

**UNC CHARLOTTE
AREA OF RESEARCH AND SCHOLARSHIP EXCELLENCE**

I. Cover Page

1. Area Title:

Ancient Human Responses to Climate Change

2. Participating Disciplines/Academic Units/Departments:

Disciplines: Archaeology, Climate Science, Geology, Paleoecology

Departments: Geography & Earth Sciences, Anthropology

3. Co-Leaders:

Patricia L. Fall, Department of Geography & Earth Sciences

Steven E. Falconer, Department of Anthropology

4. Area of Unique Distinction

5. Keywords: Climate Change, Deep Time, Adaptation, Societal Response

II. Executive Summary: Ancient Human Responses to Climate Change

A core team of accomplished UNC Charlotte scientists coordinates their research to explore *Ancient Human Responses to Climate Change*, thereby constituting an **Area of Unique Distinction**, as we look toward moving our university toward R1 status. This team, headed by Professors Patricia Fall (Geography & Earth Sciences) and Steve Falconer (Anthropology), investigates climate change and societal responses to explain the dramatic abandonment of the world's earliest cities. This research addresses basic social and environmental questions regarding the development of early agrarian civilizations, and the social and physical landscapes they engendered, in which modern societies continue to live. Interdisciplinary studies featuring collaboration between archaeologists, geographers, climatologists, Earth scientists, and artists **(such as this one)** are particularly well-suited to apply deep time perspectives to the study of climate change and human-environmental interaction. In this capacity, the collaborations we exemplify are unique in their ability to assess competing explanations for how and why human societies alternatively persevere or collapse in the face of major environmental challenges.

The importance of multi-disciplinary perspectives on past climate change is signaled by a special feature in the *Proceedings of the National Academy of Sciences* (2020) on Archaeology, Climate and Global Change. A lead article captures this scientific niche succinctly: “The past is a multimillennial experiment in human ecodynamics” [the interaction between social systems, climate and environment], “and, together with our transdisciplinary colleagues, archaeology is well positioned to uncover the lessons of that experiment.” **A better understanding of the interactions between human and environmental systems can “shed light on how we arrived at the present day and help us search for sustainable trajectories toward the future.” (1)**

At UNCC, we direct our group's focus to the winds of change that swept across the Mediterranean world at the dawn of civilization, when cities first emerged, dramatically collapsed and then rapidly redeveloped. The most crucial interval of environmental dynamics lies between 2200 and 1900 BCE, when the Mediterranean Basin and possibly the entire globe experienced “**the 4.2 k Event**,” an interval of sharp climate change and social upheaval named for its chronological position 4,200 years ago. In conjunction with a current revolution in radiocarbon dating, the 4.2 k Event is gaining traction as the leading paradigm for explaining the fates of ancient societies regionally and even globally. **(2)** Elucidation of ancient environmental change holds major implications for understanding how and why the earliest urban civilizations rose and collapsed, particularly in how these societies responded successfully or catastrophically. Among major human social innovations, cities and their institutions have a long history of short-term decision-making, often with unforeseen long-term consequences. Thus, studies of early civilization (literally “life in cities”) are ideal for discerning how societies have responded most effectively to past challenges, and how modern societies **must develop ever more sophisticated responses for the future. (3)**

III. Evidence of Strength and Excellence:

Through the entirety of human existence, humans have implemented myriad responses to drastically changing conditions. Scientific investigation through a wide range of disciplines documents how we, *Homo sapiens*, have exercised our ability to adapt to changing environments, often by changing those environments themselves. Recent scholarship across the disciplines of the natural and social sciences reveals that human antiquity features a variety of dramatic episodes of social resilience or collapse amid the development of ancient civilization, with emerging evidence of climate change as a major cause. Celebrated case studies range from climate change and plague as contributors to the devolution of the Western Roman Empire (4) to the drought-induced collapses of Classic Maya (5) and Egyptian (6) civilization to the pronounced impacts of the Little Ice Age on 16th-18th century European societies. (7)

Much work remains to be done, however, as attention often is focused on a single society and the precise links between climate change and human responses frequently remain to be pinpointed. To develop an increasingly sophisticated understanding of human responses to past and future stresses, we must broaden our purview and turn higher resolution scientific focus to the behaviors and institutions through which we have responded to climate change and reworked the environments around us. Our international team represents a diverse new multidisciplinary collaboration designed to compete for large-scale external grants to study these linkages, with particular attention to how human societies have responded to climate stress with varying degrees of success through the discontinuous development of human civilization. We direct our attention to the investigation of human responses to climate change at the dawn of civilization. In this capacity, our research is designed strategically to consider the intertwined courses of both climate and social dynamics over broad geographic space, cross-cutting scientific disciplines and the dimensions of both time and space.

Accordingly, our research illuminates the often-precarious relationships between agrarian societies, both ancient and modern, and their ecological settings. This approach sets the stage for current scientific and popular discussion of the significance of modern climate change informed by the scientific disciplines represented by our group, through research in the natural and social sciences grounded in deep time. **From this perspective, we can infer trajectories of change over thousands of years, discern the fates of civilizations, and contribute novel insights on climate change and social responses in the modern world derived from deep antiquity.**

Our core faculty members form a cluster of UNCC researchers that includes both established leaders (Fall, Falconer, Eppes) and rising stars (Scheff, Lai). We represent a confluence of natural and social scientists that already has a joint vision of how we will explore and communicate the myriad ways humans have responded to climate change. One major expression of the collective cohesion and collaborative success of our *Area of Unique Distinction* is our award, less than a year ago, of one of just three inaugural UNCC IGNITE Planning Grants (2020-2022). Our collaborations now extend to a total of 17 colleagues in the natural and social sciences and art in the US, Canada, Australia, Italy, Switzerland, and Israel, thereby demonstrating our aptitude for broadening our scientific agenda and aspirations. Our progress in expanding the scientific and popular reach of this project is indicative of how we have and will continue to achieve research excellence and international prominence in our chosen investigatory arena. UNC Charlotte could build on our past and current success most effectively by increasing

its paleo-horsepower through hiring Assistant Professors in paleoclimatology and/or paleoclimate modeling (e.g., who could be housed in Geography & Earth Sciences) and in human-environmental interactions (e.g., stable isotope analysis of ancient human, animal and plant remains to infer past climates and agrarian responses; potentially housed in Anthropology). These would be critical steps in building our university's ability to train Ph.D. students in increasingly high-caliber interdisciplinary research.

Our five core faculty members have published nearly 250 scientific articles and books, including high impact papers in the *Proceedings of the National Academy of Sciences* (2), *Nature Communications* (2), *Nature Climate Change*, *Nature Geoscience*, *Scientific Reports*, *Environmental Research Letters*, *Current Climate Change Reports*, *Reviews of Geophysics*, and *Molecular Biology & Evolution*. Over the past five years, we have generated over \$1.4 million in external grant funding. Our research features artistic, as well as scientific communication of our insights on the effects of climate change on human societies to both popular and professional audiences (**Fig. 1**). Scientific portraits of life and landscapes in the deep past hold special appeal for popular audiences and thereby provide particularly effective avenues for broad dissemination of the importance and implications of socio-environmental research.



Fig. 5. Middle Bronze Age community at Tell el-Hayyat, Jordan (ca. 1800 BCE), showing its Canaanite temple *in antis* and surrounding anthropogenic landscape.

Artist Gary James' depiction conveys the vibrancy of village life during the redevelopment of Levantine cities. His work provides a catalyst for discussion of environmental, agricultural and social inferences with the public and among project members and professional colleagues.

Foremost among the current and future broader impacts of our research group is the training of young female scholars. Among our main international collaborators, six are women, including three early career female professors, two of whom are of Hispanic descent. Eppes and Fall are Full Professors, and women comprise less than 15% of Full Professors in the Earth Sciences nationally. **Fall** ranks in the **top 2% of the world's most cited researchers**, among only 5 female scientists at UNC Charlotte, and the only woman from CLAS. **Eppes** (with UNC Charlotte's Russell Keanini) received the **2020 Kirk Bryan Award** from the Geological Society of America for distinguished research in geomorphology. Collectively, our group has mentored 129 undergraduate and post-graduate students to the completion of their advanced degrees. Fall and Eppes have particularly strong records of mentoring students from underrepresented groups, and Fall and Falconer have mentored 48 female students to the completion of their Ph.D. and M.A. degrees, including four Latinx scholars. Internationally, seven of our post-graduate trainees now serve as faculty, museum curators, or Department of Antiquities administrators in Jordan and Cyprus. We will continue to recruit students from underrepresented groups and provide opportunities that expand their participation in science. Broadened faculty and student contributions will enable our uniquely distinguished members to generate sophisticated insights on human responses to climate change, grounded in the past with an eye to the future.

IV. Alignment with Regional and National Priorities

National Priorities:

One of the most pronounced and celebrated changes signaled by the new Biden administration is a return to science-driven policymaking, particularly regarding how the United States will respond to the challenges of climate change. The federal government has issued an explicit **pledge to address the *Climate Change Emergency (8)***, our country is rejoining the Paris Climate Accord, President Biden has appointed a Science Advisor to be a member of his cabinet, and the White House has created a special Office on Domestic Climate Policy. In Congress, a Green New Deal is discussed as a linchpin of near future progressive legislation, and even General Motors has announced a goal of selling only zero-emission vehicles by 2035. Federal funding and administrative agencies that fund a full range of disciplines (e.g., *NSF, NEH, NASA, DOE, NIH, NOAA, USDA, USGS, US Fish and Wildlife, DOD, DOT*) have made climate change a singular target of scientific study and response. Climate Change and how we respond to it has been an issue at least since the advent of agriculture 12,000 years ago, and today arguably our response to climate change forms the foremost challenge facing modern society.

Priorities of Professional Societies and Organizations:

The American Association for the Advancement of Science (AAAS) has reaffirmed its position that ***global climate change is caused by human behavior, is a demonstrable present-day reality, and it is a growing threat to societies. (9)*** Indeed, increasingly sophisticated climate modeling suggests that climate change could be much more extreme than we realize. **(10)** Leading professional societies and national organizations in the natural and social sciences, including *The American Geophysical Union, The Geological Society of America, The American Meteorological Society, The Ecological Society of America, The American Anthropological Association and the American Society for Overseas Research* have issued statements on climate change. These demands for action are consistently grounded in deep time perspectives and call for explicit attention to the effects of climate change on social equity.

State, Regional and Local Priorities:

Governor Roy Cooper has made a special point of issuing a **Climate Science Report (11)** that calls for an unprecedented statewide ***Climate Risk Assessment and Resilience Plan***, in large part to respond to social inequities exacerbated by climate change. Detailed study of the causes and consequences of past social responses to climate change aligns clearly with the most ambitious aspects of **UNC Charlotte's** role as North Carolina's Research University. Our project dovetails further with our university's ambition to take on the biggest questions facing humanity, generate the most scientifically sophisticated insights from the past, and mold the most effective responses for the future.

V. Supporting Documents

Ancient Human Responses to Climate Change

Members for Area of Unique Distinction:

Name	Title	Contribution/Expertise Human Response to Climate Change
Eppes, Martha Cary (Missy)	Professor of Earth Sciences	Climate change as it impacts erosion, weathering and landscape evolution; documenting past climates
Falconer, Steve	Professor of Anthropology	Comparative analyses of rise and collapse of early urbanized civilizations, reconstruction of communities and social responses
Fall, Patricia (Pat)	Professor of Geography & Earth Sciences	Long-term societal responses, Human-environmental interactions
Lai, Luca	Instructor of Archaeology	Archaeology of ancient Mediterranean, stable isotope analysis of human and animal diet and environments
Scheff, Jacob (Jack)	Assistant Professor of Meteorology and Earth Sciences	Climate dynamics, the water cycle and the atmospheric circulation