptation, resilience, and the human aspects of climate change, including Kristi Ebi, technical consultant to the IPCC who is intimately familiar with the process for generating IPCC reports; and Arun Agrawal, University of Michigan political scientist and an internationally known expert on adaptation and resilience. The GCCTF supports anthropological contributions to interdisciplinary research on climate change through our in-house column “Changing the Atmosphere.” The task force organized workshop panels and colloquia in interdisciplinary settings, including a panel for the Policy Studies Organization (PSO) DuPont

Summit 2014, which brings together students, policy professionals, scientists, engineers, and social scientists on a variety of topics. Our panel, entitled “Anthropological Engagements with Climate & Environmental Change: Whither Policy?” featured some of the task force’s findings and presentations by anthropologists working on climate change, including Shirley Fiske, Susan Crate, Satsuki Takahashi, Ed Liebow, and Christine Miller Hesed, PhD candidate at University of Maryland.

The current re-structuring of global interdisciplinary relationships with respect to social sciences, earth system sciences, and climate sciences holds some promise for future anthropological engagement. Future Earth (FE) is a new institutional amalgamation of the International Human Dimensions Programme (IHDP), DIVERSITAS, and International Geosphere-Biosphere Programme (IGBP) within the Future Earth. The plan is to develop a new environmental science research agenda for the next 10 years. The International Social Science Council (ISSC) has the lead for social sciences. The ISSC and Future Earth efforts are global in scope, although based in Europe; Future Earth will replace all the preceding *global* programs except the World Climate Research Programme (climate modeling). In addition, the Vilnius Declaration on Humanities in the Environment, and the Swedish MISTRA-FORMAS public/private environmental humanities funding initiative are intended to build capacity nationally and internationally to integrate the humanities and social sciences with environmental sciences.

The ISSC undertook a critical assessment of the roles of social sciences and humanities in climate and earth science research (<http://www.worldsocialscience.org/resources/publications/>), which provided important building blocks for integration of social sciences. Building presence, relationships, and support for the cornerstones identified in the report is likely to take time and concerted effort, particularly at the “bench” level where most scientific research takes place. We call attention to the responses and challenges identified by Palsson et al. 2013. The task force believes that there is much more to be done to fully fund, integrate and lead interdisciplinary investigations in the climate change community, dialogue, and research. We provide observations and suggestions in the recommendations section (section 8.0) for future action, and for interdisciplinary integration (section 6.0).

School for Advanced Research (SAR) Short Seminar: “Changing the Atmosphere: Anthropological Engagement with Climate”

The GCCTF realized early on that we needed space and time for face-to-face interaction to consider the meaty, complex, and global issues of anthropology and climate change. We therefore prioritized the need to secure funding for structured dialogue very early in our existence as a task force. Within the first month, we began crafting a proposal to the School for Advanced Research (SAR), that has a highly-regarded program for scholarly and applied seminars. In writing the proposal, all task force members participated via conference calls and frequent emails to set the direction and topics for the proposal. It was this initial activity that helped help galvanize our thematic foci for our work—the problematic issues of vulnerability-adaptation-resilience; issues of power and control; and the search for interdisciplinary radiation and research frontiers.

We crafted a proposal around three core issues for anthropology: the importance of integrating knowledge of human interactions with climate from the past with contemporary calls for climate policy; the problematizing of central concepts of climate change policy, namely adaptation, vulnerability and resilience; and a discussion centered around anthropology and community engagement. The short seminar was held October 8-11, 2013, with all members participating, from as far away as New York and Sweden (with last-minute exception of one member who was prohibited from traveling due to the federal shutdown). The co-organizers of the seminar were Shirley Fiske, Anthony Oliver-Smith, and Lisa Lucero, with collaboration from the entire GCCTF.

The task force enthusiastically thanks SAR for their support. The SAR seminar was a critical motivator and focal point in our process of meshing ideas and theories across our own discipline and interdisciplinary frontiers. The SAR's long-term support for anthropological endeavors and conversations of the future – whether it be building capacity through funding agencies like NSF; or support for groups such as the association's Global Climate Change Task Force and IHOPE—make it possible to focus and energize groups such as ours. Great appreciation is extended to the Director of SAR at the time, Dr. James Brooks; to Dr. John Kantner, the associate director at the time; and to Dr. Nicole Taylor, Director of Scholar Programs. All went above and beyond in marshaling support for our mission and group. During our work in Santa Fe, we were able to consult with interim director, David Stuart; and with Jerry and Paula Sabloff, of the Santa Fe Institute, all of whom provided inspiring comments and insights.

We note here that the SAR support provided the potential to receive a grant from The Atlantic Philanthropies for participants' travel funding to the SAR workshop; the latter provided leverage for our request to AAA for matching support. We submitted a budget initiative to match the foundation's support. We understand that it is highly unusual for AAA to fund task forces, commissions and committees, and are very grateful to the AAA and to The Atlantic Philanthropies for their support. We feel that the face-to-face time in Santa Fe was critical to producing a coherent and comprehensive report.

Drafting and Reviewing the Report

Subsequent to the SAR seminar and the sessions held at the AAA Meetings in Chicago 2013, the task force expanded and refined the sections in the report and developed sections on conclusions and the AAA statement. The task force developed two sequential drafts prior to peer review; each section was spearheaded by a team leader or co-leader, and the first draft was reviewed and commented on by the entire task force. As a result of our internal comments and revisions, a second draft was prepared which was sent out for peer review. Subsequently, further revisions were undertaken in response to observations regarding gaps in the report and suggestions for reorganizations.

The task force identified 53 potential reviewers from the interdisciplinary and disciplinary sectors and including associations and non-profits (e.g. National Academy of Sciences). Of these, 30 colleagues agreed to review the report under a very short time

frame. Ultimately we received review comments from about 20 reviewers. We asked the reviewers to look at the report in “landscape style” and to identify inaccuracies and gaps. We are enormously grateful for the thorough reading and critical comments—and copy edits—made by the reviewers, as they have helped to strengthen the report beyond measure. We acknowledge the reviewers individually in the front acknowledgement page of the report. ■

Appendix 3: Objectives of the AAA Global Climate Change Task Force

- Recognize and communicate anthropological roles in and contributions to the study of climate change and climate-related issues, with particular emphasis on representing many voices and capturing stories, past and present;
 - Promote understanding of adaptation through an examination of social-cultural contexts of vulnerability, resilience and other concepts shaping the global efforts to address impacts of climate change;
 - Promote analysis of process, discourses, and institutions associated with climate change science and policy;
 - Advance knowledge of the social and cultural systems underlying energy consumption and the intensification of consumption;
 - Utilize “lessons learned” from archaeological and anthropological understandings of environmental change from both long and mid-short range perspectives;
 - Advance the understanding of social and cultural contexts that influence mitigation, e.g. energy systems of varying carbon-intensity;
- Promote engagement of the American Anthropological Association and anthropologists in general with public policy agendas and the greater public interest, utilizing media and outreach modalities to reach beyond the discipline;
- Communicate and translate local peoples’ observations, perceptions, and concerns to the media and general public;
- Produce guiding documents to recognize, promote, and develop anthropological contributions to global climate change-related issues;
- Support anthropologists and anthropology students who are interested and engaged in climate research across all sub-disciplines of anthropology, by promoting public and professional exchange of ideas and networks, providing forums to listen and learn, and producing guidance documents on human dimensions of climate and climate change;
- Support anthropological contributions to interdisciplinary research on climate change through panels, workshops, publications, engagement with publicly accessible websites/databases, and participation at conferences;
- Articulate new research directions within the discipline and profession, and develop ties with researchers in other disciplines;
- Provide the AAA with proposed actions and recommendations to support and promote anthropological engagement with climate change;

- By focusing on the complementary interdisciplinary approaches to climate change, bring about recognition, respect, and exchange among the different perspectives within anthropology. ■

Appendix 4: “Changing the Atmosphere” Columns in Anthropology News

[Sarah Strauss](#) is the contributing editor of [Changing the Atmosphere](#), the AN column of the [AAA Global Climate Change Task Force](#).

List of Changing the Atmosphere columns, dates, titles, and individuals featured.

February 2012

Tales from the AAA Task Force on Global Climate Change

Inaugural column, introduction to task force, research profiles on Strauss and Fiske

<http://www.anthropology-news.org/index.php/2012/02/14/tales-from-the-aaa-task-force-on-global-climate-change/>

March 2012

Of Cows, Corn, and Climate

Profiles on Susie Crate (GMU/Siberia) and Richard Moore (Ohio State University, Ag/corn-based biofuels, water, and climate)

<http://www.anthropology-news.org/index.php/2012/02/14/tales-from-the-aaa-task-force-on-global-climate-change/>

April 2012

Listening to Locals, Recognizing Risks, Reframing Discourse

George Luber (CDC/National Center for Environmental Health) and Hildegard Diemberger (Cambridge University/Tibet & climate histories)

May 2012

Of Aquifers and Islands

Heather Lazrus, NCAR, plus review of *There Once Was an Island*

June 2012

“Experiencing Rio+20”

Myanna Lahsen and Colleen Scanlan Lyons, Guest Contributors

Photo essay and analysis

Summer 2012

Communication, Consultation, Collaboration

Profiles on Tony Oliver-Smith (University of Florida, Disaster/

Development/CC) and Carla Roncoli (University of Georgia/CFAR, Burkino Faso)

Sept 2012

Climate Change Impacts across the Americas

Profiles of Richard Wilk (Indiana University, energy, food, consumer society, and sustainability in Belize and the USA) and Lissie Wahl (Research Fellow, Harvard Medical School, deforestation and disease in the Amazon basin)

Oct 2012

Agriculture and Adaptation from Africa to the Andes

Profiles on Ben Orlove (Columbia University, Andes, glaciers, El Nino) and Jen Shaffer (University of Maryland, culture and landscape in Mozambique)

Nov 2012

A Snapshot of Climate Change in Rural Tanzania, 2010-2011

L Jen Shaffer, University of Maryland, guest contributor, photo essay

January 2013

Landscape, Climate, and Social Memory

<http://www.anthropology-news.org/index.php/2013/01/28/landscape-climate-and-social-memory/>

Carole Crumley (Swedish University of Agricultural Sciences, Uppsala; IHOPE and historical ecology in Burgundy, France)

February 2013

Of Climate, Kings, and Cenotes

<http://www.anthropology-news.org/index.php/2013/02/21/of-climate-kings-and-cenotes/>

Lisa Lucero (University of Illinois, Urbana-Champaign; Mayan archaeology and water management/climate impacts)

May 2013

Variability and Change in the Drylands of Kenya

<http://www.anthropology-news.org/index.php/2013/05/31/variability-and-change-in-the-drylands-of-kenya/>

Kathleen Galvin (Colorado State University, Water, food, and climate variability in Kenya)

[Strauss was on sabbatical during May 2013 until September 2013]

December 2013

From Sweden to China

Cindy Isenhour (University of Maine, Sweden and China, consumer society)

<http://www.anthropology-news.org/index.php/2013/12/16/from-sweden-to-china/>

March 2014

Sagas for Sustainability

Tom McGovern (Hunter College, Arctic/Archaeology) ■

Appendix 5: Supplementary Historical Material for Section 1.0

Appendix 5 presents supplementary material on the historical development of the relationship between anthropology, other social sciences, and the “human dimensions of global climate change.”

Mead and Kellogg’s conference on the atmospheric commons came at a time when interest in the atmosphere and its earthly expression, climate, was building—at research institutes and in academia across the (US) country. The National Center for Atmospheric Research (NCAR), in Boulder, Colorado, established a Societal Impacts unit as an early interdisciplinary expression of interest in the social sciences turned toward climate and the atmosphere. The climate phenomenon of El Niño and the social impacts of El Niño were an early focus at NCAR, as well as the growing concern of carbon dioxide. Michael Glantz, a political scientist and the team leader, correctly presaged the difficulty that the US would have politically in dealing with a slow-onset crises in the atmosphere in an early editorial in *Nature* (Glantz 1979).

Steve Rayner and colleagues were among other early participants in tackling global change from a cultural and policy perspective (e.g. Gerlach and Rayner 1989; Rayner and Malone 1998). The 4-volume study *Human Choice and Climate Change: An International Assessment* (1998) was produced to accompany one of the earliest of the IPCC assessments. Rayner was also lead author on the topic of climate and sustainable development for the 3rd and 4th IPCC assessments and along with others has consistently taken a critical posture toward the architecture and assumptions behind the UNFCCC as a way of understanding and managing climate change.

The enactment of the US Global Change Research Program (USGCRP) in 1990 authorized a national research program, as part of the international climate research effort focused on the earth and biogeophysical sciences; but social scientists in the US argued that to fully understand climate change phenomena social sciences must be included along with the international instrumentation programs being developed and funded. In interagency “Human Dimensions of Global Change” program took shape. In 1995 the anthropology division at NSF produced a cogent report on research priorities for anthropology in global environmental change; the National Science Foundation (NSF) initiated an interdisciplinary human dimensions of global change program under the leadership of geographer Tom Baerwald. Other federal agencies established “human dimensions” programs, as part of USGCRP in the 1990s, including the Department of Energy, working through Battelle Pacific Northwest Laboratories; the US Department of Agriculture, and the National Oceanic and Atmospheric Administration (NOAA), through its grants program on climate change. NOAA funded a number of anthropological studies, particularly with respect to climate and climate services.

The interdisciplinary nature of climate-related research has been evident from the start. Economists discuss the effects of climate change on national and international economies, and debate the proper frameworks for making trade-offs between expenses in the present (for reducing emissions or for adapting to impacts) and gains in the future (which derive from

reduced harm). They consider the effects of different economic instruments—taxes, cap and trade systems, and incentives—in promoting less carbon-intensive energy systems. Political scientists study climate treaties, protocols, and other agreements, whether between nations, provinces, cities or other units, to coordinate their reductions in emissions and to finance adaptation. Sociologists conduct public opinion studies which trace the shifting views of climate issues, analyze the institutions which seek to influence climate change discussions, and look more broadly at vulnerability, resilience, and risk in social life. Psychologists consider the cognitive and emotional mechanisms that influence the perception of climate change as a risk and which shape the propensity to take action to address it. It is noteworthy that not only do these disciplines contribute generally to the study of climate change, but also that scholars in these disciplines participate with each other and with natural scientists in concrete projects, as detailed in Section 6.0.

The work and contributions of a number of anthropologists such as Emilio Moran and others began emerging in the mid to late 90s. Anthropological research is prominent in one of the first assessments of research priorities for social sciences in the yoke of climate change (NRC 1999). An early volume by archaeologist Brian Fagan provided a definitive account of climate and its impacts on the history of civilization (Fagan 1999), followed by a number of volumes on climate, change, and civilizations across the globe.

NOAA initiated a *Human Dimensions of Global Change* program that was instrumental in funding applied climate research by anthropologists in the late 1990s and fostering the development of a collaborative network of researchers—by bringing its funded researchers together every couple of years (see Roncoli 2006). The program funded both ethnographic work and archaeological research that was quite different from scientific research traditionally funded by NOAA. The NOAA-funded HDGC research in this time period centered on the challenges and dilemmas of communicating seasonal climate forecasts to rural producers (farmers, pastoralists, fisheries, etc.). NOAA sought to improve their ability to communicate climate forecasts and justify the investment in longer-range forecasts with economic impact. The studies addressed key issues concerning risk perceptions and management, decision making processes, social production of knowledge, and interactions of science, policy, and politics, and they generated the first conference panels, journal issues, edited volumes explicitly focused on the anthropology of “climate,” at least in the applied field. Most of the research was published in interdisciplinary climate or environmental journals, including *Science* and *Nature* – and has been influential in what eventually developed into the “climate services” community (<http://gfcs.wmo.int/>). The research represents a good example of anthropologists acting as cultural interpreters, as mentioned in Section 6.2, feeding back to the scientific community what lay/local peoples’ information priorities and concerns and facilitating the integration of scientific and indigenous understandings/knowledge of climate, among other things (Orlove et al. 2000; Broad and Agrawala 2000; Broad et al. 2002; Broad et al. 2007; Roncoli et al. 2009; Lemos et al. 2002; and Peterson et al. 2010)

Federal funding programs and appropriations levels are susceptible to political elections and therefore turnovers in the Administrations that oversee them. The HDGC program was re-defined and funding was cut under the George W. Bush Administration starting in 2000, and within NOAA the focus was channeled more narrowly to Sectoral Application Research

Program, eventually exclusively funding only research in the US. NOAA Climate Program Office continues to fund anthropology research through its Regional Integrated Science and Assessment (RISA) program, based in consortia of regional universities across the US, such as the Southeast Climate Consortium (see e.g. Crane 2010; Bartels et al. 2013).

As public discourse and appreciation of climate change has grown in the late 90s and the 21st century, and as politicization of concepts and global governance has increased, there has been an increase and a diversification of interest by anthropologists in climate-related research and engagement. An appreciable number of anthropologists take a critical perspective of the climate science-driven hegemony of the climate governance process, and the inability to hear other voices speaking of alternative realities (e.g. Verweij et al. 2006;) and the inability to see the complexity between the atmosphere, the geosphere, and interactions with humans. Growing numbers of anthropologists are documenting the effects that climate variability has on people and the things that people do that contribute to GHGs. The growing body of scholarship today in global climate change anthropology now includes at least a half dozen books and edited volumes from major publishers dealing specifically with the anthropology and archaeology of climate change (in alphabetical order, Baer and Singer 2009; Crate and Nuttall 2009; Dove 2013; Fagan 2010; McIntosh, Tainter, et al. 2013; Rayner and Malone 1998; Redman 2004; Strauss and Orlove 2003). The number of high-level synthesis and review articles continues to grow in peer-reviewed journals, both nationally and internationally (deMenocal 2001; Barnes et al. 2013; Crate 2011; Hastrup 2013; Palsson et al. 2013; van der Leeuw 2008). In addition there have been special issues of journals on anthropology (or ethnography) guest-edited by anthropologists, including one in a climate science journal over a decade ago and one in the *American Anthropologist* (Magistro et al. 2001; Nelson et al. 2009).

There is substantial presence of anthropologists engaged with climate change issues outside of academia—in non-governmental organizations, global research organizations such as the IHDP (now Future Earth), research institutes and consortia, government organizations, and non-profits (see Sidebar). In addition there is both an internal and external recognition that there are anthropological experts on the human dimensions of climate change. As early as 1999, Kathryn Brown, science writer for *Science*, concluded that “Climate anthropologists appear to be making strides at relating global warming models to everyday lives” (Brown 1999:1141). There is external demand for anthropologists and social scientists to increase engagement with the issue, as presented argued in previous paragraphs on global developments.

The number of anthropologists who are doing research on climate change and climate-related topics is growing, the number of faculty teaching classes with climate change topics and modules, or with syllabi entirely focused on climate change are growing and morphing (e.g. classes on the “Anthropocene”); and higher numbers of peer-reviewed articles by anthropologists or teams with anthropologists are appearing in cross-disciplinary journals such as *Global Environmental Change*; *Climatic Change*; *Nature Climate Change*; *WIREs Climate Change*; *Climate and Development*; *Climate Risk Management*, and *Weather, Climate and Society*, to name but a few. Anthropology ranks eighth, a relatively strong ranking, among 27 sciences in the number of articles published on climate change and environmental change (2000-2010 period), in an ISSC-commissioned bibliometric report for the ISSC (Hackmann and St. Clair 2012:10). ■

Appendix 6: Supplementary Materials for Section 2.0

Consumption

In the late 20th century, the prevailing theories of consumer growth were based either on modernization theory or in the mass-culture theories of the Frankfurt School. In the hands of theorists like Rostow (1960) and Myrdal (1957), the “hierarchy of needs” defined by Abraham Maslow (1943), provided a template for the future. Once people had satisfied their physical needs for food, shelter, clothing and transportation, they would concentrate on higher needs like self-fulfillment, and pursue education, music, and high culture, instead of spending money on more cars, bigger houses, and greater luxury. This prediction has been refuted by history. The Frankfurt school, in contrast, predicted the growing power of the mass media to promote consumerism, but did not pay any sustained attention to the more subtle ways that advertising uses gender differences, sexuality, class divisions, nationalism and sport to constantly promote new forms of consumption.

More recent anthropological work has studied both the spread of consumer culture around the world through processes of nationalization and globalization, as well as developing a more social and symbolic analysis of consumer culture in general. Anthropologists of consumption build on Bourdieu’s (1984) analysis of class ranking and competition in promoting consumer culture, but have also concentrated on the way consumption increasingly fulfills needs for meaning and significance in social life (Miller 1997, 1998). They point out how often consumerism is fed by positive social motives like love, friendship, idealism, and the celebration of life-transition events like weddings and funerals. Consumer culture spreads globally through mass media, tourism, migration, and by forcing people out of subsistence livelihoods, particularly in areas with a growing middle class, by hijacking or appropriating positive social impulses and emotions, fragmenting communities into families and focusing on individual insecurities, particularly those associated with cleanliness, fertility and sexuality (e.g., Foster 2008, Burke 1996). The ideology of modernism and progress, often in concert with new religious sects, plays a fundamental role by providing models of material abundance.

An average North American already consumes between 20 and 60 times the materials and energy as a person in a poor agrarian country, and the disparities in per capita greenhouse gas emissions can be greater. The richest 20% of the world’s population consume 11 times as much meat as the poorest 20%. They consume 17 times as much energy, 77 times as much paper, and 145 times as many cars. North American supermarkets now stock more than 30,000 items from all over the world, each one with an individual history. A walk down the aisles in a suburban US supermarket illustrates the point—entire aisles are devoted to different brands of bottled water, chips, and snack bars. Anthropologists were among the first to propose looking at the ‘social lives of things’ (Kopytoff 1986) as they move through complex life cycles and engagements with different peoples on their way from origin to disposal. So far there have been excellent monographs on major global consumer products like ramen noodles, Coca-Cola, coffee, bananas and sugar, among others.

However, an especially important area of research in many parts of the world is the growth of the illegal and informal economies, which move huge amounts of consumer goods, people and money, in networks that are completely invisible in official statistics (e.g. Nordstrom 2004)

Another critical question for the immediate future is the direction that the massive middle classes in South and East Asia, particularly India, Indonesia and China will take. When it comes to calculating the global economic effects of consumer culture, both through extraction and waste, the potential growth in these large Asian countries dwarfs that of the rest of the low-consuming world. What kind of consumption growth path will they take, and what kind of consumer culture will they have 25 years from now? We could conceivably double the number of private automobiles in the world in a little more than a decade.

Land Use

Tropical deforestation is caused by both the expansion of agriculture and commercial logging in many places (e.g., Brosius 1997; Rudel et al. 2005). Indonesian deforestation is caused by the conversion of forest to palm oil plantation under REDD+ programs (e.g., Howell 2013; Carlson et al. 2012). In the Amazon basin, soybean production and cattle ranching for the global market, as well as road and other infrastructural development (Hoelle 2012; Almeyda Zambrano et al. 2010) are significant drivers of deforestation. In the Amazon, land was parceled out to private corporations and investors to build the Belem-Brazilia Highway in 1958 (Moran 1993). Moreover, Vasquez-Leon and Liverman (2004) showed convincingly how government schemes and political processes over the course of the last 300 years in Mexico promoted land use change, from stripping mountain forest ecosystems for mining purposes (1700-1900s), to large scale clearing of coastal plains for crop cultivation (1900-1990), and finally to forest clearing for livestock production and export to US markets (1970s). In Africa, bilateral economic assistance has focused on crop cultivation more than livestock production, resulting in conversion of rangelands to croplands even where rainfall is low and variable (Galvin 2009; Glantz 1994). East African pastoralists are changing their land use and livelihood strategies in the face of climate change, but also legal changes in land tenure, ecosystem fragmentation, and population growth (Galvin 2008, 2009). People are diversifying and intensifying their livelihoods (e.g., Mertz et al. 2005).

There has been a great deal of research on how livelihood decisions of farm households affect land use and household well-being (e.g., Moran et al. 2005; Netting et al. 1984). Anthropologists have also shown how the needs of households shaped by age and gender, structure, or economic constraints affect land use decisions. For example, in the Swiss alps, Strauss (n.d.) has shown the transformation of commonly held pastures into ski areas and traditional multigenerational housing structures into tourist-centered apartment blocks; existing social and governance strategies for subsistence practices were used to adapt to changing opportunities in land use, with a resulting ability of families to stay together in the community instead of out-migrating, as had been the previous pattern. These decisions have sometimes promoted land degradation and sometimes inhibit adaptation to climate change (e.g., Hobbs et al. 2008). Understanding local observations of land use change over time and space, as well as systems of land use management, are necessary to address issues of climate change (Cliggett 2005; Johansson 2012).

Population

The concept of carrying capacity has a long history in anthropology. The carrying capacity for humanity was first calculated by van Leeuwenhoek in 1679, and his estimation of 13.4 billion people still holds surprisingly well (Cohen 1995:342). Currently, it is suggested that the population will reach a maximum of about 9.6 billion by the middle of the 21st century. (<http://esa.un.org/wpp/>). Malthus's original population model in 1783 suggested dire consequences as human population growth extended past carrying capacity. But this is an oversimplified and decontextualized view.

Anthropologists tend to challenge some claims posed by demographers with regards to population dynamics, in particular the assumption that there has only been one demographic transition that occurred following the Industrial Revolution. Archaeologists have studied the long-term history of population dynamics, suggesting that transitions were observed on at least two other occasions, first with the development of tool technologies and second, with the Neolithic agricultural revolution (Nag 1962, 1973).

The following are examples of gender and population. Studies in both Senegal and in Bolivia showed that increased access to contraceptives and education did not result in lower fertility rates, due in large part to the lack of alternative livelihoods and economic security, coupled with strong cultural norms that pressure women to maintain high fertility rates (McCallister et al. 2012; Foley 2007).

Global policies add to the paradox of populations issues. Conflicting objectives of global policies are at work here: while the UN Council of Parties takes aim at decreasing carbon emissions, world agricultural policies promote energy-intense production and trade. The World Trade Organization international agreement on Agriculture in 1995 increased agricultural industrialization based on fossil fuels, already started under the Green Revolution, which replaces animal and human labor in food production; and food is produced for global markets, no longer produced locally for local consumption, resulting in transportation emissions, land use change to single commodities for the world markets, decreasing diversity of agricultural production, and increasing aggregate carbon emissions.

Anthropological Approaches to Human-Environment Interactions

There is a wealth of early studies in human-environment interactions. A few follow. In the 1960s, biological anthropologists were studying climatic effects (e.g., hypoxia, cold and heat) on the human body within an adaptation framework (Thomas 1976; Dyson-Hudson and Little 1983; Baker and Little 1976). There was considerable integration of the study of behavior and biology in an environmental context (cf. Goodman and Leatherman 1998). Rappaport's work emphasized the feedbacks between humans and their environment; one key message in his seminal book, *Pigs for the Ancestors*, was that people maintain environmental homeostasis through cultural adaptations including rituals (Rappaport 1967) (see also section 4.1).

Ethnography

Encompassed in the ethnographic approach is the notion that weather, seasons and climate provide fundamental rhythms for human culture. All of these factors affect how humans make a living, shape recreational activities, and connect individuals to regional and national identities (Strauss and Orlove 2003). Critical to this observation is the fact that as climate changes, the ways that people are able to subsist in a particular place may be placed at risk in different ways, and may ultimately, whether suddenly or after prolonged stresses, force segments of a population to move to a totally different environment, with all of the impacts on health, access to resources, and identity loss that this may entail.

Models and Other Tools

One example of participatory methods and that couples indigenous knowledge, science, and technology (e.g., GIS, remote sensing), is highlighted in a project to address weather and environmental changes in the drylands of Kenya (Galvin 2013). The project used workshops, focus group discussions, and participatory video, coupled with the science of regional land cover, wildlife and livestock changes, and weather and climatic trends to address solutions to environmental problems. In response to these changes, some communities have developed local level land use plans, conservancies, and/or mixed agricultural/livestock production land use plans.

Though tools and pathways of integration are increasing, the ability to integrate across the sciences it is not without challenges. There remain issues of scale in regards to mismatched social-organizational scales, for example when comparing administrative boundaries with landscape scales in which ecological flows (e.g., water, wildlife and soil nutrients) occur. There are scales of drivers and impacts that go between the local, regional, national, and to the global scale, such as climate change, land use, and market influences that are difficult and sometimes intractable. There are also challenges associated with human populations that are important but sometimes difficult to integrate, including information on equity, gender, class, ethnicity, power and history. These are important because they determine winner and losers of social inquiry and they are central to realizing change in practice on the ground (cf. Boone and Galvin in press). ■

Appendix 7: Case Studies of Anthropological Engagement in Interdisciplinary Research

We include here a set of cases that illustrate these points about anthropological participation in interdisciplinary projects. For other cases discussed in this report, please look to:

1. The US National Climate Assessment (Section 1.6)
2. The International Human Dimensions Programme (IHDP) (Section 1.6)
3. The International Geosphere-Biosphere Programme (IGBP) (Section 1.6)
4. The Exchange of Local Observations and Knowledge in the Arctic (ELOKA) (Section 5.4)

Case 1: Arctic Indigenous Knowledge

Anthropologist Igor Krupnik, Arctic Studies Center, Smithsonian, contributes groundbreaking research on anthropology and climate change, collaborating with natural scientists and Arctic communities on observations of their rapidly changing environment (Krupnik and Jolly 2002), and more recently as the main representative of the social and human studies during the International Polar Year (IPY) 2007–2008 (Krupnik et al. 2009). The fourth IPY contrasted to the previous three in that it included the social sciences and actively engaged the general public in education, outreach and communication. To these ends, Krupnik brought social/human research and collaboration with polar residents to the IPY agenda. Within the context of his larger IPY role, Krupnik coordinated the activities of Canadian, US, Russian, Greenlandic, and French research teams, working with experts from over 20 indigenous communities from Bering Strait to Greenland, in the project SIKU (Sea Ice Knowledge and Use in the North), focused on comparing stories of ice use and knowledge across the Arctic (Krupnik et al. 2010). The SIKU project has introduced a new field of interdisciplinary research, the social life of sea ice or the study of social (socio-cultural) aspects of the natural world, by exploring indigenous people's knowledge and use of sea ice on a pan-Arctic scale.

Case 2: Anthropologists and Humanists

There are a number of examples of the participation of anthropologists in interdisciplinary projects involving the humanities. For example, Julie Cruikshank, well-known for her prizewinning work on the interaction of indigenous and scientific perspectives on glacier dynamics (2005), was the lead speaker in a lecture series on climate change and the humanities sponsored by the Illinois Program for Research in the Humanities in 2009-10. The other speakers included the historian Carolyn Merchant, the literary scholar Rob Nixon, and the philosopher Andrew Light. Their work jointly provided fresh insights into the projected consequences of climate change in terms of lived experience, and serve to locate current debates about climate change within broader and longer-established narratives of nature, civilization and the human. In a related vein, Andrew Mathews and Matthew Wolf-Meyer organized a conference “Climate Change, Geoengineering, and Science Fiction” at the University of California Humanities Research Institute. Held in 2013, it drew together science fiction writers, environmental and social scientists and humanists to discuss the role of narrative and imagination in the construction of future worlds.

Case 3: Promotion of Renewable Energy

The anthropologist Bonnie McCay, best known for her research on fishing communities of Canada and the US, participated as a member of New Jersey's Blue Ribbon Panel on Development of Wind Turbine Facilities in Coastal Waters, along with a political scientist, an attorney, and representatives of state agencies. This group was tasked with making a recommendation about whether, the construction of off-shore windmills to generate electricity would be long-term interests of the people of New Jersey. This judgment involved balancing environmental benefits for fossil fuel reductions and economic benefits of energy security against possible environment harms to wildlife, economic effects on fisheries and tourism, and the distribution of any adverse effects among communities of different socioeconomic levels. Drawing on her long ethnographic experience working with interacting sets of diverse actors in situations of uncertainty and risk, McCay recognized the need to work within the varying cultural and institutional perspectives of the groups who were involved. Serving as an interlocutor, she proposed "adaptive management" as a framework that would be acceptable to all the parties; this perspective allowed them to agree that the construction of a trial set of offshore turbines would allow scientists and policy makers to collect, analyze, and reflect upon actual environmental and economic data before proceeding with plans for larger-scale wind farms. In this way, she suggested to the panel, New Jersey could make an "investment in knowledge"—an investment that could provide clues to the viability of offshore wind power as part of a multifaceted long-term energy plan for the state. This framing of the issue was ultimately accepted by the panel, and in April 2006 it came to play a key role in the panel's final report (available at <http://www.njwindpanel.org/docs/finalwindpanelreport.pdf>) (Brown 2007).

Case 4: Ethnography and the Use of Insurance for Adaptation

In 2005, Nicole Peterson began working with climate scientists and economists at Columbia University's International Research Institute in Climate and Society (IRI) to develop a project on weather-based insurance products. These products allow small-scale farmers in developing countries to purchase insurance against crop failure, with the payoff tied to specific "indexes" or levels of local rainfall. This rainfall is easy to measure, and unlikely to involve disputes between farmers and the project, unlike the earlier insurance products offered on harvest levels on farms, which are hard to measure and often provoke disputes. Pilot studies have shown that such projects allow farmers to invest more heavily in years when abundant rains are forecast, since they can protect themselves against risk, but they require customization to specific settings and careful introduction. Peterson joined a group in northern Ethiopia, and conducted ethnographic interviews, surveys, focus groups and experimental games. She was able to link local perceptions of environmental variability to specific features of the insurance products. She found that existing adaptive strategies could be incorporated into the projects, and that attention to local social contexts facilitated the introduction and implementation of the programs. She has since followed up with trips to Malawi, Honduras, and Guatemala to develop index insurance (Peterson 2012).

Case 5: Anthropology and Climate Risk Communication

Kenneth Broad, an environmental anthropologist at the University of Miami, conducted research on a key area of climate risk communication, the "cone of probability" which displays the predicted track of hurricanes. This cone is familiar as a white or light-shaded zone around a storm's predicted path. The National Hurricane Center (NHC) has relied on it since 2002 as the principal mechanisms for communicating the path to the public, in order to encourage local

resident, emergency managers and others to take preparations that can reduce possible harm. The cone of probability is also widely used in commercial print and broadcast media. Collaborating with atmospheric scientists, psychologists and geographers, Broad conducted ethnographic research within the NHC, carried out interviews, and analyzed a variety of government documents and public comments on the NHC website. His research documents a number of forms of misinterpretation of the cone of probability by the public (Broad et al. 2007), about the likely course and strength of hurricanes, and of the risks which they present. He has followed up this research with additional surveys and lab experiments which simulate different hurricane forecast products (Meyer et al. 2013), and made presentations about it to the NHC. Drawing on this and other research, the NHC has modified its hurricane communications products to present information in ways that are more easily grasped and that promote more effective preparations.

Case 6: Integrating Archaeology, History and Future Policies.

The Integrated History of People on Earth (IHOPE; <ihopenet.org>) is a global network of researchers (many of them anthropologists) and research projects using historical ecology's integrated approach to study combined human and Earth system history (Costanza et al. 2012; Sinclair et al. 2010; van der Leeuw et al. 2009; 2011). IHOPE's long-term, human-scale perspective is intended as a corrective to models based on Earth system science that exclude knowledge of the world drawn from the social sciences and humanities and from communities of practice. (IHOPE is also discussed in Section 3.4)

IHOPE's projects highlight interdisciplinary cooperation. An example is The North Atlantic Biocultural Organization (NABO; <http://www.nabohome.org/>), which was founded in 1992 to improve communication and collaboration among scholars with interests in the North Atlantic region (McGovern et al. 2007). Initially focused upon the archaeology and paleoecology of Viking Age colonization, the NABO group studies the region from prehistory through the early modern period, from Labrador to Finnmark. NABO cross-cuts national and disciplinary, improving data comparability and supporting fieldwork, student training, and outreach to other scholars, communities, and the general public. Recently NABO and its sister organization the Global Human Ecodynamics Alliance (GHEA; <http://www.gheahome.org>) have begun collaborating with the Nordic Network for Interdisciplinary Environmental Studies (NIES; <http://www.kth.se/abe/nies>). NABO practices historical ecology, GHEA focuses on long-term dynamics of coupled human and natural systems and NIES coordinates member institutions and research groups in the study of literary texts, historical documents and other textual artifacts, such as Icelandic sagas, with a view to qualitatively analyzing environmental information and representation; NIES fosters the development of aesthetically and ethically orientated historians, philosophers and literary scholars, helping them to become the next generation of environmental humanists.

Case 7: Coupled Human-Natural Systems and Ecosystems Research

The South Turkana Ecosystem Project, begun in 1980, was one of the earliest interdisciplinary projects to explicitly link social science and ecology and resulted in one of the most detailed studies of a pastoral system ever conducted. Most of the funding derived from the National Science Foundation, primarily Ecosystems Program. From 1980 to 1995 over 100 students, scientists and fieldworkers worked to address issues of how the Turkana pastoral population and the ecosystem functioned under extreme climate variation (at a time significantly prior to current global interests in climate change). Fourteen dissertations, over 2000 publications and two books

were produced (cf. Little and Leslie 1999, McCabe 2004). Analysis of ecosystem dynamics showed that pastoral land use did not degrade the environment (contrary to the commonly held belief of a ubiquitous ‘tragedy of the commons’ by pastoralists) and that this arid land was not at an equilibrium state, a debate that, 20 years later, produced a paradigm shift in ecology and arid lands economic development (Ellis and Swift 1988). Social anthropological work among the Turkana showed a social organization that was flexible to environmental exigencies but also to raiding and the threat of violence (e.g., McCabe 1985; Gray et al. 2003). Human biology studies showed a persistent population that was chronically undernourished, where childhood growth was slow and where disease had devastating effects (e.g., Shell-Duncan 1995; Galvin 1992). Finally the demography and reproductive work showed high fertility and a strong seasonality to birth, in fact, one of the most seasonally skewed patterns ever recorded for a human population (Leslie and Fry 1989). Humans were considered an integral part of the day savanna ecosystem and the project was a collaborative, longitudinal effort. Because so little was known about Turkana biology and behavioral impact on the environment, the early studies tended to be descriptive. Later studies tended to be more specific—herd management strategies, social networks, management effects on tree growth, dwarf shrub ecology, etc. The South Turkana Ecosystem Project showed the value of an interdisciplinary study to a set of problems of great complexity.

Case 8: Participatory Research in US Agriculture

The Southeast Climate Consortium (SECC) is one of 11 Regional Integrated Sciences and Assessments programs funded by NOAA’s Climate Program Office to develop information and tools for climate adaptation. The SECC is a partnership of land-grant universities and extension services in the Southeast US, and focuses on providing climate services for agriculture. For the last 10 years, SECC anthropologists have collaborated with agricultural and climate scientists making significant programmatic contributions. Ethnographic research in the SECC has illuminated the social nature of information processing and risk management. In doing so, it has helped move beyond a managerial conceptualization of “information use” in “decision-making,” and highlighted the performative nature of agricultural decision making as a process constituted by a combination of planning, experimentation, and improvisation and informed by multiple forms of knowledge. SECC anthropologists have pushed the boundaries of the accepted role of social science in climate services, namely identifying users’ information need and assessing impacts of information use. They have brought equity to the forefront of the SECC programmatic agenda by reaching out beyond the traditional clientele of agricultural extension (large-scale farmers) to include “underserved” groups, such as organic and African American farmers. This shift has prompted a more critical analysis of users’ engagement in research, including an understanding of how historical contexts (e.g. Civil Right struggles) shape the way these farmers relate to scientific and government institutions that produce and diffuse climate information. As with all good ethnography, overcoming these barriers requires long-term engagement, strategic partnerships, transparency, and commitment (Bartels et al. 2013; Bolson et al. 2013; Crane et al. 2010; Crane et al. 2011; Furman et al. in press; Furman et al. 2011; Roncoli et al. 2012). ■

Appendix 8: Syllabi of Courses on Anthropology and Climate Change

There are nine syllabi dealing with the general area of “climate change and anthropology” on the AAA’s Teaching Materials web site. We include one example below. To locate additional syllabi, we invite you to go to http://www.aaanet.org/customcf/syllabi/search_form.cfm and enter the words “climate change” in the key word search box.

The AAA’s Teaching Material web site is a publically-available platform to post and find teaching resources, such as syllabi. The GCCTF asked colleagues to post their syllabi on the Teaching Material site and added the key words, “climate change” so that individuals can search for climate-related concepts and approaches in teaching about global environmental change or climate change. There has been extended discussion on the EANTH listserv (<http://www.aaanet.org/sections/ae/index.php/listserv/>) about syllabi on related topics such as “the Anthropocene,” related to climate change but with broader scope and framing. This discussion is also an indication of how anthropologists’ thinking about and presentation of climate phenomena related to humanity is continually evolving.

Anthropology and Climate Change ANTH468C/689C

Tues & Thurs 3:30 – 4:45 pm
Rm. 1114

Woods Hall

Instructor: Dr. L. Jen Shaffer
Wednesdays ,
Office: Woods Hall B0107
Phone:
Course ELMS address:

Office Hours: Tuesdays 2:00 – 3:00 pm,
and by appointment

Email:

Course Description

Climatic changes have helped shape hominin evolution, contributed to the rise and fall of complex societies, and affected socio-ecological systems. Human activities now influence ongoing climatic change, and the outcome remains uncertain for communities and cultures around the world. This interaction between humans and climate provides a rich area of study for anthropologists in an interdisciplinary context. In this course, we will explore past, present, and future interactions between humans and climate. Discussions, methods-oriented activities, case study analyses, and a final project provide students a foundation for appreciating the role of anthropology in understanding, responding to, and preparing for climate change.

Course Objectives

Course Materials and Readings

There is no single textbook for this class. We will access a variety of book chapters, journal articles, videos, and websites during the semester. Materials and readings will be posted to

ELMS so that you may access them any time. The syllabus, assignments and grading rubrics will also be posted to ELMS.

Coursework

Your learning, and ultimately your grade, is based on participating in classroom activities, completing a series of short assignments, and writing a term paper. *Precis??* (extra credit)

Grading Criteria

Student’s grades will be calculated as follows:

Total Allowed	Your Grade
------------------	---------------

Class Participation

Short Assignments (7 total)

- Communicating Science Presentation
- Climate Data Analysis
- Media Discourse Analysis
- Weather Indicators Free-listing
- Risk & Vulnerability Analysis
- Climate Policy Simulation Game (online)
- Role of Anthropology Essay

Term Paper

- Paper idea
- Annotated bibliography
- Full-sentence outline
- Final paper
- Revised final paper (*optional*)

TOTAL

Course Schedule

This schedule is subject to change at the instructor’s discretion. All schedule and reading changes will be announced in class.

DATE	TOPIC & READINGS	DUE
Th, 26 Jan	Course Introduction Mental models	
T, 31 Jan	Natural Climate Variation solar and earth input, C & H ₂ O cycles	
Th, 2 Feb	Natural Climate Variation Student presentations of basic concept explanations	Communicating Science
T, 7 Feb	Hominid Evolution & Climate Bipedalism, tools?, etc	Paper Idea
Th, 9 Feb	The Human Diaspora Migration out of Africa, Bering Straits, Australia	
T, 14 Feb	Reconstructing Past Climate	Climate Data Analysis

	Sources of evidence, validity, problems (Tosh?, Nicholson 1979?)	
Th, 16 Feb	Domestication & Agriculture Middle East, Akkad, Indus Valley	
T, 21 Feb	Situated Livelihoods Beyond environmental determinism, Steward's culture core Class exercise: ecosystems and finding food	Annotated Bibliography
Th, 23 Feb	Strategies & Assets for Change Portfolios, 5 strategies (Agrawal, Cashdan, etc.)	
T, 28 Feb	Thresholds & Tipping Points Angkor (Sheffer, Dakos, Carpenter, Holling??)	
Th, 1 Mar	Food Security & Famine Ireland, India (poor British colonial policy effects)	
T, 6 Mar	Contagion & Pandemics Aztec, Black Death	
Th, 8 Mar	Final Lessons from Norse Greenland Tom McGovern talk at Penn State	Media Discourse Analysis
T, 13 Mar	Welcome to the Anthropocene! Great acceleration, Industrial Revolution, greenhouse gases	
Th, 15 Mar	Deniers, Skeptics, & the IPCC	Full Sentence Outline
T, 20 Mar	SPRING BREAK	
Th, 22 Mar	*****No Class!*****	
T, 27 Mar	Mis(?) -Communication Media, scientists, communication, use assignment analysis	
Th, 29 Mar	Indigenous Knowledge, Cultural Change, & Community-based Adaptation UNDP & Community based adaptation, mental models of CC (Moç), reception studies, integrating local knowledge	Weather Indicators
T, 3 Apr	Risk & Vulnerability Extreme weather, Hurricane Katrina	
Th, 5 Apr	Increasing Temperatures & Melting Ice Extreme heat urban areas, Arctic, Andes/Himalayas	Risk & Vulnerability Analysis
T, 10 Apr	Drowning Lands, and & Rising Seas Bangladesh, Tuvalu, Venice (art study), Chesapeake Bay	
Th, 12 Apr	Droughts, Floods, & Fire Australian bushfires, drought & mental health	

	(Alston, solastalgia), E. African drought	
T, 17 Apr	Values and Perceptions as Behavioral Obstacles Leiserowitz?, Gifford 2011	Final Paper DUE
Th, 19 Apr	Transition, Transformation, and Adaptive Capacity Nelson, Adger & Brown 2007, Transition Towns?	
T, 24 Apr	Global Climate Policy & Environmental Justice Dombrowski 2010?, Schroeder 2010?	
Th, 26 Apr	U.S. Climate Policy	
T, 1 May	Human Security in an Uncertain Future Scenarios, Gaspar?, O'Brien, St. Clair, & Kristofferson 2010?	Climate Policy Simulation Game (online)
Th, 3 May	Maryland Climate Policy Town hall role play, Naijar et al. 2010	
T, 8 May	Positive Futures Pumzi movie, discussion	
Th, 10 May	Sharing What We've Learned Speed presentations of papers	Role of Anthropology
15-17 May	FINALS WEEK	Final Paper Rewrite DUE (optional)

http://www.bbc.co.uk/sn/hottopics/climatechange/climate_challenge/

<http://www.globalwarminginteractive.com/index.htm>

<http://www.climate.org/topics/climate-change/science-in-six-findings.html>

http://anthro.palomar.edu/homo/homo_3.htm

<http://www.undp->

[adaptation.org/projects/websites/index.php?option=com_content&task=view&id=203](http://www.undp-adaptation.org/projects/websites/index.php?option=com_content&task=view&id=203)

<http://e->

education.mediasite.com/mediasite/Viewer/?peid=ddc59ce0609e4a8090d36947b654f4fe1d

(McGovern Talk)

My Expectations of Students in this Course

Attendance & Participation

Everyone's learning depends on your participation in class discussions and activities. Therefore, attendance is really important. You will be graded on your in-class participation – either you participate or you don't. Absenteeism makes class participation impossible. Medical excuses, religious observance, obituaries (need evidence), and attendance at an academic conference (need evidence) are justifiable excuses for missing class. Please see below for evidence requirements. If weather, vehicle maintenance, heartache, savage attack by velociraptors, etc. causes you to miss class, I will be sympathetic, but you will not earn any participation points. ■

Appendix 9: Graduate Training and Certificate Programs

There are many degree programs around the world that may appeal to anthropology students who would like to study the human dimensions of global environmental change from an interdisciplinary perspective. Some of the institutions have degree-granting programs; others offer certificates; still others are Anthropology/Geography degrees with specialties in environment or climate change. We have grouped them into two types: those where we know there is social science/anthropological connections (mentoring, teaching, curricula); and those where we do not know or there is less connectivity.

This list is not intended to be comprehensive, but provides an idea of the fast-growing range of programs available.

Programs with Involved Anthropology Faculty

The following are samples of environmental change/climate change programs distinguished by the involvement of anthropology faculty in mentoring and research.

The **Colorado State University** in Fort Collins has the *School of Global Environmental Sustainability*, with a number of associated Master's and Ph.D. level graduate degree programs available (see <http://sustainability.colostate.edu/education/csu-programs-graduate-students>). Of particular interest is the Ph.D. program in Ecology with a focus on Human-Environment Interactions (see <http://www.ecology.colostate.edu/curriculum-specializations.aspx>). Students take courses in social and ecological sciences and there are many courses that cover aspects of climate change.

Columbia University has several programs related to global environmental change, among them the *Earth Institute's Master of Arts in Climate and Society* (<http://www.earth.columbia.edu/articles/view/2593>), which has been operating for over ten years.

Indiana University offers graduate degree programs in *Climate and Environmental Change* (<http://www.climate.indiana.edu/>) through the *Department of Geography*, with support for anthropological research on climate change through the Anthropological Center for Training and Research on Global Environmental Change (<http://www.indiana.edu/~act/>).

At **Rutgers University** in New Jersey, students working on degrees in a variety of fields can choose to complete an additional *Graduate Certificate in the Human Dimensions of Environmental Change* (see <http://www.humanecology.rutgers.edu/gradStudyCert.asp>).

The **University of Maine** has a new Ph.D. program in *Anthropology and Environmental Policy*

(see <http://umaine.edu/anthropology/degree-programs/phd-in-anthropology-environmental-policy/>), with a Master's program in *Quaternary and Climate Studies* via the Climate Change Institute, focused on archaeology, biology, earth sciences, environmental sciences; the archaeology faculty are jointly appointed in Anthropology and the Climate Change Institute (see <http://climatechange.umaine.edu/graduate/about>). To support graduate studies in the area of climate change within these programs, the University of Maine also has IGERT funding for *Adaptation to Abrupt Climate Change (A2C2)*, which is a doctoral training program for students in earth sciences, ecology, anthropology, archaeology, international affairs, and economics. (see <http://a2c2igert.umaine.edu/>).

The **University of Maryland** houses a number of climate-related Centers: *ESSIC - Earth System Science Interdisciplinary Center*, is a joint center between the University of Maryland departments of Atmospheric & Oceanic Science, Geology, Geography and the Earth Sciences Directorate at the NASA/Goddard Space Flight Center (See <http://essic.umd.edu/joom2/>). Their focus is climate variability, atmospheric composition, and global carbon and water cycles. U MD also houses the *Joint Global Change Research Institute (JGCRI)*, a joint partnership with Pacific Northwest National Laboratory; it houses an interdisciplinary team dedicated to understanding the problems of global climate change and their potential solutions and includes a specialty of Climate Impacts and Adaptation, with social scientists on the faculty (<http://www.globalchange.umd.edu/>). The university also houses the Center for Integrative Environmental Studies (CIER) which has a focus on economics and regional and local climate change (<http://cier.umd.edu/>). The Anthropology Department offers an applied anthropology Masters (MAA) and Doctoral degree programs that have an Environmental Anthropology track, in which students can choose to focus on global climate change. Faculty and students work collaboratively with ESSIC, JCRI, CIER and other environmental programs on campus.

Interdisciplinary Programs

The following programs offer a strong basis in interdisciplinary work, but it was not clear whether they include social science or anthropology in their mentoring or content:

The **University of Bern's Graduate School of Climate Sciences** offers both Master's and Ph.D. level programs in *Climate Science* (see <http://www.climatestudies.unibe.ch/>).

The Ph.D. program in Science and Management of Climate Change, established in 2007, is managed jointly through the **Università Ca' Foscari in Venice and the Euro-Mediterranean Centre for Climate Change** (see <http://venus.unive.it/phd-climate-change/>).

The **University of East Anglia** offers a MSc in Climate Change, based in the Climatic Research Unit at the School of Environmental Sciences. The degree program is designed to provide an interdisciplinary knowledge of climate change science, society and policy. The course content is designed to careers in areas as diverse as government agencies, business consultancies and academia. The social history of climate change, climate risk perception, climate economics, and mitigation and adaptation are mentioned. <http://www.uea.ac.uk/study/postgraduate/taught-degree/detail/msc-climate-change>

Northern Arizona University's recently established program on *Climate Science Solutions* (see <http://nau.edu/CEFNS/NatSci/SESES/Climate-Science-Solutions/>) is housed in the School of Earth Sciences and Environmental Sustainability.

The **Cabot Institute** at the **University of Bristol, UK**, has a focus on risk and uncertainty in a changing climate. They have a Master's program in Climate Change Science and Policy, as well as a PhD program in Environment, Energy, and Resilience (see <http://www.bristol.ac.uk/cabot/>).

The **University of British Columbia, the University of Washington, the University of California-Irvine and Northwestern University** jointly offer an online, non-credit Certificate in Decision Making for Climate Change (see <http://www.pce.uw.edu/certificates/climate-change-decision-making.html>).

The **University of Waterloo** has a new *Masters of Climate Change (MCC)* program in the Faculty of Environment (see <https://uwaterloo.ca/environment/climate-change>), which took in its first students in September, 2013. This one-year, course-based climate change program is the first of its kind in Canada. The MCC provides an interdisciplinary educational experience for students and practicing professionals interested in the rapidly evolving field of climate change and diverse the research, policy and management career paths emerging in in business, NGOs, education, and all levels of government.

Note: For a comprehensive view of degree programs with a sustainability focus, the Association for the Advancement of Sustainability in Higher Education (AASHE) publishes a list of academic programs in this area. See <http://www.aashe.org/resources/academic-programs/>. ■

References

- Adams, Richard Newbold
1978 Man, Energy, and Anthropology: I Can Feel the Heat, But Where's the Light? *American Anthropologist* 80(2):297-309.
- Agar, Michael H.
1996 *The Professional Stranger: An Informal Introduction to Ethnography*. 2nd edition. San Diego: Academic Press.
2004 We Have Met the Other and We're All Nonlinear: Ethnography as a Nonlinear Dynamic System. *Complexity* 10(2):16-24.
- Agrawal, Arun
2010 Local Institutions and Adaptation to Climate Change. *In Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World*. Robin Mearns and Andres Norton, eds. Pp. 173-198. Washington, DC: World Bank.
- Aguirre, B.E.
2007 Dialectics of Vulnerability and Resilience. *Georgetown Journal of Poverty Law and Policy* XIV(1):39-60.
- Almeyda Zambrano, Angelica M, Eben N Broadbent, Marianne Schmink, Stephen G. Perz, and Gregory P. Asner
2010 Deforestation Drivers in Southwest Amazonia: Comparing Smallholder Farmers in Iñapari, Peru, and Assis, Brazil. *Conservation & Society* 8(3):157-170.
- Arctic Council
2013 Arctic Resilience Interim Report 2013. Stockholm Environment Institute and Stockholm Resilience Centre, Stockholm.
- Arizpe, Lourdes, Margaret Priscilla Stone, and David C Major, eds.
1994 *Population and Environment: Rethinking the Debate*. Boulder, CO: Westview Press.
- Aporta, Claudio, and Eric Higgs
2005 Satellite Culture: Global Positioning Systems, Inuit Wayfinding, and the Need for a New Account of Technology. *Current Anthropology* 46(5):729-754.
- Appadurai, Arjun, ed.
1986 *The Social Life of Things: Commodities in Cultural Perspective*. Cambridge, UK: Cambridge University Press.
- Avallone, Isabela Valdetaro, Janaina de Moura Engracia Giraldo, Sonia Valle Walter Borges de Oliveira
2012 Conscious Consumption: A Study on Plastic Bags' Consumers in Brazil. *International Journal of Psychological Studies* 4(1):122-134.
- Axtell, Robert L., Joshua M. Epstein, Jeffrey S. Dean, George J. Gumerman, Alan C. Swedlund, Jason Harburger, Shubba Chakravarty, Ross Hammond, Jon Parker, and Miles Parker
2002 Population Growth and Collapse in a Multiagent Model of the Kayenta Anasazi in Long House Valley. *Proceedings of the National Academy of Sciences* 99 (suppl 3): 7275-7279.
- Baer, Hans, and Merrill Singer
2009 *Global Warming and the Political Ecology of Health. Emerging Crises and Systemic Solutions*. Walnut Creek, CA: Left Coast Press.

- Baker, Paul T, and Michael A. Little
1976 *Man in the Andes: a Multidisciplinary Study of High-Altitude Quechua*. Stroudsburg, PA: Dowden, Hutchinson and Ross.
- Balée, William
2006 The Research Program of Historical Ecology. *Annual Review of Anthropology* 35(5):15-24.
- Bank, Leslie
1997 The Social Life of Paraffin: Gender, Domesticity and the Politics of Value in a South African Township. *African Studies* 56(2):157-179.
- Barnes, Jessica
2014 *Cultivating the Nile: The Everyday Politics of Water in Egypt*. Durham, NC: Duke University Press.
- Barnes, Jessica, Michael Dove, Myanna Lahsen, Andrew Mathews, Pamela McElwee, Roderick McIntosh, Frances Moore, Jessica O'Reilly, Ben Orlove, Rajindra Puri, Harvey Weiss, and Karina Yager
2013 Contributions of Anthropology to the Study of Climate Change. *Nature Climate Change* 3:541-544.
- Barrios, Roberto
2011 If You Did Not Grow Up Here, You Cannot Appreciate Living Here: Neoliberalism, Space-Time, and Affect in Post-Katrina Recovery Planning. *Human Organization* 70(2):118-127.
- Bartels, Wendy-Lin, Carrie A. Furman, David C. Diehl, Fred S. Royce, Daniel R. Dourte, Brenda V. Ortiz, David F. Zierden, Tracy A. Irani, Clyde W. Fraisse, and James W. Jones
2013 Warming Up to Climate Change: A Participatory Approach to Engaging with Agricultural Stakeholders in the Southeast US. *Regional Environmental Change* 13(1):45-55.
- Barthel, Stephan, Carole Crumley, and Uno Svedin
2013 Bio-Cultural Refugia--Safeguarding Diversity of Practices for Food Security and Biodiversity. *Global Environmental Change* 23:1142-1152.
- Beck, Ulrich
1992 *Risk Society: Towards a New Modernity*. Newbury Park, CA: Sage Publications.
- Benson, Larry V., Timothy R. Pauketat, and Edward R. Cook
2009 Cahokia's Boom and Bust in the Context of Climate Change. *American Antiquity* 74:467-483.
- Berkes, Fikret
1999 *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Philadelphia: Taylor & Francis.
- Berkes, Fikret, Carl Folke, and Johan Colding
2000 *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press.
- Bernstein, Steven, Matthew Hoffmann, Beth Jean Evans, David Gordon, and Hamish van der Ven
2013 *Creating Pathways to Decarbonization*. Workshop Report, University of Toronto, Munk School of Global Affairs. May 2, 2013.
- Birkmann, Jorn
2011 Regulation and Coupling of Society and Nature in the Context of Natural Hazards. *In Coping with Global Environmental Change, Disasters and Security: Threats, Challenges, Vulnerabilities and Risks*. H. G. Brauch, U. Oswald Spring, C. Mesjasz, J. Grin, P. Kameri-Mbote, B. Chourou, P. Dunay and J. Birkmann, eds. Pp. 1103- 1128. Berlin-Heidelberg: Springer-Verlag

- Blaikie, Piers, Terry Cannon, Ian Davis, and Ben Wisner
1994 *At Risk: Natural Hazards, People's Vulnerability and Disasters*. London: Routledge.
- Blaikie, Piers, and Harold Brookfield
1987 *Land Degradation and Society*. London, U.K.: Methuen.
- Blaser, Mario
2009 The Threat of the Yrmo: The Political Ontology of a Sustainable Hunting Program. *American Anthropologist* 111(1):10–20.
- Bohle, Hans G., Thomas E. Downing, and Michael J. Watts
1994 Climate Change and Social Vulnerability: Toward a Sociology and Geography of Food Insecurity. *Global Environmental Change* 4(1):37-48.
- Bolson, Jessica B., with Christopher J. Martinez, Norman Breuer, Preet Srivastava and P. Knox
2013 Climate Information Use among Southeast US Water Managers: Beyond Barriers and Towards Opportunities. *Regional Environmental Change* 13(1):141-151.
- Boone, Randell B., Kathleen A. Galvin, Nicole M. Smith, and Stacy J. Lynn
2000 Generalizing El Niño Effects Upon Maasai Livestock Using Hierarchical Clusters of Vegetation Patterns. *Photogrammetric Engineering and Remote Sensing* 66(6):737-744.
- Boone, Randell B., and Kathleen A. Galvin
In Press Simulation as an Approach to Social-Ecological Integration with an Emphasis on Agent-Based Modeling. In *Understanding Society and Natural Resources: Forging New Strands of Integration Across the Social Sciences*. M.J. Manfredo, A. Rechkemmer, and J.J. Vaske, eds. London, UK: Earthscan.
- Boserup, Ester
1965 *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Chicago: Aldine.
- Bourdieu, Pierre
1984 *Distinction: A Social Critique of the Judgment of Taste*. Cambridge, MA: Harvard University Press.
- Box, George E. P., and Norman R. Draper
1987 *Empirical Model Building and Response Surfaces*. New York: John Wiley and Sons.
- Bradley, Daniel and Alan Grainger
2004 Social Resilience as a Controlling Influence on Desertification in Senegal. *Land Degradation & Development* 15(5):451-470.
- Bravo, Michael T.
2009 Voices from the Sea Ice: The Reception of Climate Impact Narratives. *Journal of Historical Geography* 35(2): 256-278
- Breglia, Lisa
2013 Energy politics on the "Other" US/Mexico Border. In *Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and Thomas Love, eds. Pp. 284-297. Walnut Creek, CA: Left Coast Press.
- Broad, Kenneth and Shardul Agrawala
2000 The Ethiopia Food Crisis—Uses and Limits of Climate Forecasts. *Science* 289(5485):1693–1694.
- Broad, Kenneth, Alexander S. P. Pfaff, and Michael H. Glantz
2002 Effective and Equitable Dissemination of Seasonal-to-Interannual Climate Forecasts: Policy Implications from the Peruvian Fishery during El Niño 1997–98. *Climatic Change* 54(4):415–438.

- Broad, Kenneth, with Alexander Pfaff, Renzo Taddei, A. Sankarasubramanian, Upmanu Lall, and Francisco de Assis de Souza Filho
2007 Climate, Stream Flow Prediction and Water Management in Northeast Brazil: Societal Trends and Forecast Value. *Climatic Change* 84(2): 217–239.
- Broad, Kenneth, with Anthony Leiserowitz, Jessica Weinkle, and Marissa Steketee
2007 Misinterpretations of the “Cone of Uncertainty” in Florida during the 2004 Hurricane Season. *Bulletin of the American Meteorological Society* 88(5):651–667.
- Broad, Kenneth, and Ben Orlove
2007 Channeling Globality: The 1997-98 El Niño Climate Event in Peru. *American Ethnologist* 34(2):285-300.
- Brondizio, Eduardo S., and Emilio F. Moran
2008 Human Dimensions of Climate Change: The Vulnerability of Small Farmers in the Amazon. *Philos Trans R Soc Lond B Biol Sci* 363(1498):1803-9.
- Brondizio, Eduardo S., and Emilio F. Moran, eds.
2012 *Human-Environment Interactions: Current and Future Directions*. Dordrecht, The Netherlands: Springer.
- Brosius, J. Peter
1997 Endangered Forest, Endangered People: Environmentalist Representations of Indigenous Knowledge. *Human Ecology* 25(1):47-69.
- Brosius J. Peter and Lisa M. Campbell
2010 Collaborative Event Ethnography: Conservation and Development Trade-offs at the Fourth World Conservation Congress. *Conservation and Society* 8(4):245-55.
- Brown, Adam
2007 Wind Energy and the Jersey Shore. *Current Anthropology* 48(1):3.
- Brown, Kathryn S.
1999 Taking Global Warming to the People. *Science* 283(5407):1440-1441.
- Brugger, Julie, Michael Crimmins, and Gigi Owens
2011 Finding a Place for Climate Science in the Rural West. *Rural Connections* 5(2):5-10.
- Brunner, Ronald D. and Amanda H. Lynch
2010 *Adaptive Governance and Climate Change*. Boston: American Meteorological Society.
- Bulkeley, Harriet
2010 Cities and the Governing of Climate Change. *Annual Review of Environment and Resources* 35:229-253.
- Burke, Timothy
1996 *Lifebuoy Men, Lux Women: Commodification, Consumption and Cleanliness in Modern Zimbabwe*. Durham, NC: Duke University Press.
- Button, Gregory
2010 *Disaster Culture: Knowledge and Uncertainty in the Wake of Human and Environmental Catastrophe*. Walnut Creek: Left Coast Press.
- Caldwell, John Charles
1984 *Desertification: Demographic Evidence, 1973-1983: A Report to the United Nations Environmental Desertification Section*. Canberra: Development Studies Centre, Australian National University.

- Cameron, Emilie S.
2012 Securing Indigenous Politics: A Critique of the Vulnerability and Adaptation Approach to the Human Dimensions of Climate Change in the Canadian Arctic. *Global Environmental Change* 22(1):103-114.
- Carlson, Kimberly M., Lisa M. Curran, Gregory P. Asner, Alice McDonald Pittman, Simon N. Trigg, and J. Marion Adeney
2013 Carbon Emissions from Forest Conversion by Kalimantan Oil Palm Plantations, 1990-2020. *Nature Climate Change* 3:283-7.
- Cannon, Terry
2008 Reducing People's Vulnerability to Natural Hazards: Communities and Resilience. Research Paper 2008/34 UNU-World Institute for Development Economics Research. Bonn: United Nations University.
- Cannon, T., J. Twigg, and J. Rowell.
2004 Social Vulnerability, Sustainable Livelihoods and Disasters: Investigating Methodologies for Vulnerability Assessments and their Links with the Sustainable Livelihoods Approach. London: Benfield Hazard Research Centre.
- Cartwright, Elizabeth
2013 Eco-Risk and the Case of Fracking. *In Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and Thomas Love, eds. Pp. 201-212. Walnut Creek, CA: Left Coast Press.
- Chase, Arlen, and Vernon Scarborough, eds.
In press The Resilience and Vulnerability of Ancient Landscapes: Transforming Maya Archaeology through IHOPE. *Archeological Papers of the American Anthropological Association*. Hoboken, NJ: Wiley-Blackwell.
- Cliggett, Lisa
2005 Remitting the Gift: Zambian Mobility and Anthropological Insights for Migration Studies. *Population, Space and Place* 11(1):35-48.
- Cohen, Joel E.
1995 Population Growth and Earth's Human Carrying Capacity. *Science* 269(5222):341-346.
- Connor, Linda H.
2010 Anthropogenic Climate Change and Cultural Crisis: An Anthropological Perspective. *Journal of Australian Political Economy* 66:247-267.
2012 Experimental Publics: Activist Culture and Political Intelligibility of Climate Change Action in the Hunter Valley, Southeast Australia. *Oceania* 82(3):228-249.
- Costanza, Robert, Lisa Graumlich, Will Steffen, Carole Crumley, John Dearing, Kathy Hibbard, Rik Leemans, Charles Redman, and David Schimel
2007 Sustainability or Collapse: What Can We Learn from Integrating the History of Humans and the Rest of Nature? *Ambio* 36:522-527.
- Costanza, Robert, Sander van der Leeuw, Kathy Hibbard, Steve Aulenbach, Simon Brewer, Michael Burek, Sarah Cornell, Carole Crumley, John Dearing, Carl Folke, Lisa Graumlich, Michelle Hegmon, Scott Heckbert, Stephen T. Jackson, Ida Kubiszewski, Vernon Scarborough, Paul Sinclair, Sverker Sorlin, and Will Steffen
2012 Developing an Integrated History and future of People on Earth (IHOPE). *Current Opinion in Environmental Sustainability* 4:106-114.
- Cote, Muriel, and Andrea J. Nightingale
2012 Resilience Thinking Meets Social Theory: Situating Social Change in Socio-Ecological Systems (SES) Research. *Progress in Human Geography* 36(4):475-489.
- Cox, Stan
2013 *Any Way You Slice It: The Past, Present, and Future of Rationing*. New York: New Press.

- Crane, Todd A.
2010 Of Models and Meanings: Cultural Resilience in Socio-Ecological Systems. *Ecology and Society* 15(4):19.
- Crane, Todd, Carla Roncoli, and Gerrit Hoogenboom
2011 Climate Variability and Adaptation: The Importance of Understanding Agriculture as Performance. *Wageningen Journal of Life Sciences*. 57(3-4):179-185.
- Crane, T., C. Roncoli, Joel Paz, Norman Breuer, Kenneth Broad, Keith T. Ingram, and Gerrit Hoogenboom
2010 Forecast Skill and Farmers' Skills: Seasonal Climate Forecasts and Agricultural Risk Management in the Southeastern United States. *Weather, Climate, and Society*. 2:44-59.
- Crate, Susan A.
2008 Gone the Bull of Winter: Grappling with the Cultural Implications of and Anthropology's Role(s) in Global Climate Change. *Current Anthropology* 49(4):569-595.
2011a Climate and Culture: Anthropology in the Era of Contemporary Climate Change. *Annual Review of Anthropology* 40(1):175-194.
2011b A Political Ecology of Water in Mind: Attributing Perceptions in the Era of Global Climate Change. *Weather, Climate and Society*. 3(3):148-164.
- Crate, Susan A., and Alexander Fedorov
2013 A Methodological Model for Exchanging Local and Scientific Climate Change Knowledge in Northeastern Siberia. *Arctic* 66(3):338-350
- Crate, Susan A., and Mark Nuttall
2009 *Anthropology and Climate Change: From Encounters to Actions*. Walnut Creek, CA: Left Coast Press.
- Cruikshank, Julie
2005 *Do Glaciers Listen?: Local Knowledge, Colonial Encounters, and Social Imagination*. Canadian Studies Series. Vancouver, CA: University of British Columbia Press.
- Crumley, Carole L., ed.
1994a *Historical Ecology: Cultural Knowledge and Changing Landscapes*. Santa Fe, NM: School of American Research Press.
1994b The Ecology of Conquest: Contrasting Agropastoral and Agricultural Societies' Adaptation to Climatic Change. *In Historical Ecology: Cultural Knowledge and Changing Landscapes*, Carole L. Crumley, ed. Pp. 183-201. Santa Fe, NM: School of American Research Press.
2003 Alternative Forms of Societal Order. *In Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula*. Vernon L. Scarborough, Fred Valdez Jr., and Nicholas Dunning, eds. Pp. 136-145. Tucson: University of Arizona Press.
In press. *New Paths into the Anthropocene*. *Oxford Handbook of Historical Ecology and Applied Archaeology*, Christian Isendahl and Daryl Stump, eds. Oxford: Oxford University Press.
- Cutter, Susan L., Lindsey Barnes, Melissa Berry, Christopher Burton, Elijah Evans, Eric Tate, and Jennifer Webb
2008 A Place-Based Model for Understanding Community Resilience to Natural Disasters. *Global Environmental Change* 18(4):598-606.
- Davison, Jean
1988 *Agriculture, Women and the Land: the African Experience*. Boulder: Westview.
- De Menocal, Peter D.
2011 Climate and Human Evolution. *Science* 331:540-542.
2001 Cultural Responses to Climate Change during the Late Holocene. *Science* 292:667-673.
- Dillehay, Tom D., and Alan L. Kolata
2004 Long-term Human Response to Uncertain Environmental Conditions in the Andes. *Proceedings of the National Academy of Sciences* 101:4325-4330.

- Doubleday, Nancy
2007 *Culturing Co-Management: Finding Keys to Resilience in Asymmetries of Power. Adaptive Co-Management: Collaboration, Learning and Multi-Level Governance*. Derek Armitage, Fikret Berkes, and Nancy Doubleday, eds. Pp.228-248. Vancouver: University of British Columbia Press.
- Douglas, Mary
1966 *Purity and Danger*. New York: Praeger.
- Douglas, Mary, and Baron Isherwood
1979 *The World of Goods*. New York: Basic Books.
- Douglas, Mary, and Aaron Wildaysky
1982 *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers*. Berkeley: University of California Press.
- Dove, Michael R., ed.
2013 *The Anthropology of Climate Change: An Historical Reader*. Chichester, West Sussex, UK: John Wiley & Sons.
- Dow, Kirstin, Frans Berkhout, Benjamin L. Preston, Richard J. T. Klein, Guy Midgley and M. Rebecca Shaw
2013 *Commentary: Limits to adaptation*. *Nature Climate Change* 3:305–307.
- Durning, Alan T.
1992 *How Much Is Enough? The Consumer Society and the Future of the Earth*. New York: W.W. Norton.
- Dyson-Hudson, Rada, and Michael A Little
1983 *Rethinking Human Adaptation: Biological and Cultural Models*. Boulder, CO: Westview Press.
- Edenhofer, Ottmar, Carl Carraro, Jean C. Charles Hourcade, K. Neuhoff, Gunner Luderer, Christia Flachsland, Michael. Jakob, AlexanderPopp, Jan Steckel, J. Strohsehein, Nico Bauer, Steffen. Brunner, Marian Leimbach, Hermann Lotze-Campen, Valentina Bosetti, Enrica De Cian, Massimo Tavoni, Olivier Sassi, Henri Waisman, R. Crassous-Doerfler, Stephanie Monjon, S. Dröge, H. van Essen, P. del Río, A. Türk
2009 *The Economics of Decarbonization. Report of the RECIPE project*. Potsdam Institute for Climate Impact Research: Potsdam.
- Ehrlich, Paul R., and Anne H. Ehrlich
2013 *Can a Collapse of Global Civilization be Avoided? Proceedings of the Royal Society B: Biological Sciences* 28(1754):20122845.
- Ellen, Roy
1982 *Environment, Subsistence and System: The Ecology of Small-scale Social Formations*. Cambridge: Cambridge University Press
- Ellis, James E., and David. M. Swift
1988. *Stability of African Pastoral Ecosystems: Alternative Paradigms and Implications for Development*. *Journal of Range Management* 41(6):450-459.
- Ensor, Marisa J., ed.
2009 *The Legacy of Hurricane Mitch: Lessons from Post-Disaster Reconstruction in Honduras*. Tempe: The University of Arizona Press
- Escobar, A.
1999 *After Nature: Steps to an Antiessentialist Political Ecology*. *Current Anthropology* 40(1):1-30.
- Fagan, Brian
1999 *Floods, Famines, and Emperors: El Niño and the Fate of Civilizations*. New York: Basic Books.

2004 *The Long Summer: How Climate Changed Civilization*. New York: Basic Books.
2008 *The Great Warming: Climate Change and the Rise and Fall of Civilization*. New York: Bloomsbury Press.
2010 *Cro-Magnon: How the Ice Age Gave Birth to the First Modern Humans*. New York: Bloomsbury Publishing.

Farbotko, Carol, and Heather Lazrus

2012 *The First Climate Refugees? Contesting Global narratives of climate change in Tuvalu*. *Global Environmental Change* 22:382-390.

Felli, Romain, and Noel Castree

2012 *Neoliberalising Adaptation to Environmental Change: Foresight or Foreclosure?* *Environment and Planning A* 44(1) 1-4.

Ferguson, James

1990 *The Anti-politics Machine: "Development," Depoliticization, and Bureaucratic Power in Lesotho*: Cambridge, UK: Cambridge University Press.

Fiske, Shirley

2011 *Climate Change from the Bottom Up*. In *Applying Anthropology in the Global Village*. Christina Wasson, Mary Odell Butler, and Jacqueline Copeland-Carson, eds. Pp. 143-172. Walnut Creek, CA: Left Coast Press.

Foley, J.A., R. Defries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, J.H. Helkowski, T. Holloway, E.A. Howard, C.J. Kucharik, C. Monfreda, J.A. Patz, I.C. Prentice, N. Ramankutty, and P.K. Snyder

2005 *Global Consequences of Land Use*. *Science* 309(5734):570-4.

Foley, J.A., Gregory P. Asner, Marcos Heil Costa, Michael T. Coe, Ruth DeFries, Holly K. Gibbs, Erica A. Howard, Sarah Olson, Jonathan A. Patz, Navin Ramankutty, and Peter K. Snyder

2007 *Amazonia Revealed: Forest Degradation and Loss of Ecosystem Goods and Services in the Amazon Basin*. *Frontiers in Ecology and the Environment* 35(1):25-32.

Foley, J.A., N. Ramankutty, K. A. Brauman, E.S. Cassidy, J.S. Gerber, M. Johnston, N.D. Mueller, C. O'Connell, D.K. Ray, P.C. West, C. Balzer, E.M. Bennett, S.R. Carpenter, J. Hill, C. Monfreda, S. Polasky, J. Rockstrom, J. Sheehan, S. Siebert, D. Tilman, and D.P. Zaks

2011 *Solutions for a Cultivated Planet*. *Nature* 478(7369):337-42.

Folke, Carl, Steve Carpenter, Thomas Elmqvist, Lance Gunderson, C.S. Holling, and Brian Walker

2002 *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations*. *Ambio* 31(5):437-440.

Folke Carl, Johan Colding, and Fikret Berkes

2002 *Synthesis: Building Resilience and Adaptive Capacity in Social-ecological Systems*. In *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Fikret Berkes, Johan Colding, and Carl Folke, eds. Pp. 252-387. Cambridge: Cambridge University Press.

Folke, Carl, Steve Carpenter, Brian Walker, Marten Scheffer, Thomas Elmqvist, Lance Gunderson, and C. S. Holling

2004 *Regime Shifts, Resilience, and Biodiversity in Ecosystem Management*. *Annual Review of Ecology, Evolution, and Systematics* 35:557-581.

Fordham, Maureen

2003 *Gender, Disaster and Development: The Necessity of Integration*. In *Natural Disasters and Development in a Globalising World*. Mark Pelling, ed. Pp. 57-74. London: Routledge.

- Foster, Robert John
2008 *Coca-Globalization: Following Soft Drinks from New York to New Guinea*. New York: Palgrave Macmillan.
- Fuessel, Hans-Martin
2009 An Updated Assessment of the Risks from Climate Change Based on Research Published since the IPCC Fourth Assessment Report. *Climatic Change* 97(3-4):469-482.
- Furman, Carrie., Carla Roncoli, W. Bartels, M. Boudreau, H. Crockett, H. Gray, and Garrit Hoogenboom.
2014 Social Justice in Climate Services: Engaging African American Farmers in the American South. *Climate Risk Management* 2:11-25.
- Furman, Carrie, Carla Roncoli, Don Nelson, and Garrit Hoogenboom
2014 Growing Food, Growing a Movement: Climate Adaptation and Civic Agriculture in the Southeastern United States. *Agriculture and Human Values* 31:69-82.
- Furman, C., Carla Roncoli, Todd Crane, and Garrit Hoogenboom.
2011 Beyond the 'Fit': Introducing Climate Forecasts among Organic Farmers in Georgia (US). *Climatic Change*. 109(3-4):791-799.
- Gallagher, Kevin
2004 *Free Trade and the Environment: Mexico, NAFTA, and Beyond*. Stanford: Stanford University Press.
- Galvin Kathleen A.
1992 Nutritional Ecology of Pastoralists in Dry Tropical Africa. *American Journal of Human Biology* 4(2):209-221.
2007 Adding the Human Component in Global Environmental Change Research. *Anthropology News* 48(9):11-12.
2008 Responses of Pastoralists to Land Fragmentation: Social Capital, Connectivity, and Resilience. *In* Fragmentation in Semi Arid and Arid Landscapes: Consequences for Human and Natural Systems. Kathleen A. Galvin, Robin S. Reid, Roy H. Behnke Jr., and N. Thompson Hobbs, eds. Pp. 369-389. Dordrecht: Springer.
2009 Transitions: Pastoralists Living with Change. *Annual Review of Anthropology* 38(1):185-198.
- Galvin, Kathleen A., Robin S. Reid, David Nkedianye, Jesse Njoka, Joana Roque de Pinho, Dickson Kaelo, Philip K. Thornton
2013 Pastoral Transformations to Resilient Futures: Understanding Climate from the Ground Up. Research Brief, April 2013. Accessed 7 July, 2014. <http://crsps.net/wp-content/downloads/Livestock-Climate%20Change/Inventoried%2010.5.13/12-2013-4-77.pdf>.
- Galvin, K.A., Philip K. Thornton, Joana Roque de Pinho, Jennifer Sunderland, and Randall B. Boone
2006 Integrated Modeling and its Potential for Resolving Conflicts between Conservation and People in the Rangelands of East Africa. *Human Ecology* 34(2):155-183.
- Geertz, Clifford
1996 Afterword. *In* Senses of Place. Steven Feld and Keith Basso, eds. Pp. 259-262. Santa Fe, NM: School of American Research Press.
- Gerlach, Luther P., and Steve Rayner
1988 Culture and the Common Management of Global Risks. *Practicing Anthropology* 10(3):15-18.
- Giddens, Anthony
1990 *Consequences of Modernity*. Cambridge, UK: Polity Press.
1999 Risk and Responsibility. *Modern Law Reviews* 62(1):1-10.

- Glantz, Michael
1979 A Political View of CO₂. *Nature* 280:189–190.
- Glantz, Michael H., ed.
1994 *Drought Follows the Plow: Cultivating Marginal Areas*. Cambridge, UK: Cambridge University Press.
- Goodman, Alan H, and Thomas L. Leatherman
1998 *Building a New Biocultural Synthesis: Political-economic Perspectives on Human Biology*. Ann Arbor, MI: University of Michigan Press.
- Gray, Sandra, Mary Sundal, Brandi Wiebusch, Michael A. Little, Paul W. Leslie and Ivy L. Pike
2003 Cattle raiding, Cultural Survival, and Adaptability of East African Pastoralists. *Current Anthropology* 44:(S5) S3-S30.
- Grimm, Nancy B., J. Morgan Grove, Steward T.A. Pickett, and Charles L. Redman
2000 Integrated Approaches to Long-term Studies of Urban Ecological Systems. *BioScience* 50:571-584.
- Gunderson, Lance, and Crawford. S. Holling
2002 *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington DC: Island Press.
- Gunn, Joel D.
1994 Global Climate and Regional Biocultural Diversity. *In Historical Ecology: Cultural Knowledge and Changing Landscapes*. Carole L. Crumley, ed. Pp. 67-97. Santa Fe: School of American Research Press.
- Gusterson, Hugh
1996 *Nuclear Rights: A Weapons Laboratory at the End of the Cold War*. Berkeley, CA: University of California Press.
- Guttman-Bond, Erika
2010 Sustainability Out of the Past: How Archaeology Can Save the Planet. *World Archaeology* 42:355-366.
- Hackmann, Heide, and Asuncion Lera St. Clair
2012 Transformative Cornerstones of Social Science Research for Global Change. Report of the International Social Science Council. Paris: ISSC. www.worldsocialscience.org.
- Hannerz, Ulf
2002 *Transnational Connections: Culture, People, Places*. New York, NY: Routledge.
- Harlan Sharon L., Anthony J. Brazel, Lela Prashad, William L. Stefanov, and Larissa Larsen
2006 Neighborhood Microclimates and Vulnerability to Heat Stress. *Social Science and Medicine* 63(11):28-47.
- Harris, Marvin
1980 *Cultural Materialism: The Struggle for a Science of Culture*. New York: Vintage Books.
- Hassan, Fekri
1994 Population Ecology and Civilization in Ancient Egypt. *In Historical Ecology: Cultural Knowledge and Changing Landscapes*. Carole. L. Crumley, ed. Pp. 155-181. Santa Fe, NM: School of American Research Press.
2007 Extreme Nile Floods and Famines in Medieval Egypt (AD 930–1500) and their Climatic Implications. *Quaternary International* 173-174:101-112.
- Hassol, Susan
2004 *Impacts of a Warming Arctic: Arctic Climate Impact Assessment (ACIA)*. Cambridge, UK: Cambridge University Press.

Hastrup, Kirsten

2009 Waterworlds: Framing the Question of Resilience. *In* The Question of Resilience. Social Responses to Climate Change, Kirsten Hastrup, ed. Pp. 11-30. Copenhagen: The Royal Danish Academy of Science and Letters.

2013 Anthropological Contributions to the Study of Climate: Past, Present, Future. *WIREs Climate Change* 4(4):269-281.

Hatt, Ken

2013 Social Attractors: A Proposal to Enhance Resilience Thinking about the Social. *Society and Natural Resources* 26(1):30-43.

Hegmon, Michelle, Mathews A. Peeples, Ann P. Kinzig, Stephanie Kulow, Cathryn M. Meegan, and Margaret C. Nelson

2008 Social Transformation and Its Human Costs in the Prehispanic Southwest. *American Anthropologist* 110(3):313-324.

Henning, Annette Cox

2005 Climate change and energy use. *Anthropology Today* 21(3):8-12.

Hess Jeremy.J., Josephine N. Malilay, and Alan J. Parkinson

2008 Climate Change: The Importance of Place. *American Journal of Preventative Medicine* 35(5):468-478.

Hewitt, Kenneth

1983 *Interpretations of Calamity: From the Viewpoint of Human Ecology*, Boston: Allen and Unwin

Hirsch, Paul D., with William M. Adams, J. Peter Brosius, Asim Zia, Nino Bariola, and Juan Luis Dammert

2011 Acknowledging Conservation Trade-Offs and Embracing Complexity. *Conservation Biology* 25(2):259-264.

Ho, Karen

2009 *Liquidated: An Ethnography of Wall Street*: Durham, NC: Duke University Press

Hobbs, N. Thompson, Kathleen A. Galvin, Chris J. Stokes, Jill M. Lackett, Andrew J. Ash, Randall B. Boone, Robin S. Reid, Philip K. Thornton

2008 Fragmentation of Rangelands: Implications for Humans, Animals, and Landscapes. *Global Environmental Change* 18(4):776-785.

Hoelle, Jeffrey

2012 Black Hats and Smooth Hands: Social Class, Environmentalism, and Work among the Ranchers of Acre, Brazil. *Anthropology of Work Review* 33(2):60-72.

Hofstadter, Douglas

1979 *Gödel, Escher, Bach: An Eternal Golden Braid*. New York: Basic Books.

Holling, Crawford S.

1973 Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics* 4:1-23.

1994 An Ecologist's View of the Malthusian Conflict. *In* Population, Economic Development and the Environment. K Lindahl-Liessling and H. Landberg, eds. Pp. 79-103 New York: Oxford University Press.

Holling, Crawford S., and Gary K. Meffe

1996 Command and Control and the Pathology of Natural Resource Management. *Conservation Biology*. 10(2):328-337.

Horne, Alexander J.

1995 Nitrogen Removal from Waste Treatment Pond or Activated Sludge Plant Effluents with Free-Surface Wetlands. *Water Science and Technology* 31(12):341-351.

- Howell, Signe
2014 Divide and Rule: Nature and Society in a Global Forest Programme. *In Anthropology and Nature*. Kirsten Hastrup, ed. Pp.147-165. London: Routledge.
- Hughes, David
2013 Climate Change and the Victim Slot: From Oil to Innocence. *American Anthropologist* 115(4):570-581.
- Hulme, Mike
2011 Meet the Humanities. *Nature Climate Change* 1:177-179.
- Hvistendahl, Mara
2012 Roots of Empire. *Science* 337(6):1596-1599.
- Iannone, Gyles, ed.
2014 *The Great Maya Droughts in Cultural Context: Case Studies in Resilience and Vulnerability*. Boulder, CO: University Press of Colorado.
- Intergovernmental Panel on Climate Change (IPCC)
2007 Summary for Policymakers. *In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon, S., C. Qin, M. Manning, Z. Cher, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller, eds. Cambridge, UK and New York, NY: Cambridge University Press.
2013 Summary for Policymakers. *In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley, eds. Cambridge, UK: Cambridge University Press.
2014 Glossary. Annex I of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. *In Climate Change 2014: Impacts, Adaptation and Vulnerability. Contributions of John Agard, Lisa Schipper, eds. Cambridge, UK: Cambridge University Press*.
- Janes, Craig R.
2010 Failed Development and Vulnerability to Climate Change in Central Asia: Implications for Food Security and Health. *Asia Pacific Journal of Public Health* 22(3 Suppl):236S-245S.
- Janssen, Marco A., with Michael L. Schoon, Weimao Ke, and Katy Börner
2006 Scholarly Networks on Resilience, Vulnerability and Adaptation within the Human Dimensions of Global Environmental Change. *Global Environmental Change* 16:240-252.
- Johansson, Maria Ulrika, Anders Granström, and Anders Malmer
2012 Tending for Cattle: Traditional Fire Management in Ethiopian Montane Heathlands. *Ecology and Society* 17(3):19.
- Johnson, Daniel P., Austin Stanforth, Vijay Lulla, and George Luber
2012 Developing an Applied Extreme Heat Vulnerability Index Utilizing Socioeconomic and Environmental Data. *Applied Geography* 35(1-2):23-31.
- Kaniewski, David, Elise Van Campo, Joel Guiot, Sabine Le Burel, Thierry Otto, and Cecile Baeteman
2013 Environmental Roots of the Late Bronze Age Crisis. *PLOS One* 8(8):e71004, pp. 1-10
- Kates, Robert William, William C. Clark, Robert Corell, J. Michael Hall, Carlo C. Jaeger, Ian Lowe, James J. McCarthy, Hans Joachim Schellnhuber, Bert Bolin, and Nancy M. Dickson
2001 Environment and Development: Sustainability Science. *Science* 292(5517):641-642.
- Kelly, Robert L., Todd Surovell, Bryan Shuman, and Geoffrey Smith
2012 A Continuous Climatic Impact on Holocene Human Population in the Rocky Mountains. *Proceedings of the National Academy of Sciences* 110(2):443-447.

- Kempton, Willett M.
 1986 Two Theories of Home Heat Control. *Cognitive Science* 10:75-90.
 1997 How the Public Views Climate Change. *Environment* 39(9):12-21.
- Kempton, Willett M., Daniel Feuermann, and Arthur McGarity.
 1992 "I Always Turn it on Super": User Decisions About When and How to Operate Room Air Conditioners. *Energy and Buildings* 18:177-191.
- Kennett, Douglas J. et al. 2012 Development and disintegrations of Maya political systems in response to climate change. *Science* 338: 788-791.
- Kingston, Darren, and Elizabeth Marino
 2010 Twice Removed: King Islanders' Experience of 'Community' Through Two Relocations. *Human Organization* 69(2):119-128.
- Kirch, Patrick
 2005 Archaeology and Global Change: The Holocene Record. *Annual Review of Environment and Resources* 30:409-440.
- Kopytoff, Igor
 1986 The Cultural Biography of Things: Commoditization as Process. *In* *The Social Life of Things: Commodities in Cultural Perspective*. A. Appadurai, ed. Pp. 64-91. Cambridge, UK: Cambridge University Press.
- Krupnik, Igor, Michael Lang, and Scott Miller, eds.
 2009 *Smithsonian at the Poles. Contributions to International Polar Year 2007-2008 Science*. Smithsonian Contributions to Knowledge. Washington, DC.
- Krupnik, Igor, Claudio Aporta, Shari Gearheard, Gita J. Laidler, and Lene Kielsen Holm, eds.
 2010 *SIKU: Knowing our Ice: Documenting Inuit Sea Ice Knowledge and Use*. Dordrecht: Springer.
- Krupnik, Igor, and Dyanna Jolly, eds.
 2002 *The Earth Is Faster Now. Indigenous Observations of Arctic Environmental Change*. Fairbanks, AK: ARCUS.
- Lahsen, Myanna
 2005 Seductive Simulations? Uncertainty Distribution around Climate Models. *Social Studies of Science* 35:895-922.
 2007 Anthropology and the Trouble of Risk Society. *Anthropology News* 48:9-10.
 2013 Anatomy of Dissent A Cultural Analysis of Climate Skepticism. *American Behavioral Scientist* 57(6):732-753.
- Lahsen, Myanna, and Carlos A. Nobre
 2007 Challenges of Connecting International Science and Local Level Sustainability Efforts: The Case of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia. *Environmental Science & Policy* 10(1):62-74.
- Lambin, Eric F., B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Günther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Moran, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, and Jianchu Xu
 2001 The Causes of Land-Use and Land-Cover Change: Moving Beyond the Myths. *Global Environmental Change* 11:261-269.

- Lansing, J. Stephen
 1991 *Priests and Programmers: Technologies of Power in the Engineered Landscape of Bali*. Princeton, NJ: Princeton University.
 2006 *Perfect Order: Recognizing Complexity in Bali*. Princeton, NJ: Princeton University Press.
- Lansing, J. Stephen, and James N. Kremer
 1993 Emergent Properties of Balinese Water Temple Networks: Coadaptation on a Rugged Fitness Landscape. *American Anthropologist* 95(1):97-114.
- Laska, Shirley, and Kristina Peterson
 2013 *Between Now and Then: Tackling the Conundrum of Climate Change Canadian Risk and Hazards Newsletter*, 5(1):5-8.
- Lave, Jean
 1991 Situated Learning in Communities of Practice. *In Perspectives on Socially Shared Cognition*, Lauren Resnick, John M. Levine, and Stephanie Teasley, eds. Pp. 62-82. Washington D.C.: American Psychological Association.
- Lavell, Allan
 2011 Unpacking Climate Change Adaptation and Disaster Risk Management: Searching for the Links and the Differences: A Conceptual and Epistemological Critique and Proposal. IUCN-FLACSO Project on Climate Change Adaptation and Disaster Risk Reduction.
- Lazrus, Heather
 2012 Sea Change: Climate Change and Island Communities. *Annual Review of Anthropology* 41:285-301.
- Leiserowitz, Anthony
 2006 Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery, and Values. *Climatic Change* 77(1-2):45-72.
- Leiserowitz, Anthony, Edward Maibach, Connie Roser-Renouf, and Nicholas Smith
 2010 *Global Warming's Six Americas*, June 2010. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change.
- Lemos, Maria Carmen, Timothy J. Finan, Roger W. Fox, Donald R. Nelson, and Joanna Tucker
 2002 The Use of Seasonal Climate Forecasting in Policymaking: Lessons from Northeast Brazil. *Climatic Change* 55(4):479-507.
- Leslie, Paul W., and Peggy H. Fry
 1989 Extreme Seasonality of Births among Nomadic Turkana Pastoralists. *American Journal of Physical Anthropology* 79:103-115.
- Lipset, David
 2013 *The New State of Nature: Rising Sea-Levels, Climate Justice, and Community-Based Adaptation in Papua New Guinea (2003-2011)*. *Conservation and Society* 11(2):144-157.
 2011 *The Tides: Masculinity and Climate Change in Coastal Papua New Guinea*. *Journal of the Royal Anthropological Institute* 17(1):20-43
- Little, Michael A.
 1995 Adaptation, Adaptability, and Multidisciplinary Research. *In Biological Anthropology: The State of the Science*. N. T. Boaz and L. Wolfe, eds. Pp. 121-148. Bend, OR: International Institute for Human Evolutionary Research.
- Liverman, Diana M, Emilio F Moran, Ronald R Rindfuss, and Paul C Stern, eds.
 1998 *People and Pixels: Linking Remote Sensing and Social Science*. Washington, DC: National Academy Press.

- Love, Thomas, and Anna Garwood
2013 Electrifying Transitions: Power and Culture in Rural Cajamarca, Peru. *In* Cultures of Energy: Power, Practices, Technologies. S. Strauss, S. Rupp, and T. Love, eds. Pp. 147-163. Walnut Creek, CA: Left Coast Press.
- Luber, George, and Michael McGeehin
2008 Climate Change and Extreme Heat Events. *American Journal of Preventive Medicine* 35(5):429-35.
- Lucero, Lisa J.
2002 The Collapse of the Classic Maya: A Case for the Role of Water Control. *American Anthropologist* 104:814-826.
2006 *Water and Ritual: The Rise and Fall of Classic Maya Rulers*. Austin: University of Texas Press.
- Lucero, Lisa J., Roland Fletcher, and Robin Coningham
n.d. From “Collapse” to Urban Diaspora: The Transformation of Low-Density, Dispersed Agrarian Urbanism. *Antiquity*. In press.
- Lucero, Lisa J., Joel D. Gunn, and Vernon L. Scarborough
2011 Climate Change and Classic Maya Water Management. *Water* 3:479-494.
- Maffi, Louisa, and Ellen Woodley
2010 *Biocultural Diversity Conservation: A Global Sourcebook*. Oxford, UK: Earthscan.
- Magistro, John, Carla Roncoli, and Mike Hulme, eds.
2001 Anthropological Perspectives and Policy Implications of Climate Change Research. Special issue, *Climate Research* 19 (2):91-178.
- Malthus, Thomas Robert
1798 *An Essay on the Principle of Population as it Affects the Future Improvement of Society*. London: J. Johnson.
- Marino, Elizabeth
2012 The Long History of Environmental Migration: Assessing Vulnerability Construction and Obstacles to Successful Relocation in Shishmaref, Alaska. *Global Environmental Change* 22(2):374-381.
- Marino, Elizabeth, and Jesse Ribot
2012 Introduction: Adding Insult to Injury: Climate Change and the Inequities of Climate Intervention. Special Issue, *Global Environmental Change* 22(2):323-328.
- Marris, Peter
1975 *Loss and Change*. Garden City, NJ: Doubleday and Company
- Maslow, Abraham Harold
1943 A Theory of Human Motivation. *Psychological Review* 50(4):370.
- McAnany, Patricia, and Norman Yoffee, eds.
2009 *Questioning Collapse: Human Resilience, Environmental Vulnerability and the Aftermath of Empire*. Cambridge: Cambridge University Press.
- McCabe, J.T.
1985 *Livestock Management among the Turkana: A Social and Ecological Analysis of Herding in an East African Population*. Ph.D. dissertation, Department of Anthropology, State University of New York.
2004 *Cattle Bring Us To Our Enemies*. Ann Arbor: University of Michigan Press.

- Mcallister, Lisa., Michael Gurven, Hillard Kaplan, and Jonathan Stieglitz
2012 Why Do Women Have More Children than They Want? Understanding Differences in Women's Ideal and Actual Family Size in a Natural Fertility Population. *American Journal of Human Biology* 24(6):786-99
- McCracken, Grant
1988 *Culture and Consumption*. Bloomington, IN: Indiana University Press.
- McGovern, Thomas H., Orri Vésteinsson, Adolf Fridriksson, Mike Church, Ian Lawson, Ian A. Simpson, Arni Einarsson, Andy Dugmore, Gordon Cook, Sophia Perdikaris, Kevin J. Edwards, Amanda M. Thomson, W. Paul Adderley, Anthony Newton, Gavin Lucas, Ragnar Edvardsson, Oscar Aldred, and Elaine Dunbar
2007 Landscapes of Settlement in Northern Iceland: Historical Ecology of Human Impact and Climate Fluctuation on the Millennial Scale. *American Anthropologist* 109(1):27-51.
- McGuire, Thomas, and Diane Austin
2013 Beyond the horizon: Oil and gas along the Gulf of Mexico. *In Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp and Thomas Love. Pp. 298-311. Walnut Creek, CA: Left Coast Press.
- McIntosh, Roderick, Joseph A. Tainter, and Susan Keech McIntosh, eds.
2013 *The Way the Wind Blows: Climate Change, History, and Human Action*. New York: Columbia University Press.
- McMichael, Anthony J.
2012 Insights from Past Millennia into Climatic Impacts on Human Health and Survival. *Proceedings of the National Academy of Sciences* 109(13):4730-4737.
- McNutt, Marcia
2013 Climate Change Impacts. *Science* 341(6145):435.
- Mead, Margaret
1980 Preface: Society and the Atmospheric Environment. *In The Atmosphere: Endangered and Endangering*, William W. Kellogg and Margaret Mead, eds. Pp. xix-xxiv. DHEW Publication No. (NIH) 77-1065. Washington DC: US Government Printing Office.
- Mead, Margaret, ed.
1955 *Cultural Patterns and Technical Change*. New York: UNESCO.
- Medina-Elizalde, Martín, Stephen J. Burns, David W. Lea, Yemane Asmerom, Lucien von Gunten, Victor Polyak, Mathias Vuille, and Ambarish Karmalkar
2010 High Resolution Stalagmite Climate Record from the Yucatán Peninsula Spanning the Maya Terminal Classic Period. *Earth and Planetary Science Letters* 298:255-262.
- Medina-Elizalde, **Martín** and **Eelco J. Rohling** 2012 Collapse of Classic Maya Civilization related to modest reduction in precipitation. *Science* 335: 956-959.
- Meltzoff, Sarah.
2013. *Listening to Sea Lions: Currents of Change from Galapagos to Patagonia*. Plymouth, UK: AltaMira Press.
- Mertz, Ole, Reed Wadley, and Andreas Christensen
2005 Local Land Use Strategies in a Globalizing World: Subsistence Farming, Cash Crops and Income Diversification. *Agricultural Systems* 85(3):209-15.
- Meyer, Robert, with Kenneth Broad, Ben Orlove, and Nada Petrovic
2013 Dynamic Simulation as an Approach to Understanding Hurricane Risk Response: Insights from the Stormview Lab. *Risk Analysis* 33(8):1532-1552.

- Michaelis, Laurie A., and Richard R. Wilk
 2005 Consumption and the Environment - Social and Cultural Development of Human Resources. *In* Encyclopedia of Life Support Systems (EOLSS). Developed under the Auspices of the UNESCO. Oxford: ELOSS Publishers. [<http://www.eolss.net>] [Accessed December 7, 2005]
- Miller, Daniel
 2013 Consumption and its Consequences. Cambridge, UK: Polity Press.
 1997 Capitalism: an Ethnographic Approach. Oxford, UK: Berg Publishers, Ltd.
 1998 A Theory of Shopping. Ithaca, NY: Cornell University Press.
- Mooney, Harold A., Anantha Duraiappah, and Anne Larigauderie
 2013 Evolution of Natural and Social Science Interactions in Global Change Research Programs Proceedings of the National Academy of Science 110 (Supplement 1): 3665.
- Moore, Frances C.
 2012 Negotiating Adaptation: Norm Selection and Hybridization in International Climate Negotiations. *Global Environmental Politics* 12(4):30–48.
- Mora, Camilo, Abby G. Frazier, Ryan J. Longman, Rachel S. Dacks, Maya M. Walton, Eric J. Tong, Joseph J. Sanchez, Lauren R. Kaiser, Yuko O. Stender, James M. Anderson, Christine M. Ambrosino, Iria Fernandez-Silva, Louise M. Giuseffi and Thomas W. Giambelluca
 2013 The Projected Timing of Climate Departure from Recent Variability. *Nature* 502 (10 October 2013):183-187.
- Moran, Emilio F.
 1993 Deforestation and Land Use in the Brazilian Amazon. *Human Ecology* 21(1):1-21.
- Moran, Emilio F., Eduardo Brondizio, and Leah K. VanWey
 2005 Population and Environment in Amazonia: Landscape and Household Dynamics. *In* Population, Land Use, and Environment: Research Directions. Barbara Entwistle and Paul C. Stern, eds. Pp. 106-134. Washington, D.C.: The National Academies Press.
- Moritz, Mark, Michael Paolisso, Courtney Carothers, Sean Downey, Kathleen Galvin, Drew Gerkey, Terrence McCabe, Amber Wutich, Rebecca Zarger, and J. Stephen Lansing
 2012 Ecological Anthropologists at ASM Explore Contributions to LTER. *LTER Network News* 25(3).
 Electronic document, <http://news.lternet.edu/Article2606.html>, accessed January 19, 2014.
- Moser, Suzanne, and Lisa Dilling
 2004 Making Climate HOT. *Environment: Science and Policy for Sustainable Development* 46(10):32-46.
- Moss, R.H., G.A. Meehl, M.C. Lemos, J.B. Smith, J.R. Arnold, J.C. Arnott, D. Behar, G.P. Brasseur, S.B. Bromell, A.J. Busalacchi, S. Dessai, K.L. Ebi, J. A. Edmonds, J. Furlow, L. Goddard, H.C. Hartmann, J.W. Hurrell, J.W. Katzenberger, D.M. Liverman, P.W. Mote, S.C. Moser, A. Kumar, R.S. Pulwarty, E.A. Seyller, B.L. Turner II, W.M. Washington, and T.J. Wilbanks
 2013 Hell and High Water: Practice-Relevant Adaptation Science. *Science* 342(6159):696-698.
- Murphy, Brenda L.
 2011 From Interdisciplinary to Inter-Epistemological Approaches: Confronting the Challenges of Integrated Climate Change Research. *The Canadian Geographer / Le Géographe Canadien* 55(4):490–509.
- Myrdal, Gunnar
 1957 Rich Lands and Poor. New York: Harpers.

- Nadasdy, Paul
2007 Adaptive Co-Management and the Gospel of Resilience. *In Adaptive Co-Management: Collaboration, Learning, and Multilevel Governance*. Derek Armitage, Fikret Berkes, and Nancy Doubleday, eds. Pp. 208-227. Vancouver, CA: University of British Columbia Press.
- Nader, Laura, ed.
2010 *The Energy Reader*. Chichester, UK: Wiley-Blackwell.
- Nader, Laura, and Stephen Beckerman
1978 Energy as it Relates to the Quality and Style of Life. *Annual Review of Energy* 3:1-28.
- Nag, Moni
1962 Factors Affecting Human Fertility in Nonindustrial Societies: A Cross-Cultural Study. *Yale University Publications in Anthropology* 66(15-18).
1973 Anthropology and Population: Problems and Perspectives. *Population Studies* 27(1):59-68.
- Nagle, John
2010 Climate Exceptionalism. *Environmental Law* 40(1):53-88.
- National Research Council (NRC)
1999 Human Dimensions of Global Environmental Change. *Research Pathways for the Next Decade*. Committee on the Human Dimensions of Global Change, Commission on Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.
2012 *Disaster Resilience: A National Imperative*. Washington DC: National Academies Press.
- National Science Foundation (NSF)
1995 Cultural Anthropology, Global Change, and the Environment: Anthropology's Role in the NSF Initiative on Human Dimensions of Global Change. Washington, DC.
- Nazarea, Virginia D.
1998 *Cultural Memory and Biodiversity*. Tucson: University of Arizona Press.
- Nelson, Donald R.
2007 Expanding the Climate Change Research Agenda. *Anthropology News* 48:12-13.
- Nelson, Donald R., and Timothy J. Finan
2009 Praying for Drought: Persistent Vulnerability and the Politics of Patronage in Ceará, Northeast Brazil. *American Anthropologist* 111(3):302-16.
- Nelson, Donald R, W. Neil Adger, and Katrina Brown
2007 Adaptation to Environmental Change: Contributions of a Resilience Framework. *Annual Review of Environment and Resources* 32:395-419.
- Nelson, Donald R., Colin Thor West, and Timothy Finan, eds.
2009 Global Change and Adaptation in Local Places. *American Anthropologist* 111(3):263-403.
- Nelson, Donald R, Colin Thor West, and Timothy J. Finan
2009 Introduction to In Focus: Global Change and Adaptation in Local Places. *American Anthropologist* 111(3):271-274
- Nelson, Laura C.
2012 *Measured Excess: Status, Gender, and Consumer Nationalism in South Korea*. New York: Columbia University Press.

- Netting, Robert M., and J. Martinez-Alier
1995 Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture. *Journal of Peasant Studies* 23(1):140-148.
- Netting, Robert M., Richard Wilk, and Eric Arnould
1984 *Households: Comparative and Historical Studies of the Domestic Group*. Berkeley: University of California Press.
- Nordstrom, Carolyn
2004 *Shadows of War: Violence, Power, and International Profiteering in the Twenty-First Century*. Berkeley: University of California Press.
- Nuttall, Mark
1998 *Protecting the Arctic: Indigenous Peoples and Cultural Survival*. Amsterdam, Netherlands: Harwood Academic Publishers.
2009 *Living in a World of Movement: Human Resilience to Environmental Instability Greenland*. In *Anthropology and Climate Change: From Encounters to Actions*. Susan A. Crate and Mark Nuttall, eds. Pp. 292-310. Walnut Creek, CA: Left Coast Press.
- O'Brien, Karen
2012 *Global Environmental Change II: From Adaptation to Deliberate Transformation*. *Progress in Human Geography* 36(5):667-676.
- O'Brien, Karen L., and Robin M. Leichenko
2000 *Double Exposure: Assessing the Impacts of Climate Change Within the Context of Economic Globalization*. *Global Environmental Change – Human and Policy Dimensions* 10(3):221-232.
- O'Keefe, Phil, Ken Westgate and Ben Wisner
1976 *Taking the Naturalness Out of Natural Disasters*. *Nature* 260(5552):566-567.
- Ogilvie, Astrid, and Gisli Palsson
2003 *Mood, Magic and Metaphor: Allusions to Weather and Climate in the Sagas of Icelanders*. In *Weather, Climate, Culture*. S. Strauss and B.S. Orlove, eds. Pp. 251-275. Oxford: Berg Publishers.
- Ojima, Dennis S., Kathleen A. Galvin, and Billie L. Turner II
1994 *The Global Impact of Land-Use Change*. *BioScience* 44(5):300-304.
- Oliver-Smith, Anthony
1995 *Peru's Five Hundred Year Earthquake: Vulnerability to Hazard in Historical Context*. In *Disasters, Development and Environment*. Ann Varley, ed. Pp. 31-48. London, UK: John Wiley and Sons.
- O'Reilly, Jessica, Naomi Oreskes and Michael Oppenheimer
2012 *The Rapid Disintegration of Projections: The West Antarctic Ice Sheet and the Intergovernmental Panel on Climate Change*. *Social Studies of Science* 42(5):709-731.
- Orlove, Ben
2005 *Human Adaptation to Climate Change: a Review of Three Historical Cases and Some General Perspectives*. *Environmental Science & Policy* 8(6):589-600.
2009 *The Past, the Present and Some Possible Futures of Adaptation*. In *Adapting to Climate Change: Thresholds, Values, Governance*. W. Neil Adger, Irene Lorenzoni, and Karen L. O'Brien, eds. Pp. 131-163. Cambridge: Cambridge University Press.
- Orlove, Benjamin S., John C. H. Chiang, and Mark A. Cane
2000 *Forecasting Andean Rainfall and Crop Yield from the Influence of El Niño on Pleiades Visibility*. *Nature* 403(6765):68-71.

- Orlove, Ben, and Merit Kabugo
2005 Signs and Sight in Southern Uganda: Representing Perception in Ordinary Conversation. *Etnofoor* 18(1):124-141.
- Orlove, Ben, Carla Roncoli, Merit Kabugo, and Abushen Majugu
2010 Indigenous Climate Knowledge in Southern Uganda: the Multiple Components of a Dynamic Regional System. *Climate Change* 100(2):243-265.
- Orlove, Ben, Heather M. Lazarus, Grete K. Hovelsrud, and Alessandra Giannini
In press Recognitions and Responsibilities: On the Origins and Consequences of the Uneven Attention to Climate Change around the World. *Current Anthropology*.
- Palsson, Gisli, Bronislaw Szerszynski, Sverker Sörlin, John Marks, Bernanrd Avril, Carole Crumley, Heide Hackmann, Poul Holm, John Ingram, Alan Kirman, Mercedes Pardo Buendía, and Rifka Weehuizen
2013 Reconceptualizing the “Anthropos” in the Anthropocene: Integrating the Social Sciences and Humanities in Global Environmental Change Research. *Environmental Science & Policy* 28:3-13.
- Patterson, Thomas
1994 Toward a Properly Historical Ecology. *In Historical Ecology: Cultural Knowledge and Changing Landscapes*. Carole L. Crumley, ed. Santa Fe, NM: School of American Research Press.
- Peet, Richard, and Michael Watts
2002 *Liberation Ecologies: Environment, Development and Social Movements*. New York: Routledge.
- Pelling, Mark
2011 *Adaptation to Climate Change: From Resilience to Transformation*. London, United Kingdom and New York: Routledge.
- Peterson, Nicole D.
2012 Developing Climate Adaptation: The Intersection of Climate Research and Development Programmes in Index Insurance. *Development and Change* 43(2):557-584.
- Peterson, Nicole D., and Kenneth Broad
2009 Climate and Weather Discourse in Anthropology: From Determinism to Uncertain Futures. *In Anthropology and Climate Change: From Encounters to Actions*. Susan Crate and Mark Nuttall, eds. Pp. 70-86. Walnut Creek, CA: Left Coast Press.
- Peterson, Nicole D., Kenneth Broad, Ben Orlove, Carla Roncoli, Renzo Taddei, and Maria-Alejandra Velez
2010 Participatory Processes and Climate Forecast Use: Socio-Cultural Context, Discussion, and Consensus. *Climate and Development* 2(1):14–29.
- Pew Research Center
2014 *Climate Change: Key Data Points from Pew Research*. Washington DC: Pew Research Center.
<http://www.pewresearch.org/key-data-points/climate-change-key-data-points-from-pew-research/>, accessed March 14, 2014.
- Pielke, Roger A., Sr., Wilby, Rob; Niyogi, Dev; Dev Niyogi, Faisal Hossain, Koji Dairuku, Jimmy Adegoke, George Kallos, Timothy Seastedt, and Katharine Suding
2012 Dealing With Complexity and Extreme Events Using a Bottom-Up, Resource-Based Vulnerability Perspective. *In Extreme Events And Natural Hazards: The Complexity Perspective*. Geophysical Monograph Series 196:345-359. A.S. Sharma, A. Bunde; V.P. Dimri, and D.N. Baker, eds. Hyderabad, India: National Geophysical Research Institute.
- Polgar, Steven
1972 Population History and Population Policies from an Anthropological Perspective. *Current Anthropology* 13(2):203-211.

- Princen, Thomas
 2002 Distancing: Consumption and the Severing of Feedback. *In Confronting Consumption*. Thomas Princen, Michael Maniates, and Ken Conca, eds. Pp. 103-132. Cambridge, MA: MIT Press,
- Rambaldi, Giacomo, Julius Muchemi, Nigel Crawhall, and Laura Monaci
 2007 Through the Eyes of Hunter-Gatherers: participatory 3D modelling among Ogiek indigenous peoples in Kenya. *Information Development* 23(2-3):113-128.
- Rappaport, Roy A.
 1967 *Pigs for the Ancestors*. New Haven, CT: Yale University Press.
- Rayner, Steve
 1989 Fiddling While the Globe Warms. Editorial. *Anthropology Today* 5(6):1-2.
 2003 Domesticating Nature: Commentary on the Anthropological Study of Weather and Climate Discourse. *In Weather, Climate, Culture*. Sarah Strauss and Ben Orlove, eds. Pp. 277-290. Oxford, UK: Berg Publishers.
 2006 Jack Beale Memorial Lecture on Global Environment Wicked Problems: Clumsy Solutions – diagnoses and prescriptions for environmental ills. Institute for Science, Innovation, and Society, ANSW Sydney Australia. <http://eureka.bodleian.ox.ac.uk/93/>, accessed July 16, 2014.
- Rayner, Steve, and Elizabeth L. Malone, eds.
 1998 *Human Choice and Climate Change: An International Assessment*. Columbus, OH: Battelle Press.
- Raven, Peter H.
 2002 Science, Sustainability, and the Human Prospect. *Science* 297:954-958.
- Redclift, Michael
 1996 *Wasted: Counting the Cost of Global Consumption*, London, UK: Earthscan Publications.
- Redman, Charles L.
 2004 *Archaeology of Global Change: The Impact of Humans on Their Environment*. Washington, DC: Smithsonian.
- Ribot, Jesse
 2011 Vulnerability Before Adaptation: Toward Transformative Climate Action. *Global Environmental Change* 21:1160-1162.
- Rockstrom, Johan, Will Steffen, Kevin Noone, Asa Persson, F. Stuart III Chapin, Eric Lambin, Timothy M. Lenton, Marten Scheffer, Carl Folke, Hans Joachim Schellnhuber, Bjorn Nykvist, Cynthia A. de Wit, Terry Hughes, Sander van der Leeuw, Henning Rodhe, Sverker Sorlin, Peter K. Snyder, Robert Costanza, Uno Svedin, Malin Falkenmark, Louise Karlberg, Robert W. Corell, Victoria J. Fabry, James Hansen, Brian Walker, Diana Liverman, Katherine Richardson, Paul Crutzen and Jonathan Foley
 2009 Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology and Society* 14(2):32.
- Rolston, Jessica Smith
 2013 Specters of Syndromes and the Everyday Lives of Wyoming Energy Workers. *In Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and Thomas Love, eds. Pp.213-226. Walnut Creek, CA: Left Coast Press.
- Roncoli, Carla
 2006 Ethnographic and Participatory Approaches to Research on Farmers' Responses to Climate Predictions. *Climate Research*, 33:81-99.
- Roncoli, Carla, Norman Breuer, David Zierden, Clyde Fraise, Kenneth Broad, and Gerrit Hoogenboom
 2012 The Art of the Science: Climate Forecasts for Wildfire Management in the Southeastern United States. *Climatic Change*. 113(3):1113-1121.

- Roncoli, Carla, Todd Crane and Ben Orlove
2009 Fielding Climate Change in Cultural Anthropology. *In* Anthropology and climate change: From Encounters to Actions. Susan Crate and Mark Nuttall, eds. Pp. 87-115. Walnut Creek, CA: Left Coast Press.
- Roncoli, Carla with Keith Ingram and Paul Kirshen
2002 Reading the Rains: Local Knowledge and Rainfall Forecasting in Burkina Faso. *Society and Natural Resources* 15:411-430.
- Rosa, Eugene A., and Thomas Dietz
2012 Human Drivers of National Greenhouse-Gas Emissions. *Nature Climate Change* 2(8):581-586.
- Rosen, Arlene Miller
2007 *Civilizing Climate: Social Responses to Climate Change in the Ancient Near East*. Lanham,MD: Altamira Press.
- Rosenzweig, Cynthia, William Solecki, Stephen A. Hammer and Shagun Mehrotra.
2010 Cities Lead the Way in Climate Change Action. *Nature* 467:909-11.
- Rostow, Walt W.
1960 *The Stages of Economic Growth*. Cambridge, UK: Cambridge University Press.
- Ruddiman, William F.
2013 The Anthropocene. *Annual Reviews Earth and Planetary Sciences* 41:45-68.
- Ruddiman, William F., and Erle C. Ellis
2009 Effect of Per-Capita Land Use Changes on Holocene Forest Clearance and CO₂ Emissions. *Quaternary Science Reviews* 28:3011-3015.
- Ruddiman, William F., John E. Kutzbach, and Stephen J. Vavrus
2011 Can Natural or Anthropogenic Explanations of Late-Holocene CO₂ and CH₄ Increases Be Falsified? *Holocene* 21(5):865-879.
- Rudel, Thomas K., Oliver T. Coomes, Emilio Moran, Frederic Achard, Arild Angelsen, Jianchu Xu, and Eric Lambin
2005 Forest Transitions: Towards a Global Understanding of Land Use Change. *Global Environmental Change* 15(1):23-31.
- Rudiak-Gould, Peter
2011 Climate Change and Anthropology: The Importance of Reception Studies. *Anthropology Today* 27(2):9-12.
2012 Promiscuous Corroboration and Climate Change Translation: A Case Study from the Marshall Islands. *Global Environmental Change* 22(1):46-54.
2013 *Climate Change and Tradition in a Small Island State: The Rising Tide*. New York: Routledge.
- Sandweiss, Daniel H., and Alice R. Kelley
2012 Archaeological Contributions to Climate Change Research: The Archaeological Record as a Paleoclimatic and Paleoenvironmental Archive. *Annual Review of Anthropology* 41:371-391.
- Sawyer, Suzana
2004 *Crude Chronicles: Indigenous Politics, Multinational Oil, and Neoliberalism in Ecuador*. Durham, NC: Duke University Press
- Sayre, Nathan F.
2012 The Politics of the Anthropogenic. *Annual Review of Anthropology* 41:57-70.

- Scarborough, Vernon, and William R. Burnside
2010 Complexity and Sustainability: Perspectives from the Ancient Maya and the Modern Balinese. *American Antiquity* 75(2):327-363.
- Scarborough, Vernon L., Fred Valdez, and Nicholas P. Dunning
2003 Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula. Tucson: University of Arizona Press.
- Scarborough, Vernon. L., Nicholas P. Dunning, Kenneth B. Tankersley, Christopher Carr, Eric Weaver, Liwy Grizioso, Brian. Lane, John G. Jones, Palma Buttles, Fred Valdez and David L. Lentz.
2012. Water and Sustainable Land Use at the Ancient Tropical City of Tikal, Guatemala. *Proceedings of the National Academy of Sciences* 109(31):12408-12413.
- Scheffran, Jürgen, Michael Brzoska, Jasmin Kominek, P. Michael Link, and Janpeter Schilling
2012 Climate Change and Violent Conflict. *Science* 336:869-871.
- Schuller, Mark, and Pablo Morales, eds.
2012 Tectonic Shifts: Haiti since the Earthquake. Sterling VA: Kumarian Press.
- Sharp, Lauriston
1952 Steel Axes for Stone Age Australians. *Human Organization* 11(2):17-22.
- Shearer, Christine
2012 The Political Ecology of Climate Adaptation Assistance: Alaska Natives, Displacement, and Relocation. *Journal of Political Ecology* 19:174–183.
- Shell-Duncan, Bettina 1995 Impact of Seasonal Variation in Food Availability and Disease Stress on the Health Status of Nomadic Turkana Children: A Longitudinal Analysis of Morbidity, Immunity, and Nutritional Status. *American Journal of Human Biology* 7(3):339-355.
- Shennan, Stephen, Sean S. Downey, Adrian Timpson, Kevan Edinborough, Sue Colledge, Tim Kerig, Katie Manning, and Mark G. Thomas
2013 Regional Population Collapse Followed Initial Agriculture Booms in Mid-Holocene Europe. *Nature Communications* 4:2486. doi:10.1038/ncomms3486.
- Shepard, Peggy M., and Cecil Corbin-Mark
2009 Climate Justice. *Environmental Justice* 2(4):1-4.
- Sheridan, Michael
2012 Global Warming and Global War: Tanzanian Farmers' Discourse on Climate and Political Disorder. *Journal of Eastern African Studies* 6(2):230-245.
- Sherry, John, ed.
1995 Contemporary Marketing and Consumer Behavior: An Anthropological Sourcebook. Thousand Oaks, CA: Sage.
- Shove, Elizabeth
2003 Comfort, Cleanliness, and Convenience: The Social Organization of Normality. Oxford, UK: Berg Publishers.
- Shrybman, Steven
2000 Trade, Agriculture, and Climate Change: How Agricultural Trade Policies Fuel Climate Change. Minneapolis: Institute for Agriculture and Trade Policy.

- Smith, Pete, Daniel Martino, Zucong Cai, Daniel Gwary, Henry Janzen, Pushpam Kumar, Bruce McCarl, Stephen Ogle, Frank O'Mara, and Charles Rice
2007 Policy and Technological Constraints to Implementation of Greenhouse Gas Mitigation Options in Agriculture. *Agriculture, Ecosystems & Environment* 118(1):6-28.
- Stepp, John Richard, Eric C. Jones, Mitchell Pavao-Zuckerman, David Casagrande, and Rebecca K. Zarger
2003 Remarkable Properties of Human Ecosystems. *Conservation Ecology* 7(3):11.
- Steward, Julian
1955 *Theory of Culture Change: The Methodology of Multilinear Evolution*. Urbana, IL: University of Illinois Press.
- Stone Brian, Jeremy J. Hess, and Howard Frumkin
2010 Urban Form and Extreme Heat Events: Are Sprawling Cities more Vulnerable to Climate Change than Compact Cities? *Environmental Health Perspectives* 118(10):1425-1428.
- Stratford, Elaine, Carol Farbotko, and Heather Lazarus
2013 Tuvalu, Sovereignty and Climate Change: Considering Fenua, the Archipelago and Emigration. *Island Studies Journal* 8(1):67-83.
- Strauss, Sarah
2007 An Ill Wind: Foehn and Health in Leukerbad and Beyond. Theme Issue, "Wind, Life, and Health," *Journal of the Royal Anthropological Institute*. (N.S.) 13(s1):163-178.
- Strauss, Sarah, Stephanie Rupp, and Thomas Love, eds.
2013 *Cultures of Energy: Power, Practices, Technologies*. Walnut Creek, CA: Left Coast Press.
- Strauss, Sarah, and Devon Reeser
2013 Siting, Scale, and Social Capital: Wind Energy Development in Wyoming. *In Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and Thomas Love, eds. Pp. 110-125. Walnut Creek, CA: Left Coast Press.
- Strauss, Sarah, and Ben Orlove, eds.
2003 *Weather, Climate, Culture*. Oxford, UK: Berg Publishers.
- Sunderland, Patricia L. and Rita M. Denny
2007 *Doing Anthropology in Consumer Research*. Walnut Creek, CA.: Left Coast Press
- Swim, Janet K., Paul C. Stern, Thomas J. Doherty, Susan Clayton, Joseph P. Reser, Elke U. Weber, Robert Gifford, and George S. Howard
2011 Psychology's Contributions to Understanding and Addressing Global Climate Change. *American Psychologist* 66(4):241-250.
- Tainter, Joseph A., and Carole L. Crumley
2007 Climate, Complexity, and Problem Solving in the Roman Empire. *In Sustainability or Collapse?: An Integrated History and Future of People on Earth*. Robert Costanza, Lisa J. Graumlich, and Will Steffen, eds. Pp. 61-75. Boston, MA: MIT Press.
- Tax, Sol
1957 Changing Consumption in Indian Guatemala. *Economic Development and Culture Change*. 5(2):147-158.
- Tengö, Maria, Eduardo S. Brondizio, Thomas Elmqvist, Pernilla Malmer, and Marja Spiereburg
2014 Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. *AMBIO: A Journal of the Human Environment* DOI 10.1007/s13280-014-0501-3.

- Thomas, R Brooke
1976 Energy Flow at High Altitude. *In Man in the Andes: a Multidisciplinary Study of High-Altitude Quechua*. Paul T. Baker and Michael A. Little, eds. Pp. 379-404. Stroudsburg, PA: Dowden, Hutchinson and Ross.
- Thornton, Philip
2001 Simulation Models for Planning. *In Planning Agricultural Research: A Sourcebook*. Govert Gijsbers, Willem Janssen, Helen Hambly Odame, and Gerdien Meijerink, eds. Pp. 309-320. New York: CABI.
- Thornton, Thomas F. and Nadia Manasfi
2010 Adaptation-Genuine and Spurious: Demystifying Adaptation Processes in Relation to Climate Change. *Environment and Society: Advances in Research* 1(1):132-155.
- Thywissen, K
2006 Core Terminology of Disaster Reduction. A Comparative Glossary. *In Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies*. Jörn Birkmann, ed. Pp. 448-496. Tokyo: United Nations University Press.
- Trentmann, Frank
2009 Crossing Divides Consumption and Globalization in History. *Journal of Consumer Culture* 9(2):187-220.
- Trouillot, Michel-Rolph
1991 Anthropology and the Savage Slot: The Politics and Poetics of Otherness. *In Recapturing Anthropology: Working in the Present*. Richard Fox, ed. Pp. 17-44. Santa Fe, NM: School of American Research Press.
- Tsing, Anna Lowenhaupt
2005 Friction: An Ethnography of Global Connection. Princeton, NJ: Princeton University Press.
- Turner II, B. L., Roger E. Kasperson, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Jeanne X. Kasperson, Amy Luerse, Marybeth L. Martello, Colin Polskya, Alexander Pulsipher, and Andrew Schiller
2003 A Framework for Vulnerability Analysis in Sustainability Science. *Proceedings of the National Academy of Science* 100(14): 8074-8079.
- Turner, Billie L., Eric F. Lambin, and Anette Reenberg.
2007 The Emergence of Land Change Science for Global Environmental Change and Sustainability. *Proceedings of the National Academy of Sciences* 104(52):20666-20671.
- Turner II, B. and J. Sabloff 2012 Classic Period collapse of the Central Maya Lowlands: Insights about human-environment relationships for sustainability. *Proceedings of the National Academy of Sciences* 109(35): 13908-13914.
- Vandehey, Scott
2013 Local power: Harnessing NIMBYism for Sustainable Suburban Energy Production. *In Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and Thomas Love, eds. Pp. 242-255. Walnut Creek, CA: Left Coast Press.
- Van der Leeuw, Sander E.
2008 Climate and Society: Lessons from the Past 10,000 Years. *Royal Swedish Academy of Sciences* 14:476-482.
2009 What is an 'Environmental Crisis' to an Archaeologist? *In The Archaeology of Environmental Change: Socio-natural Legacies of Degradation and Resilience*. Christopher T. Fisher, J. Brett Hill, and Gary M. Feinman, eds. Pp. 40-61. Tucson: University of Arizona Press.

- Van der Leeuw, Sander E., with Robert Costanza, Steve Aulenbach, Simon Brewer, Michael Burek, Sarah Cornell, Carole Crumley, John A. Dearing, Catherine Downy, Lisa J. Graumlich, Scott Heckbert, Michelle Hegmon, Kathy Hibbard, Stephen T. Jackson, Ida Kubiszewski, Paul Sinclair, Sverket Sörlin, and Will Steffen
2011 *Toward an Integrated History to Guide the Future*. *Ecology and Society* 16(4):2.
<http://dx.doi.org/10.5751/ES-04341-160402>
- Vásquez-León, Marcela
2009 *Hispanic Farmers and Farm Workers: Social Networks, Institutional Exclusion, and Climate Vulnerability in Southeastern Arizona*. *American Anthropologist* 111(3):289-301.
- Vásquez-León, Marcela, and Diana Liverman
2004 *The Political Ecology of Land-use Change: Affluent Ranchers and Desittute Farmers in the Mexican Municipio of Alamos*. *Human Organization* 63(1):21-33.
- Vayda, Andrew P., and Bonnie J. McCay
1975 *New Directions in Ecology and Ecological Anthropology*. *Annual Review of Anthropology* 4:293-306.
- Verweij, Marco, Mary Douglas, Richard Ellis, Christoph Engel, Frank Hendriks, Susanne Lohmann, Steven Ney, Steve Rayner, and Michael Thompson
2006 *Clumsy Solutions for a Complex World: The Case of Climate Change*. *Public Administration* 84(4): 817–843.
- Walker, Brian, and David Salt
2012 *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function*. Washington, DC: Island Press.
- Walker, Brian, C.S. Holling, Stephen R. Carpenter, and Ann Kinzig
2004 *Resilience, Adaptability and Transformability in Social-Ecological Systems*. *Ecology and Society* 9(2):5. <http://www.ecologyandsociety.org/vol9/iss2/art5>
- Weisser, Florian, Michael Bollig, Martin Doevenspeck, and Detlef Müller-Mahn.
2014 *Translating the ‘Adaptation to Climate Change’ Paradigm: The Politics of a Travelling Idea in Africa*. *The Geographical Journal* 180(2):111-119. doi: 10.1111/geoj.12037.
- Welsh, Marc
2014 *Resilience and Responsibility: Governing Uncertainty in a Complex World*. *The Geographical Journal* 180(1):15-26. doi: 10.1111/geoj.12012.
- West, Colin Thor
2009 *Domestic Transitions, Desiccation, Agricultural Intensification, and Livelihood Diversification among Rural Households on the Central Plateau, Burkina Faso*. *American Anthropologist* 111(3):275-288.
- West, Paige
2006 *Conservation Is Our Government Now: The Politics of Ecology in Papua New Guinea*. Durham, NC: Duke University Press.
2012 *From Modern Production to Imagined Primitive: The Social Life of Coffee from Papua New Guinea*. Durham, NC: Duke University Press.
- Weszkalnys, Gisa
2013 *Oil’s Magic: Contestation and Materiality*. *In Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and ThomasLove, eds. Pp. 267-283. Walnut Creek, CA: Left Coast Press.
- White, Leslie
1943 *Energy and the Evolution of Culture*. *American Anthropologist* 45(3):335-356.
1959 *The Evolution of Culture: The Development of Civilization to the Fall of Rome*. New York: McGraw-Hill.
2008 *Modern Capitalist Culture*. Walnut Creek, CA: Left Coast Press.

- Whitehead, Harold, and Peter J. Richerson
2009 The Evolution of Conformist Social Learning Can Cause Population Collapse in Realistically Variable Environments. *Evolution and Human Behavior* 30:261-273.
- Wilhite, Harold
1996 The Dynamics of Changing Japanese Energy Consumption Patterns and their Implications for Sustainable Consumption. American Council for an Energy Efficient Economy (ACEEE) Summer Study, Human Dimensions of Energy Consumption. Washington, DC: American Council for an Energy Efficient Economy.
1998 Framing the socio-cultural context for analyzing energy consumption. *In* Bernard Giovannini and Andrea Barazini, eds. *Energy Modelling Beyond Economics and Technology*. Pp. 37-55. Centre Universitaire d'étude des problèmes de l'énergie. Geneva: University of Geneva, Universitaire d' Geneva.
2013 Energy Consumption as Cultural Practice: Implications for the Theory and Policy of Sustainable Energy Use. *In* *Cultures of Energy: Power, Practices, Technologies*. Sarah Strauss, Stephanie Rupp, and T. Love, eds. Pp. 60-72. Walnut Creek, CA: Left Coast Press.
- Wilhite, Donald A., and Roger S. Pulwarty
2005 Drought and Water Crises: Lessons Learned and the Road Ahead. *In* *Drought and Water Crises: Science, Technology, and Management Issues*. Donald A. Wilhite, ed. Pp. 389-398. Books in Soils Plants and the Environment Series, Volume 86. Boca Raton, FL: CRC Press.
- Wilk, Richard, and Harold Wilhite
1984 Household Energy Decision Making in Santa Cruz County, California. *In* *Families and Energy: Coping with Uncertainty*. Bonnie M. Morrison and Willett T. Kempton, eds. Pp. 449-59. East Lansing: Michigan State University.
1985 Why Don't People Weatherize their Homes? An Ethnographic Solution. *Energy: The International Journal*. 10(5):621-630.
- Wilcox, Ashlee Cunsolo, Sherilee L. Harper, James D. Ford, Victoria L. Edge, Karen Landman, Karen Houle, Sarah Blake, and Charlotte Wolfrey
2013 Climate Change and Mental Health: An Exploratory Case Study from Rigolet, Nunatsiavut, Canada. *Climatic Change* 121(2):255-270.
- Winther, Tanja
2008 *The Impact of Electricity: Development, Desires and Dilemmas*. New York: Berghahn Books.
- Wisner, Ben, Peter. Blaikie, Terry Cannon, and Ian Davis
2004 *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. 2nd edition. London, UK: Routledge.
- Wood, Gillen
2008 The Volcano Lover: Climate, Colonialism, and the Slave Trade in Raffles's 'History of Java'. *Journal of Early Modern Cultural Studies* 8:33-55.
2014 *Tambora: The Eruption That Changed the World*. Princeton, NJ: Princeton University Press.
- Wutich, Amber
2012 Gender, Water Scarcity, and the Management of Sustainability Tradeoffs in Cochabamba, Bolivia. *In* *Gender and Sustainability: Lessons from Asia and Latin America*. Pp 97-120. Tucson: University of Arizona Press.
- Yusoff, Kathryn and Jennifer Gabrys
2011 Climate Change and the Imagination. *Wiley Interdisciplinary Reviews: Climate Change* 2(4): 516-534.
- Zalasiewicz, Jan, Mark Williams, Alan Haywood, and Michael Ellis
2011 The Anthropocene: A New Epoch of Geological Time? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 369(1938):835-841.

Zhang, David D., Peter Brecke, Harry F. Lee, Yuan-Qing He, and Jane Zhang
2007 Global Climate Change, War, and Population Decline in Recent Human History. Proceedings of the National Academy of Sciences 104:19214-19219.

Zhang, David D., Harry F. Lee, Cong Wang, Baosheng Li, Qing Pei, Jane Zhang, and Yulun An
2011 The Causality Analysis of Climate Change and Large-Scale Human Crisis. Proceedings of the National Academy of Sciences 108:17296-17301. ■