BIOARCHAEOLOGY AND CLIMATE CHANGE IN THE PUBLIC REALM

Emily Katherine Parnell

Honors Thesis

Appalachian State University

Submitted to the Department of Anthropology
and The Honors College
in partial fulfillment of the requirements for the degree of

Bachelor of Science

May, 2017

Approved by:

Gwen Robbins Schug, Ph.D., Thesis Director

_____

Ellen Cowan, Ph.D., Second Reader

_____

Christina Sornito, Ph.D., Third Reader

_____

Timothy Smith, Ph.D., Departmental Honors Director

_____

Ted Zerucha, Ph.D., Interim Director, The Honors College

_____

ABSTRACT

Climate change is a topic of ongoing debate in contemporary society. As more and more people accept the reality of global climate change in the modern world, many are left wondering how they are being affected. One of the most publicized responses has been from governmental agencies and popular authors, claiming that climate change is a threat to human security and is directly correlated with incidents of violence. These claims project a pessimistic view of the future, implying that humans are subjected to "instinctual" violent tendencies by global climate change. Meanwhile, bioarchaeologists argue against this perspective, instead advancing the notion that human actions occurring during a period of climate change are based largely on pre existing social structures rather than climate itself. Bioarchaeological evidence has shown that, rather than responding violently, numerous past populations have peacefully adapted to new environments in times of climatic and environmental stress.

Still to be examined in the midst of these views, however, is the fact that bioarchaeological research is largely inaccessible to the public. Thus, this project draws attention to the necessity of developing new methods of outreach that can better inform people about the reality and future of climate change. For my purposes, this project proposes the use of educational internet videos as a valuable learning tool. My claim is that these videos have the potential to allow researchers to reach a broad audience, creating digital learning communities, and ultimately fostering a widespread, informed concern for the environment.

INTRODUCTION

Climate change is one of the most complex issues of modern society. Key to its complexity is the particular disparity in acknowledging climate change among elected leaders, non-scientists, and scientists. At this point in time the vast majority of scientists are in agreement that climate change is occurring and is strongly influenced by humans. Many governments also hold this belief, however some, like the United States government, actively present downplayed perspectives on climate change to the public, resulting in misinformation and climate change denial (Brulle & Roberts 2017). One reason that this occurs is to support the economic positions of fossil fuel and non-renewable energy corporations. Meanwhile, other components of the government actively present a perspective which acknowledges climate change; however, they do so in a way that implies that contemporary war and violence is a result of climate-induced resource scarcity and societal stress (Barnett 2007). While it is important for policy and planning experts to understand environmental implications for human life, it is difficult to predict the socio-cultural and biological impacts of global warming for human populations. This is due to the variability of environmental circumstances and human response, paired with the vastness of human cultural diversity.

Archaeological projects that examine how climate change affected past human populations can contribute knowledge about how specific populations responded to their environmental stressors, the historical and socio-cultural factors shaping those choices, and the success or failure of short-term solutions. Unfortunately, academic publications are not easily accessible to the public. In addition to expensive pay-walls,

research on this subject is often fraught with anthropological jargon and complex data analyses, making any articles that are physically accessible difficult to understand. Policy and planning professionals do not currently rely on anthropological literature as a basis for their work (Robbins Schug, Parnell, & Harrod in prep). Interdisciplinary publication might remedy the issue of planning and policy professionals ignoring anthropology (Buikstra in prep).

In addition to changing the professional discourse on human response to climate change, bioarchaeologists should work to present their research in new ways that can be directly accessed by the public. This project proposes the production of Internet videos as a means to remedy bioarchaeology's inaccessibility to the general public. The videos created for this project serve to exemplify one of the many ways in which anthropological theories and ideas can be presented in a colloquial manner, with an emphasis on the topic of climate change and violence from a perspective of human variability and resilience.

This project seeks to examine the inaccessibility of bioarchaeological literature on climate change, as compared to the widespread nature of popular publications and governmental statements on the violent future of human life in the face of global climate change. Internet videos are posited as an educational tool to convey bioarchaeological findings in order to make them more widely accessible; and are analyzed in order to understand how and for whom they are most effective. Bioarchaeological evidence of human variability in response to environmental stress is explored in a literature review, emphasizing the significance of public outreach. The

combination of these analyses should encourage greater public outreach efforts amongst bioarchaeologists, specifically through Internet videos, as a way to combat determinist ideas of human response to climate change, and to highlight human agency in working to conserve and improve the environment for future generations.

ACCESSIBILITY AND PUBLIC OUTREACH

The field of anthropology as a whole is one that is seldom directly discussed in modern society. Of course numerous topics that are studied in anthropology are debated and are unconsciously brought up in casual conversation; however many people are unfamiliar with the field and how it is relevant in modern society. It is as if the general public and anthropologists as academics exist in two separate realms that have relatively little interaction or crossover. While it can be argued that it is human nature to form different circles of interaction, as evinced by the overall concept of self versus other, it must also be recognized that interaction with a broad audience and the dispersion of information is a primary goal of all academics.

Many, if not all, academic pursuits are in some way relevant to modern society—otherwise they likely would not be conducted to begin with. The bioarchaeological study of the relationship between violence and climate change is certainly pertinent to the current global situation. If the general public is not able to access the research being conducted, however, its significance is relatively diminished.

There are typically two manners in which bioarchaeological studies are inaccessible to the public: either they are published in a journal or edited print that

requires a paid subscription, or they are so densely packed with scientific and anthropological jargon that one either has to look up countless definitions, or risk overlooking crucial information. These characteristics of academic publications are problematic when it comes to dispersing information, but justified within their own scholarly realm. In order to maintain the academic integrity of these publications, while still presenting the information in a way that is attainable to a broader audience, a new method must be devised to communicate ideas and research.

Some researchers, specifically within the field of anthropology, have begun to develop new methods of presentation and public outreach in order to make their findings more widely accessible. For instance, the 2013 discovery of *Homo naledi* (Berger, et al., 2015), while a revolutionary finding to begin with, was made even more revolutionary in its manner of publication. Led by archaeologist Lee Berger, the entire excavation process of Dinaledi Cave was documented on the Internet through blogs, Twitter and Facebook posts, and more. The presentation of *Homo naledi* and Dinaledi Cave is unique because these findings were made available online prior to any official publication or peer review process. In addition, once articles were through being subjected to the rigorous academic publication process, they were published in journals and websites that do not require subscriptions or payments, making them accessible to anyone. The combination of use of social media, free academic articles, and the sheer significance of the findings, has led *Homo naledi* to be one of the most widely discussed anthropological topics in the twenty-first century.

The Internet in general is an incredible medium through which anthropology is

made accessible to the world. Social media platforms like Facebook offer a variety of ways to present information. One option is to create specific groups visible only to those accepted as members, such as the Bioanthropology News group. Groups are beneficial because they allow members with similar interests to communicate with one another and share their praises and critiques of the latest anthropological findings. Similarly, Facebook allows users to create "pages" related to specific topics or organizations. For example, there is a page entitled "Powered by Osteons-by Kristina Killgrove" based off of a Forbes blog of the same name (www.poweredbyosteons.org). This particular Facebook page and blog summarizes recent anthropological research in a way that is interesting and understandable, and also provides links to similar sources of critiques and commentaries on anthropological topics. Pages are open, meaning their content can be viewed and shared by anyone. This format makes individual discussions slightly more difficult, but it does make information more widely accessible.

The world is currently living in a digital age. Information and media is constantly at our fingertips. It is only logical for scholars to attempt to capitalize on this Internet driven, instant-gratification mentality. By producing short, entertaining, free, and colloquial videos, bioarchaeologists and other academics can at the very least take a step in the direction of engaging the public in their research and conveying the contemporary significance of their findings.

Video as an Educational Tool

If a bioarchaeologist or other researcher would like to create videos to represent their work, they must have a thorough understanding of the target audience. Important questions to ask when tailoring a topic to a broad audience include: how is modern media consumed? What is the average amount of time that an individual will spend watching an educational video? Are animated, or live-action videos preferred? And, what issues to people care about in modern society?

These questions are best answered through the perspective of "digital storytelling" (Dreon, Kerper, Landis 2011). Digital storytelling, according to educational technology professors Oliver Dreon and Jon Landis, as well as children's literature professor Richard Kerper, is "the art of combining narrative with digital media…to create a short story." Educators created this concept in an attempt to better connect with and teach students who have grown up with easy access to technology, also known as "digital natives." The creators of digital storytelling emphasize the significance of ethos within a storytelling project, as students tend to express greater interest in narratives that utilize comedic tone, or focus on subjects that students can relate to (Dreon, Kerper, Landis 2011; Johnston 2015).

While Internet videos can be useful tools in a wide array of settings, for the purposes of this project the target audience consists of teens and adults outside of a classroom or lecture-style context; individuals who likely have never heard of the field of bioarchaeology, but enjoying attaining knowledge from forms of mass media such as podcasts and internet videos. The choice to cater the videos to this particular audience

was partly inspired by the popularity of other Internet videos amongst a similar demographic.

In 2012, John Green of CrashCourse gave a TEDtalk entitled "The nerd's guide to learning everything online." The presentation focuses primarily on the love of learning that is inherent to humans, but is especially apparent in millennials (individuals born between the early 1980s and the late 1990s). Green argues that Internet videos and channels that aim to educate are capable of creating learning communities composed of the viewers. In this way, educational videos can function as a pseudo-classroom; the viewers are able to leave questions and comments regarding the topic covered in the video, to which other viewers and/or the creators of the video may reply. This leads to the exchange of knowledge that can resemble the historic Socratic seminar.

This concept of Internet videos creating and sustaining communities is revolutionary in education. Many school systems in the United States cannot afford to offer full courses on topics such as astronomy, anatomy, or ecology. Even schools that are able to "cover" these topics may only do so in a brief section of a much broader course. Students who are interested in these less frequently taught subjects can now attend a virtual classroom on their own time.

Educational videos are also an excellent tool for study and review, as they often explain the most important content in a short period of time; this allows students to watch and hone in on the information they need, rather than sifting through lengthy material at the risk of not finding or retaining the answer to their initial question. This is not to discredit traditional methods of teaching and studying. It has been shown

countless times that hand-written note taking and the use of textbooks as sources of information are useful, and possibly even necessary in students' accumulation of information (Oppenheimer & Mueller 2014). Educational videos and digital storytelling are best implemented as additional resources alongside the traditional ones rather than replacements.

Several individuals have recognized that significance of reaching a broad audience through Internet sharing and accessibility. Academics, entertainers, and teachers have begun to create short, entertaining, educational videos that can be accessed for free through popular websites like Youtube. They create channels through which their videos are dispersed, and they gain subscribers and followers, ultimately creating a network of information sharing. Some of the most popular channels include CrashCourse, Khan Academy, and TEDtalks. There are many more, but these three channels in particular will be investigated in order to understand the format of their videos and what makes them successful.

One of the most popular educational YouTube channels at the moment is CrashCourse. This channel is created and maintained by the Green brothers, Hank Green who is a scientist, and John Green, a young adult fiction author. CrashCourse is broken down into many playlists based on subject. There is CrashCourse History, Philosophy, Biology, Chemistry, and more; each playlist having a minimum of seven videos, some with as many as forty-seven. The videos utilize a combination of live-action focus on the Green brothers, and relatively simplistic seeming animation to illustrate the key points of the video lecture.

In addition to the immense success of the original CrashCourse channel, several offshoot channels have been created targeted towards other audiences. These include CrashCourse Kids, SciShow, Thought Café, and Sexplanations.

The script writers implement a very colloquial language in all their videos, and rely heavily on the use of similes, comparing the topic at hand to easy-to-understand common objects and concepts. While this style of language and presentation is not for everyone, it has been very successful in reaching young audiences, hopefully positively impacting their academic careers.

CrashCourse and related videos are not intended to replace traditional classroom education, rather serve as a supplement, introduction to academic topics, or study/review tool.

Khan Academy is another successful informative video series. The format is somewhat less eclectic than that of CrashCourse, but the information provided is equally invaluable. Khan Academy videos typically utilize a type of animation that represents an interactive blackboard. For example, videos created to assist with learning principles of math or chemistry demonstrate how problems can be solved using color coding to visually show how certain elements or numbers interact, alongside a voiceover explaining every step of the process.

In addition to the lesson-based videos, Khan Academy offers multiple choice and fill-in-the-blank review questions, similar to what would be seen on an Advanced Placement test in high school, covering the material discussed in the video. This feature makes the resource more interactive and allows participants to test their knowledge on

the material, honing in on applied skills, memorization, and concentration throughout the video lesson.

Khan Academy is a more traditional lesson-based resource than CrashCourse and TEDtalks, possibly increasing its appeal to parents and teachers wanting to encourage supplemental learning and subject review outside the classroom.

On a scale of formality, CrashCourse lies at the more colloquial end, and Khan Academy is on the more formal and traditional end. Somewhere in the middle is TEDtalks. TEDtalks is a well-known source of information on a wide variety of topics. Unlike CrashCourse and Khan Academy, TEDtalks was not created as an Internet resource; rather it began as a conference on technology, entertainment, and design. Keeping true to its roots, TEDtalk videos and podcasts are recordings of presentations from conferences around the world, dealing with any number of topics. Presenters featured in TEDtalks range from doctoral professors, to high school students. As long as an individual has an idea to share, they can be considered to present at a TED conference. This diversity allows for broader audiences to relate to a given topic. Some presentations are conducted at an advanced academic level, but most are much more colloquial, allowing audiences to learn about practically any subject with or without prior knowledge.

Due to the success of the original TEDtalk format, the organization has also extended its process to include animated videos. Scripts for videos are submitted by experts on the topic, and then revised in collaboration with members of the TED team. In-house graphic designers then create animations to accompany the script.

The animation used in CrashCourse and TED videos, along with the style and syntax of the CrashCourse, TED, and Khan Academy video series, inspired the format of the videos created for this project. The first step in producing this style of educational video was to access a program to assist in animation.

In order to create videos to be posted online, the creator must be familiar with a fairly wide array of technological tools and applications. Luckily, there are several programs online available to assist in video composition, including the one utilized for the Bioarchaeology and Climate Change series, GoAnimate. GoAnimate is a downloadable application to which users must pay to subscribe. Once an account is created, the user can compile images, voice-overs, and music into a smooth, complete video. The "camera-focus" and length of time that certain images appear on screen can be adjusted in order to animate the composition and align it with the sound. One of the defining characteristics of GoAnimate is its animation style. The application provides an extensive set of pre-designed, animated characters, including some based on celebrities and politicians, which can be included in the video and made to move in certain ways or complete certain actions, and express certain emotions.

GoAnimate also provides numerous background templates, including a variety of ecological scenes, as well as presentation-style backgrounds that include preformatted text-boxes. In addition to adding characters to these scenes, the video maker can add "props" such as plants, animals, and material objects that can serve as further detail in the background, or can be manipulated by one of the characters. These features are incredibly useful in composing a seamless video.

The videos are written and designed to be viewed as part of a series. The first three videos serve as introductory sources to the field of bioarchaeology and the study of climate change, targeted towards audiences who may have never heard of bioarchaeology, and may be misinformed about the process and implications of climate change.

Following the introduction, videos are structured around a summarized version of articles regarding a particular civilization that experienced a period of climate change. They are arranged chronologically, beginning in the Early Holocene and going up to the Anthropocene. They closely examine case studies relevant to the time period presented in order to see how different societies at different times responded to climate change. Multiple studies on the same civilization are compiled in order to create a "big picture" understanding of the research that can be conveyed to the public through free Internet videos. While the video scripts included in this project only discuss Early and Middle Holocene Old World populations, the format lends itself to a continued chronological series, possibly being made more specific through regional foci[1].

As the majority of the videos proposed in this project are based on previously published bioarchaeological research, any number of videos could potentially be added to the series, expanding the audience of bioarchaeology and allowing for continued public outreach. Long term educational projects such as this can make bioarchaeology more widely accessible, encouraging an adoption of critical worldviews that can help humans to understand our modern world and our role as a part of it.

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[1] Video scripts are included in the Appendix.

PRESENTATION OF CLIMATE CHANGE IN THE MODERN WORLD

While most bioarchaeologists and paleoclimate researchers are thoroughly analyzing how past humans responded to climate change given their unique sociocultural situations, governmental policy-makers are publishing deterministic information claiming that modern climate change poses a threat to "human security" (Robbins Schug, Parnell, & Harrod in prep). This is incredibly problematic because it ultimately reflects an antiquated ideology that humans are inherently violent, denying the ability of humans to choose not to act violently, to choose to cooperate with one another, and to use ingenuity to find new ways to peacefully adapt to their changing environments. While climate change can, and likely will, have disastrous effects on the global environment, it is important for the public to be aware of their own power to overcome and incite positive change. By making bioarchaeological research more accessible to the public, people will be able to develop a more nuanced view of human response to climate change that, rather than depressing them and making them fearful of the environment and other communities, will inspire them to make a change for the better.

In order for the public to recognize the utility of bioarchaeological research in relation to climate change, they must first be made aware of the issues that encompass modern literature on climate change and human response.

The world has recently entered a new epoch known as the Anthropocene. Previous epochs have been based on climatic or ecological events that have significantly impacted the world. This one is based on a single species, *Homo sapiens*, that has

affected the planet in such a way that it is now considered distinct from any other time since its formation.

The starting date of the Anthropocene is still under debate (Walker et al. 2012); as such, human response to climate change from the nineteenth century on will be analyzed in this section, acknowledging that some of the specific examples may technically have occurred during the Late Holocene.

When examining case studies of anthropocene human responses to climate change, a disturbing pattern starts to arise. Most research on violence and climate change in the modern area that is accessible online is centered on regions that already experience stigmatization from western perspectives. This trend, while surely unintentional, reflects historical biases influenced by racism and colonialism.

Numerous studies have been conducted on how African populations have responded to climate change in recent decades, many of which claim that wars and other conflicts across the continent are attributable to the stresses of climate change (Brown, Hammill, & McLeman 2007; Shackleton et al. 2015). These examples, like much of human security literature, are based on deterministic ideologies that ignore human interaction and agency in favor of focusing solely on how the environment influences human life. In addition, these studies essentialize African communities by overlooking their unique histories and cultures in order to categorize them all as one: African.

Luckily, many researchers do recognize the nuanced methods with which human response to climate change must be viewed (Buhaug 2010; Theisen & Verhoeven 2011). This includes studying specific regions or populations of Africa rather than the

continent as a homogeneous entity.

The Middle East is another region that has been subject to significant stigmatization in recent history, and today is known as a hotbed of international conflict. One specific country experiencing seemingly endless turmoil is Syria. One hypothesis posited in the popular news source The New York Times is that this conflict is linked to a climate change-induced drought (Fountain 2015). As the article is from a popular newspaper, it doesn't have many references and the author is not an expert in anthropology or related fields; however, the article is significant because it is widely accessible by the public, creating a perception of direct social effects climate change can have on modern society. Articles like this one are deceptive. They convincingly attribute violence to climate change, while skirting around governmental and overall cultural complexities that may be more influential on the prevalence of violent acts.

Shockingly few case studies have been conducted pertaining to human response to climate change in westernized, first-world countries. There are, however, publications that focus on global commonalities and how they may respond to climate change. For example, several studies have been conducted claiming that urban centers and people living in poverty will be more strongly affected by climate change than those of better financial means living in suburban areas (Anderson 2001; Barnett 2007; Bartlett 2008; Hardoy & Pandiella 2009; Mares & Moffett 2015). Public policy and planning researchers also often cite declines in global health as a future outcome of climate change, describing increases in famine, respiratory diseases, heat stress, and water-borne diseases resulting from decreased resource availability and urban

crowding (Bartlett 2008; Bowles, Butler, & Friel 2014). These events are not impossible, but may still be prevented through positive human action.

The largely deterministic views posited within this Anthropocene climate research, combined with the interestingly specific regional foci of the studies, casts a highly pessimistic cloud over the future of Earth and humanity.

BIOARCHAEOLOGY AND CLIMATE CHANGE LITERATURE REVIEW

An argument amongst authors of popular literature related to climate change is that changes in climate will result in increased interpersonal violence (Diamond 2005; Pinker 2011). Some academics also take this stance, believing that there are direct cause and effect scenarios involving climate change and human response, suggesting that climate change results in a scarcity of resources, leading to an increased prevalence of aggression and irritability, higher frequencies of violent tendencies, and increased rates of civil unrest (Anderson 2011; Barnett 2007; Brown, Hammill, & McLeman 2007). Publications such as these have spurred governmental reactions and analysis of climate change as a threat to security (Barnett 2007; Brown, Hammill, & McLeman 2007; Detraz & Betsill 2009; Mason 2013; O'Sullivan 2015).

While climate change is a pressing issue, these publications seem to cherry-pick their evidence in order to demonstrate the most drastic results of climate change on human life. This process eliminates potential analyses of civilization that experienced climatic changes that managed to thrive and adapt to their new environments. Additionally, these doomsday descriptions often misinterpret, or even ignore historical

and archaeological evidence that indicates that while a society may have "collapsed," it was not necessarily due entirely to climate change. Such an interpretation falls back onto determinist theoretical views, in which human agency is denied or ignored.

In order to accurately create an argument regarding human response to climate change, an interdisciplinary analysis of academic literature must be conducted, making note of variability in response and prior socioecological conditions. Many studies have been conducted globally, with foci on various time periods, in order to study how specific shifts in climate impacted the lifestyles and social interactions of human populations. The following section serves to analyze some of these studies chronologically, in search of a conclusion as to whether or not climate change leads to higher rates of interpersonal violence.

Pleistocene

The Pleistocene Epoch, spanning from approximately two million to twelve thousand years ago (Walker et al. 2012), was a time of significant climatic and biological change. It was during this time that anatomically modern humans first made their appearance in Africa and began their dispersal throughout Europe and Asia and, towards the end of the epoch, into the western hemisphere.

Climate change in the late Pleistocene significantly impacted human life, particularly in regard to population size and migration. Ice core samples indicate that approximately 75,000 years ago there was an explosive volcanic eruption in Indonesia, large enough that ash remained within the stratosphere for years (Behringer 2010).

The accumulation of ash would have caused global cooling, and impacting plant growth and therefore the entire food chain. Changing temperatures also resulted in changing ecosystems. These environmental pressures would have forced humans to either adapt to their shifting environments, relocate, or die. Paleoanthropologists predict that all three of these responses took place.

Paleoanthropological evidence indicates that there was a decrease in *Homo sapiens* populations around the same time as this volcanic eruption and its resulting consequences (Behringer 2010), indicating the severity of the event on the survival of the species. *Homo sapiens* proved to be resilient, however, and found new ways to survive in the face of the turbulent climate that ensued. Archaeological evidence shows that modern humans began to migrate out of Africa, into Europe and Asia, and eventually into the Americas during the Upper Paleolithic (Burroughs 2005). A popular theory is that migration was closely related to climate. For example, glaciation would have lowered sea levels, forming a land bridge connecting Asia and America which humans would have been able to walk across. If this hypothesis is presumed to be true, it could be argued that the Americas became inhabited when they did as an ecological result of and sociological response to climate change.

At the end of the Ice Age, around 14,500 years ago, Earth experienced a steady warming period, resulting in improved conditions for plant and animal life (Behringer 2010; Burroughs 2005). This period was followed by approximately three thousand years of fluctuating temperatures ranging from glacial cool periods, to warmer periods that eventually became more stable, allowing for the transition to the Holocene epoch

(Burroughs 2005).

It can be argued that during this time *Homo sapiens* began to flourish, becoming more culturally recognizable as "human." During the late Pleistocene these early humans began creating material cultures, in which physical objects represented thoughts or concepts. This is often seen archaeologically in the form of cave art, beads, figurines, and other "non-utilitarian" objects and aspects of design (D'Errico et al. 2016; Henshilwood & Niekerk 2016).

Prior to the birth of agriculture in the Holocene, human were rarely sedentary, and practiced lifestyles of hunting and gathering or pastoralism. It is hypothesized that Pleistocene hunter-gatherer communities were predominantly egalitarian in nature (Cashdan 1980). The combination of a lack of clear inequality and a mobile lifestyle suggests that violence likely would have been less prevalent. So while the Pleistocene was experiencing significant climate change, human populations may have been adapting to their shifting environments by moving to a new location rather than striking out against one another with violence.

Early Holocene-Old World

The Holocene began approximately 12,000 years ago (Walker et al. 2012). This new epoch is differentiated from the Pleistocene by marking the end of the glacial period (Walker et al. 2012). Warming temperatures created in environments that, upon interaction with human populations, became suitable for agricultural practices. Agriculture appeared in the Old World earlier than in the New World likely due to

environmental conditions including the species of wild plants and animals available that were able to be domesticated.

Çatalhöyük, located in present-day Turkey, is one of the most impressive known early Holocene towns. Based on isotopic analyses, researchers predict that Çatalhöyük was occupied from approximately 9.3 to 8.2 thousand years ago (Burroughs 2005). As an agricultural community, the population of Çatalhöyük depended upon reliable sources of food and water within the region. Bioarchaeologists have discovered that while Çatalhöyük certainly had the resources necessary to flourish, it may not have been situated in the most ecologically efficient location, indicating that perhaps site preference was influenced by sociocultural factors not related to subsistence (Rosen & Roberts 2014). It is possible that Çatalhöyük was established due to geographic ties to spirituality, convenience of trade and travel, or proximity of non-agricultural dietary staples (Rosen & Roberts 2014).

Around 8,200 years ago we see evidence of cooling temperatures and increasing aridity in the Middle East (Asouti 2009). Around this same time the population of Çatalhöyük declined significantly (Burroughs 2005). Many researchers have hypothesized that the population decline is directly correlated with the climatic event of 8.2 kya. It is possible however, that the two occurrences are more coincidental. Paleo-environmental reconstructions show that the 8.2 kya climatic event varied greatly by geographic area, and was relatively short in duration (Asouti 2009). Knowing this, researchers should use caution when labeling climate change a primary factor in the “collapse” of Çatalhöyük.

The bioarchaeological research at Çatalhöyük pertaining to climate change is significant on a larger scale in that it reflects the nuanced perspective that must be taken when examining human response to their environments. This particular population likely did not "collapse" due strictly to climate change. To say so is to aggrandize the impact of a relatively minor climatic event, as well as overlook human agency. It is possible that Çatalhöyük was depopulated as a response to human-based environmental degradation, such as alluvial sedimentation and decreased rates of tree colonization (Rosen and Roberts 2014).

Humans have been altering their landscapes for thousands of years, often in ways that are harmful to the survival of their own communities. In the face of modern climate change and changing ecosystems, we must examine ways that humans alter the landscape, and determine how we can do so in a way that will benefit future generations.

Early Holocene-New World

There have been few bioarchaeological studies conducted regarding the implications of climate change on humans living in the New World during the early Holocene. No publications were found for this literature review that discussed human interaction with the environment based on this time period and geographic specification. This could be due, in part, to poor preservation, possibly related to shifting sea levels that may have submerged any evidence of human settlement (Erlandson & Braje 2011). Paleoclimatological studies, however, are ongoing (Briner et

al. 2016; Kaufman et al. 2016). The information gained from these studies can provide bioarchaeologists with the background knowledge of past climate, allowing them to make hypotheses regarding how humans lived and may have responded to specific shifts in the environment.

Middle Holocene-Old World

The Middle Holocene began approximately 8,000 years before present, and is commonly distinguished from the early Holocene by a global cooling event that took place 8.2 kya—the same time, and possibly same climatic event, that may have impacted Çatalhöyük (Asouti 2009; Walker et al. 2012).

Paleoclimatological research has shown that during the third millennium B.C. climate in the Arabian Peninsula became much more arid. Bioarchaeologists have argued that this climatic change led to shifts in sociocultural practices, in some cases significant enough to redefine societies. For example, prior to the aridification during the third millennium B.C., a civilization known as Umm an-Nar resided in the area that is present day Oman (Gregoricka 2014). Umm an-Nar is one of the largest known Bronze Age civilizations on the Arabian Gulf. It was likely a significant trade post in ancient Mesopotamia for resources like copper and diorite (Settlement and Cementery of Umm an-Nar Island).

Bioarchaeological evidence suggests that during the period of climate change, the community adopted a more mobile lifestyle, altered their mortuary practices, and experienced a collapse in trade relations (Gregoricka 2014). Following this transitory

period, a new society is established known as the Wadi Suq (Gregoricka 2014). Comparative isotopic analyses of the two populations shows that the Umm an-Nar people were not replaced by newcomers in the region, rather there was continuity between the two groups (Gregoricka 2014).

Gregoricka's research on the Umm an-Nar and Wadi Suq is significant because it demonstrates how one society can adapt to its shifting environment to become another. This counters the argument for societal collapse in the face of environmental stress. In this particular study, it also refutes the concept of a violent transition of power and identity, as the Wadi Suq likely developed from the Umm an-Nar. This study as a whole highlights an excellent example of human resilience and adaptability.

The period of aridification experienced in the Arabian Peninsula was by no means the only example of climate change during the Middle Holocene in the Old World. Around 4000 years ago western Japan experienced a period of climate cooling. During this time there was a gradual population increase thought to be related to increased human migration (Kusaka, Nakano, Morita, & Nakatsukasa 2012). Researchers tested this hypothesis by comparing the presence or absence of tooth ablation, a ritual practice, between early and late populations in this area to predict whether or not ablation is a distinguishing feature of locals versus immigrants (Kusaka, Nakano, Morita, & Nakatsukasa 2012). Additionally, strontium isotopic analyses were run on human skeletal materials from both periods to look for indicators of immigration (Kusaka, Nakano, Morita, & Nakatsukasa 2012).

The results of this study did not reveal a statistically significant change in

immigration levels during the period of climatic change. Kusaka et. al. state that there may, in fact, have been immigration, just in areas with similar strontium signatures. It is also possible that the population adapted to its changing environment through new dietary and sociocultural practices. While the hypothesis in this case was rejected, it creates important questions both within bioarchaeology, and within research on modern responses to climate change.

Similar studies have been conducted in other regions regarding the impact of climate change on human migratory patterns (Stojanowski & Knudson 2014). Unlike the Japanese study led by Kusaka, Stojanowski and Knudson's 2014 research on Saharan populations does support the hypothesis that one response to climate change was increased human mobility. These two studies have very similar methods and goals, but reached different conclusions. This exemplifies the variability of human response to external stimuli, once again providing reason to apply critical analysis towards modern proclamations of the effects that climate change will inevitably have on human life.

Middle Holocene-New World

Middle Holocene climate changes in the New World are typically characterized by changes in patterns of precipitation rather than temperature. Changes in precipitation can alter river and lake levels, as well as soil moisture and acidity. The combination of these consequences leads to changes in local flora and fauna, ultimately affecting human subsistence and cultural practices (Sandweiss et al. 2006). Sandweiss et al. examine this perspective on climate change in the context of the Central Andes,

acknowledging that changes in human behavior are typically multi-causal, and should not be attributed entirely to climate response.

As with the New World early Holocene research, there are few studies that actually combine the studies of past civilizations with that of past climate change. More research needs to be conducted with this goal in mind in order to create a more comprehensive view of how different societies experienced and interacted with their environments at different points throughout human history. It is encouraging, at least, to see the few publications there are on the matter emphasizing the importance of taking human agency and culture into consideration when analyzing changing societal identities and behaviors.

Late Holocene-Old World

The Middle Holocene is hypothesized to have transitioned to the Late Holocene around 4.2 kya due to a widespread aridification event (Walker et al. 2012).

The Indus civilization is an area that is commonly used to research and explain human response to climate change during the Late Holocene. Specifically, the city of Harappa within the Indus civilization is useful in this endeavor. Harappa existed predominantly between the second and third millennia B.C.E., known for its complex urbanization and trade networks (Wright 2010). The climatic event experienced by Harappans was likely related to a weakened monsoon system, which would have rapidly altered the environment (Robbins Schug et al. 2013). Authors such as Jared Diamond have argued that this shift in environment was the catalyst for the “collapse”

of Harappa (Diamond 2005). These claims, however, fail to acknowledge bioarchaeological research on the dissolve of Harappan civilization, ultimately ignoring archaeological evidence that explains the reality of Harappa, in favor of unfounded ideas that climate change is at the root of all societal issues.

While Jared Diamond theorizes the collapse of Harappan society was a result of climate change, bioarchaeology tells a different story. Human skeletal remains from Harappa have been examined for evidence of infectious disease, traumatic injuries, evidence of migration, mortuary treatment, and more in order to create a more complete image of Harappan life (Robbins Schug et al. 2013; Robbins Schug & Goldman 2014; Robbins Schug 2016). Robbins Schug found many of these characteristics to be closely tied to identity and related social complexities that are based more largely on the structuralization of the urban city rather than on transitional environments.

Late Holocene- New World

Extensive bioarchaeological and paleoclimatological research has been conducted regarding late Holocene period populations in the New World.

An excellent example of human response to climate change comes from the prehistoric population of San Pedro de Atacama in Chile (Torres-Rouff, Costa-Junqueira, & Llagostera 2005; Torres-Rouff, Junqueira 2006). This population experienced a variety of climatic events, most notably a period of severe drought, resulting in a depletion of resources used by the local Tiwanaku society. Bioarchaeological research has identified increased frequencies of cranial lesions during this time period, thought

to be associated with interpersonal violence. The archaeological record also shows an increased prevalence of fortified sites, accompanied by decreased evidence of material culture at this time, supporting the theory that populations may be allocating resources to defense and survival in ways they had not previously (Torres-Rouff, Costa-Junqueira, & Llagostera 2005; Torres-Rouff, Junqueira 2006).

Torres-Rouff and Junqueira argue that evidence of environmental stress and an increased prevalence of indicators of interpersonal violence in the Atacama Desert support the claim that climate change can result in violence. While the correlation does seem to be very strong, it is important to look at the progression of social structures within and around the community to see if there are signs of increased levels of violence prior to the shift in climate.

The San Pedro de Atacama population also, however, experienced periods of immense prosperity, characterized by plentiful resource availability and notable population growth (Torres Rouff, Junqueira 2006). As indicated in other civilizations that experienced similar patterns of growth and decline, such as Harappa, it is important to note that factors such as population growth and increased social stratification and poverty are also important catalysts of interpersonal violence. It is possible that the increasing pressures on the society of San Pedro de Atacama were merely exacerbated by the dramatic shift in climate and resource availability. In other words, interpersonal violence in San Pedro de Atacama is affected by a combination of cultural and environmental factors.

Further research has been conducted in the Atacama Desert and other regions

the western americas during this time period; also supporting the hypothesis that climate change may have been a contributing catalyst for increased rates of interpersonal violence (Gamble 2007; Gordon 2015; Gumerman 1988; Harrod & Martin 2014; Standen, Arriaza, Santoro, Romero, & Rothhammer 2010).

Late holocene populations further north were also experiencing the stress of changing climates and environments. In the 13th and 14th centuries the American Southwest experienced an increase in interpersonal and intergroup violence resulting from a shift in socio-political structure, which bioarchaeologists suggest arose due to climate change (Baustian, Harrod, Osterholtz, & Martin 2012). In this particular study, the researchers examined a sample of 187 human skeletons to determine what type of traumatic injuries were sustained, whether the injuries were lethal or nonlethal, and whether there were patterns of injury based on sex or age. The authors were specifically interested in non-lethal cranial depression fractures. They found that in the Grasshopper Pueblo men and women were equally likely to sustain non-lethal CDFs. The authors concluded that the high prevalence of CDFs resulted either from increased interpersonal violence as the population grew and resources became more scarce, or from intergroup violence in which other groups attacked the Grasshopper Pueblo, likely due to a lack of resources resulting from changing climate and environment (Baustian, Harrod, Osterholtz, & Martin 2012).

When studying violence in any society it is important to investigate who is inflicting the act of violence and upon whom. One way to research this is by looking at raiding practices. Raiding was a common practice in late Holocene New World

populations, therefore it can provide significant insights into acts of violence, and possibly reflect environmental and climatic stressors. In the article, "Beaten Down and Worked to the Bone: Bioarchaeological Investigations of Women and Violence in the Ancient Southwest," researchers examine patterns of traumatic injuries, as well as demographic patterns of individuals targeted for acts of violence, and how the combination of these patterns can reveal gender roles and identities within raiding societies. Specific focus is placed on nonlethal traumas to the crania, mortuary status, and entheseal changes. Based on this research, it was determined that within the one South American population, La Plata, there were two primary groups of women. One group consisted of local women. These individuals experienced a lower frequency of cranial trauma, typically received standard burials, and did not express significant entheseal changes associated with strenuous labor. The second group consisted of women who were likely obtained from raids. These women had cranial trauma, irregular burials, and entheseal changes that suggest the endurance of hard labor over a long period of time. The researchers hypothesize that the local women may have been able to maintain their own quality of life by supporting the structural and physical violence inflicted upon the women obtained during raids. While this article does not specifically deal with climate change, one could question the reasoning behind raiding in the first place. Was it due to a lack of resources? If so, could that indicate that climate influenced raiding practices, thus indirectly affecting the structural violence seen within the La Plata population?

In the analysis of previous studies emphasis has been placed on combating the

essentialist ideology that there is a direct correlation between climate change and levels of interpersonal violence. While this concept is far too simplistic, it is not totally without warrant. Bioarchaeological studies of regions like the Atacama Desert, Grasshopper Pueblo, and La Plata civilization demonstrate that, under certain sociocultural constraints, climate change can contribute to an increase in violence. This type of information has been made public, leading to great concern for governmental planners and policy makers.

CONCLUSION

As the Earth experiences shifting climates and resulting environmental changes in the coming years, it is important for the public to be made aware of the reality of climate change. Governmental agencies have been proclaiming that climate change is a "threat to human security." This is often the public's only source of information on climate, and it conveys the perspective that the human race is doomed to a future of violence and disease. Bioarchaeological literature shows in many cases, however, that humans are incredibly resilient and adaptable. While the rapid climate change we are experiencing is concerning on a number of levels, it is not reason to believe that we must all resort to violence in order to survive.

Bioarchaeological studies demonstrating how past populations survived environmental stressors provide hope and inspiration for modern societies to develop ways to withstand the inevitable climate change, and help prevent further climatic and environmental stress. However, bioarchaeological research is typically inaccessible to

the public. Educational internet videos are an excellent way to spread information, as evinced by resources like CrashCourse, Khan Academy, and TEDtalks. The creation of a video series pertaining to bioarchaeology and climate change could similarly reach a wide audience, conveying accurate information about the reality of climate change and the power humans have to survive and improve the world for future generations.

APPENDIX

Video Script #1

Bioarchaeology and Climate Change 101

Hi! And welcome to Bioarchaeology and Climate Change 101.

If you are someone who pays any attention to the news or modern media, you might be under the impression that the apocalypse is just around the corner. There is war, depletion of natural resources, global warming, and frequent natural disasters. Things are looking pretty bleak. But how are all of these issues related, and what can we do to fix them?

There is no simple answer, but a big step on the right track would be to look to the past. Bioarchaeology, as defined by Dr. Jane Buikstra in 1977, is the multidisciplinary research program addressing questions of burial, social organization, behavior and activities, paleodemography, population interaction, diet, and disease.

One of the most interesting ways bioarchaeologists can learn about the past is by examining human skeletal remains. Depending on environmental conditions, bones can be preserved for thousands of years, allowing a personal insight into past life. Bones can have numerous features that are helpful in the study of the past, including evidence of fractures, diseases, cultural practices, and nutrition. Combining these indicators with archaeological and historical methods of research can allow anthropologists to create an image of what life was like within a specific community.

You might be thinking, “sure that’s pretty cool, but how can studying the past help us today?”

The video series Bioarchaeology Speaks aims to answer this question and more! Over the course of these videos we will investigate specific populations throughout history and prehistory that experienced significant periods of climate change, focusing on how each population responded to its environment and why. Examining how past populations responded to climate change and other environmental stressors does, in fact, allow us to gain a better perspective on modern issues. The earth is experiencing rapidly changing climate, and a steady growth in population that in some ways reflects ancient past civilization. When making comparisons between the past and present, however, we have to remember to incorporate any relevant variables into the study our archaeological investigations of climate change, including the implications of social inequality, colonialism, capitalism, social structure, and more. Through these methods we can recognize both the similarities and differences between those populations and modern ones, creating a better understanding of our own socioecological situation, and giving us further insight into the lives and resilience of past populations.

Video Script #2

Bioarchaeology and Climate Change 102: What is Climate Change?

Hi! And welcome to Bioarchaeology and Climate Change 102. Like global

temperatures, the topic of climate change has been increasingly hot in politics and the media for the past few decades. But what exactly IS climate change? We'll start by saying what climate change is NOT. Climate change is not a concept "created by and for the Chinese in order to make U.S. manufacturing non-competitive." Sorry President Trump, climate change is real. And it is affecting our environment in a very real way.

According to the Intergovernmental Panel on Climate Change, climate change "refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity."

Let's break that down. First thing's first: climate. Climate is actually different from weather, which varies day-by-day, or even hour-by-hour. Climate is the average of weather conditions in a specific area over a long period of time. So we could say that the climate of Antarctica is cold and icy, characterized by lots of snow and ice.

Or could we?

Research has shown that the climate of Antarctica is changing. While it is still cold, over the past few decades it has become warmer and has begun to lose its characteristic ice and snow.

As previously mentioned, climate IS changing worldwide, including in

Antarctica. But how? And why? What evidence is there that we should worry? Climate change does happen naturally to a certain extent, but humans have exponentially influenced the rate at which it occurs and the degree of change experienced.

Earth's atmosphere is composed of several types of greenhouse gases that prevent infrared radiation from escaping the atmosphere, warming the Earth. The most influential greenhouse gas is our friend carbon dioxide. Carbon dioxide enters the atmosphere naturally as a result of decomposition, respiration, and ocean emissions. Humans significantly increase the amount of CO_2 in the atmosphere through deforestation, the burning of fossil fuels, cement manufacturing, and the use of electricity. Carbon dioxide is one of the longest lasting compounds in the atmosphere, meaning that it has a high warming potential. Any amount of CO_2 emitted will remain in the atmosphere for thousands of years. If increased amounts are released, there is an increased concentration of CO_2 in the atmosphere, increasing Earth's average temperatures. By this logic, scientists can determine that if CO_2 emissions continue at the rate they are now, temperatures will continue to rise throughout the foreseeable future.

As greenhouse gas concentrations increase and temperatures rise, a ton of different ecological responses can occur. As polar ice caps melt, sea levels rise and the acidity of the water can change, affecting marine life. Ocean temperatures will also change due to the influx of cold water from the melting

glaciers. This can alter the temperature of major currents that are necessary for warming parts of the world like Europe. Other factors include changes in levels of precipitation, increased prevalence of social inequality, pathogens, parasites, and diseases, all of which could influence human health, culture, and social interactions.

Aside from using logic and statistical calculations to predict the effects of climate change on humans, scientists can study how past populations responded to climate change that they experienced. This provides a model so that we can hopefully avoid making some of the mistakes that past societies made, or we can be inspired by whatever they did to ensure their survival and quality of life.

So how do we study climate change in the past?

The most direct way of observing climate in the past is through the analysis of ice core samples. The way this works is basically a big, hollow, straw-like, metal cylinder is drilled through a glacier or other body of ice so that when it is brought back to the surface, it's holding a nice cylinder of ice, with the oldest ice at the bottom, and the newest at the top. There should be lots of little air bubbles trapped throughout the sample. These little bubbles actually reflect the composition of the atmosphere at the time they were frozen. Researchers can analyze the chemical makeup of the bubbles for things like carbon dioxide levels and compare their results with those of the bubbles found in a different section of the ice core, allowing them to make predictions about past climate and how it has changed over time.

Another cool way to look at climate change in the past is through dendrochronology. Remember when you were a kid and you learned that you could figure out how old a tree is from counting its rings? Well it turns out you can learn more than just its age. Trees live and grow largely in response to their environments. If there is a year without very much rain, a tree might not grow as much as it would during a year that had closer to an average amount of precipitation. This type of response is reflected in the rings. So if researchers know what year a tree was cut down, they can use the rings to count backwards and see which years may have experienced severe droughts or other climatic events. When combined with other archaeological evidence, that type of information can be extremely helpful in piecing together a more complete story of past human life.

We mentioned before how big an impact carbon has on climate change today, so it makes sense that bioarchaeologists would want to study carbon levels in the past. Luckily for them, there is a little scientific process known as radiocarbon dating. Radiocarbon dating, also known as carbon-14 dating, can be used to figure out the age of organic materials like wood, bone, hair, soil, seeds, pollen, and more. This is thanks to the carbon cycle, which allows carbon to be present in all living things and their surroundings. Here's how the carbon cycle works: carbon dioxide in the atmosphere is absorbed and used by plants in photosynthesis. Plants expel oxygen, which is used in animal respiration. Animals then exhale carbon dioxide, renewing the cycle. Plants can also be

consumed by animals, transferring the carbon from one organism to another. When plants and animals die, they decompose, passing carbon into the soil. This carbon in the ground can be processed in plants again through the roots, or it can become a fossil fuel, which when burned by humans deposits more carbon dioxide into the atmosphere.

Carbon-14 dating focuses on the decomposition part of the carbon cycle, or the lack thereof. When an organism dies, its carbon-14 levels decay at a known rate. This means that researchers can determine the amount of carbon within, let's say a human bone, then calculate how much carbon has been lost, allowing them to figure out how long ago the person died.
Bioarchaeologists can use similar methods with other organic compounds like oxygen, potassium, uranium, chlorine, and more to make inferences about the natural composition of the planet in the past.

Another form of evidence that can literally tell us what the climate was like at a given time is historical documentation. Humans have been keeping records of their lives for thousands of years through writing, hieroglyphs, art and drawings, and numeric systems. At one point in time someone may have kept a journal describing a dry season and how their family or community may have suffered as a result. Someone else may have kept a tax record indicating through numbers that in a certain year there were fewer products available for taxation than at a previous time. These are two very different examples of documentation, but they could both be used to understand climate at a given

time and how it affects human life. Of course, any information recorded by humans is at risk of being biased by the authors, as well as possibly subjected to researcher-bias. There are also plenty of societies that had no known system of record keeping. This is why it is important to always look at multiple lines of evidence within the field of bioarchaeology.

Video Script #3

Bioarchaeology and Climate Change 103: What is Bioarchaeology?

Hi! And welcome to Bioarchaeology and Climate Change 103. In our last episode we talked about what climate change actually is and how we can study it in the past, but we haven't addressed the other part of our title: bioarchaeology. Let's start with archaeology. When you think of archaeology you might think of dinosaurs, Indiana Jones, and the Egyptian pyramids. In reality, archaeologists don't study dinosaurs (we leave that to paleontologists), Indiana Jones is more of a treasure hunter than a scientific archaeologist, and, while Egyptian pyramids are fascinating archaeological subjects, they are by no means the only things worth studying. In the United States, archaeology is a subfield of anthropology, meaning that it is focused on the study of human populations, specifically past populations. Archaeologists rely on the material evidence of past life to understand how people lived and interacted.

Now throw in the prefix "bio." Bioarchaeology. Bioarchaeology uses organic (biological) material evidence of past life to understand how people

lived and interacted. One of the primary organic materials used is human bone. A skeleton can tell so much about a person's life. Sex, age, height, disease, traumatic injury, diet, migration: all of this can be directly recorded in bone. Bioarchaeologists use a variety of methods to study human skeletal material in order to make predictions about how an individual or a population lived, including quantitative and qualitative methods.

In the last episode we talked a little bit about carbon within the atmosphere and how it influences climate, and how radiocarbon dating uses this to date organic materials such as bone.

Carbon can be used for more than just dating though. A lot can be inferred about past diets from carbon analyses.

When plants are eaten by other organisms (like humans) the carbon that is transferred reflects how the plant initially processed it during photorespiration. So bioarchaeologists are able to determine whether a person's diet consisted largely of plants such as maize. As the saying goes, you are what you eat; and if you eat a lot of maize, it can be reflected in your skeleton.

Other chemicals that can be studied to understand past life include strontium and oxygen. These isotopes are incredibly helpful in the study of human migration patterns. Strontium, for example, is typically found in water. When humans drink water, they also ingest this strontium and it becomes incorporated into the body, including the skeleton. Bioarchaeologists assume that if the strontium isotopic signature found within a human skeleton matches

that of a nearby body of water, the individual likely grew up in that region. If the isotopic signatures do not match, bioarchaeologists can hypothesize that the individual emigrated from a different area.

Bioarchaeologists also rely a lot on observational skills and diagnostic knowledge, much like doctors do to understand health and social interactions in the past. Skeletons often have marks on them, known as lesions, that can be contextualized to create an image of how individuals lived and interacted with others and their environments. Skeletal lesions can typically be classified as traumatic or pathological.

Traumatic lesions reflect injuries that an individual suffered in their life. Bioarchaeologists are usually able to determine if an injury happened before the person died, after they died, or if the injury happened around the time of death. They can also differentiate between different types of injuries. Was the person stabbed with a knife, or were they beaten up in a fist-fight?

Some types of traumatic injuries can be associated with specific actions or movements. For example, fractures that are found in the middle of the ulna, one of the bones of the forearm, can sometimes be associated with self-defense. These are known as parry fractures. They can occur when a person raises their arm to cover their head and face or otherwise ward off blows from someone or something else.

Of course it is totally possible that traumatic lesions are not the result of violence. Maybe someone tripped and broke their leg, or was attacked by an

animal. Traumatic lesions could even be the result of cultural or medical practices. Bioarchaeologists have to think about all these possibilities to make sure they present the most accurate and complete depiction of past societies that they are able to.

More often than traumatic lesions, bioarchaeologists analyze signs of pathology. Pathologies are any marks left on the skeleton that could have been from disease. This includes infectious diseases like leprosy and tuberculosis, nutritional deficiencies like scurvy and rickets, degenerative diseases like osteoarthritis, and general indicators of stress.

One common problem that comes up when looking at skeletal pathologies is known as the Osteological Paradox. Most diseases must be active within an individual for an extended period of time before they will alter the bony tissue. This means that individuals can die from a disease way before it starts to affect their bones. Skeletons of these individuals might actually look healthier than those of people who suffered longer from a disease, when in reality they were less fit to survive. So were people who have skeletal pathological lesions more or less healthy than those without? This careful analysis of human skeletal remains is pretty different from how Indiana Jones treats the skeletons he comes across

When researchers expand their analysis to view other factors of archaeological context, such as what types of objects a person is buried with and where they are buried in relation to other aspects of the population, even more can be hypothesized about past life.

Archaeology is pretty commonly regarded as an interesting subject, especially when skeletons are involved, but how is it relevant to modern society?

Aristotle once said, "Knowing yourself is the beginning of all wisdom." When we try to understand how past humans lived, we get a glimpse of how we came to be today, which in turn allows us to project that knowledge into the world to see things with more rationality and compassion.

Video Script #4

Bioarchaeology and Climate Change 201: Studies in the Early Holocene Old World

Hi! And welcome to Bioarchaeology and Climate Change 201. In our first few episodes we have really unpacked what climate change and bioarchaeology are in order to understand the science behind this type of study. Now let's look at some actual examples of how bioarchaeology is used to understand climate change in the past.

First, some background: The Holocene began approximately 12,000 years ago. This epoch is differentiated from the Pleistocene, the time before in which *Homo sapiens* continued to evolve and spread across the planet, by marking the end of the glacial period (Walker et al. 2012). Warming temperatures in the early Holocene created environments that, upon interaction with human populations, became suitable for agricultural practices. Agriculture appeared in the Old World earlier than in the New World likely due to unique environmental conditions; this includes the species of wild plants and animals native to the specific regions

that were able to be domesticated.

Agriculture is super important in human history because it completely redefined society. When you know how to grow your own food, you don't have much reason to move around as a way to survive. This creates sedentary communities. If you are good at growing your own food, you might produce more than you actually need. Surpluses can lead to developments in storage practices, and diversification of skills, trade economies, and, eventually, to hierarchical societies. Agriculture is huge.

As influential as agriculture has been on human life, you would think that societies would build their entire lives around it, and that changing climate would be absolutely devastating to agricultural populations. This is sometimes true, but not always.

Çatalhöyük, located in present-day Turkey, is one of the most impressive known early Holocene towns. Based on isotopic analyses, researchers predict that Çatalhöyük was occupied from approximately 9.3 to 8.2 thousand years ago. As an agricultural community, the population of Çatalhöyük depended upon reliable sources of food and water within the region. Archaeologists have discovered that while Çatalhöyük certainly had the resources necessary to succeed as a community, it may not have been situated in the most ecologically efficient location. It was in the middle of a swamp. Not the best place to be growing crops. The decision to establish Çatalhöyük in a swamp, even though there were probably perfectly farmable areas nearby, indicates that maybe site

preference was influenced by sociocultural factors not related to growing food. It is possible that Çatalhöyük was established where it was due to geographic ties to spirituality, convenience of trade and travel, or proximity of non-agricultural dietary staples.

Around 8,200 years ago we see evidence of cooling temperatures and increasing aridity in the Middle East. Around this same time the population of Çatalhöyük declines significantly. Many researchers have hypothesized that the population decline is directly correlated with the climatic event of 8.2 kya. But it's possible that the two occurrences are more coincidental.
Paleo-environmental reconstructions show that the 8.2 kya climatic event varied a lot by geographic area, and didn't actually last that long. Knowing this, researchers should use caution when saying that Çatalhöyük "collapsed" due to climate change.

The bioarchaeological research at Çatalhöyük about climate change is significant on a larger scale because it shows just how many factors have to be taken into consideration when examining human response to their environments. This particular population probably didn't "collapse" due strictly to climate change. To say so is to overemphasize the impact of a relatively minor climatic event, as well as overlook human agency, or the human ability to make choices and impact their surroundings.

So if climate change didn't cause Çatalhöyük to collapse, why are we talking about it in our Bioarchaeology and Climate Change video?

Because it shows how many factors we have to take into consideration when determining what leads to the downfall of a civilization. A lot of the public literature on climate change makes it seem like there is no hope for humanity, we are all going to die because the Earth is broken beyond repair. That type of thinking denies our own agency. We have the power to change our destructive habits, we have the power to elect government officials who will make environmental protection a priority, and we have the power to show compassion to the people of the world and help each other overcome the problems we as a global community are facing.

Video Script #5

Bioarchaeology and Climate Change 202: Studies in the Middle Holocene Old World

Hi! And welcome to Bioarchaeology and Climate Change 202. Today we are moving forward in time from the Early to Middle Holocene. The Middle Holocene began approximately 8,000 years before present, and is commonly distinguished from the early Holocene by a global cooling event that took place 8.2 kya—the same time, and possibly same climatic event, that may have impacted Çatalhöyük, which we talked about in episode 201.

Paleoclimatological research has shown that during the third millennium B.C. climate in the Arabian Peninsula became much more arid. Bioarchaeologists have argued that this climatic change led to shifts in sociocultural practices, in some cases significant enough to redefine societies. For example, prior to the

aridification during the third millennium B.C., a civilization known as Umm an-Nar lived in the area that is present day Oman. Umm an-Nar is one of the largest known Bronze Age civilizations on the Arabian Gulf. It was probably an important trade post in ancient Mesopotamia for resources like copper and diorite, which is a type of igneous rock more commonly known as granite.

Bioarchaeological evidence suggests that during the period of climate change, the community became more mobile, changed the ways they buried their dead, and experienced a collapse in trade relations. Following this period of change, a new society is established known as the Wadi Suq. Comparative isotopic analyses of the two populations shows that the Umm an-Nar people were not replaced by newcomers in the region, rather there was continuity between the two groups.

The research on the Umm an-Nar and Wadi Suq is important because it shows how one society can adapt to its shifting environment to become another. This totally goes against the argument for societal collapse in the face of environmental stress. In this particular study, it also contradicts the concept of a violent transition of power and identity, as the Wadi Suq likely developed from the Umm an-Nar. This study as a whole is an excellent example of human resilience and adaptability.

The period of aridification experienced in the Arabian Peninsula definitely wasn't the only example of climate change during the Middle Holocene in the Old World. Around 4000 years ago western Japan experienced a period of

climate cooling. During this time there was a gradual population increase thought to be related to increased human migration. Researchers tested this hypothesis by comparing the presence or absence of tooth ablation, the ritual practice of removing specific teeth, between early and late populations in this area to predict whether or not ablation is a distinguishing feature of locals versus immigrants. Additionally, strontium isotopic analyses were run on human skeletal materials from both periods to look for indicators of immigration.

The results of this study didn't reveal a statistically significant change in immigration levels during the period of climatic change. The researchers explain that there actually may have been immigration, just in areas that had similar strontium signatures. It is also possible that the population adapted to its changing environment through new dietary and sociocultural practices instead of or in addition to immigration. Even though the hypothesis in this case was rejected, it brings up important questions both within bioarchaeology, and contemporary climate research.

Similar studies have been conducted in other regions, such as the Sahara, regarding the impact of climate change on human migratory patterns. Unlike the Japanese study, recent research on Middle Holocene Saharan populations does support the hypothesis that one response to climate change was increased human mobility. These two studies have really similar methods and goals, but reached different conclusions. This is a perfect example of the variability of human response to the environment, once again making us question modern

proclamations that climate change will destroy human life.

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