

Global Environmental Change Threats to Heritage and Long Term Observing Networks of the Past.

Project Description: The past decade has seen growing world-wide concern for the accelerating impact of environmental change on heritage at the global scale. Sites and structures that have endured for centuries and millennia are being swept away in increasing numbers around the world. Once destroyed, these resources are gone forever with irrevocable impact on human heritage and archives of scientific data. Unlike damage caused by human action, there is no recourse to “developer pays” strategies for mitigation where wind, ocean, and rising soil temperatures impact thousands of sites at once. The *American Anthropological Association’s* Global Climate Change Task Force’s official report [Statement on Humanity and Climate Change](#) is representative of current international scholarly expressions of urgent concern. As organizations and communities have mobilized to respond, two intertwined concerns have energized scholars and citizens and form the basis for this IHOPE Theme:

- 1) Loss of key elements of cultural heritage, both major historic sites of established great social and economic value to local and global communities and previously unknown sites often undocumented before becoming exposed and rapidly damaged by environmental change (Harvey & Perry 2015).
- 2) Loss of the rich environmental and cultural record represented by sites with rich organic preservation that are now being mobilized as a “distributed long term observing network of the past” through new techniques including ancient DNA and a wide range of stable isotopes now being applied to large, well-studied zooarchaeological collections spanning millennia. Major resources for understanding long term variability in key economic species (cod, salmon, domestic stock, insects, crops, and weeds) and past adaptation to climate change are being destroyed just as their full potential for global change science is being realized.

This IHOPE Theme will work to combine these two intertwined areas of concern and to connect the many local, regional, national and international groups now organizing to respond to urgent threats around the world. This program will work to coordinate and connect projects and practitioners, encourage communication, and spread best practice. It will work to raise awareness of the urgency of these threats in the global change research community, and work collaboratively to bring on line the major new funding sources that will be required to meet these challenges. We welcome broad engagement by the widest possible spectrum of stakeholders and organizations.



Figure 1 Boddin Limekiln Scotland: Historic site falling into the sea. (Photo Tom Dawson)

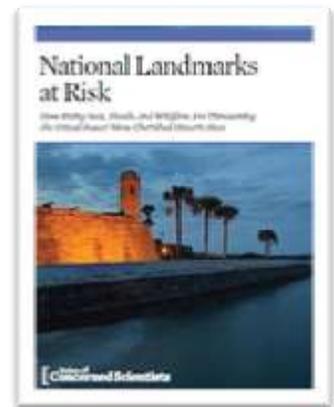


Figure 2 Union of Concerned Scientists (2014)
www.ucsusa.org/assets/documents/global_warming/National-Landmarks-at-Risk-Full-Report.pdf

Threats to Heritage: As many workers have noted, calculations of gradual rates of erosion based on linear models of incremental change provide a somewhat deceptive picture of actual threats. While gradual change is constant, the real damage is often done in a matter of hours and days by major storms that can impact hundreds of sites in multiple countries. Extreme weather events are now recognized as a growing feature of 21st century global change in many areas, and the need for a coordinated international response is becoming increasingly clear worldwide.



Figure 3. Archaeologists working at the water's edge in storm conditions in Shetland UK (Tom Dawson photo)

Two recent meetings and a national government policy memorandum may illustrate the increasing concern with global change impacts on heritage in the 21st century and growing broad based international support for action:

- ***The Pocantico Call to Action on Climate Impacts and Cultural Heritage*** was drafted by representatives of over twenty local, national, and international organizations who came together at the Pocantico Center of the Rockefeller Brothers Fund, February 2 – 4, 2015, to consider strategies and develop an action agenda for preserving and continuing cultural heritage in a changing climate. In March 2014 the *Society for American Archaeology* board of directors formally endorsed the *Pocantico Call to Action* issued by the Union of Concerned Scientists, the National Trust of Historic Preservation, SAA, and the J.M. Kaplan Fund. This international call to action is now posted on multiple organizational websites and has a growing list of individual and organizational sponsors. <http://saa.org/Portals/0/SAA/GovernmentAffairs/POCANTICO.pdf>
- ***The Weather-Beaten Archaeology Conference: Revealing Concealing & Erasing*** hosted March 7-8th 2015 at the Institute of Technology, Sligo, Eire. This conference was initially conceived as a local response to the damage caused by the extreme storms of 2013-14 in Ireland, but rapidly expanded into a major international gathering of archaeologists, heritage managers, environmental scientists, and the interested public. As noted in the workshop bulletin: "Coastal archaeological sites have always been vulnerable to erosion. In recent years this vulnerability has become a contentious issue when a variety of archaeological sites across Northern Europe were impacted by the winter storms of 2013-14. Stone forts fell into the sea. Castles crumbled to the ground. Shipwrecks, middens, timber trackways and ancient drowned forests were revealed for the first time in centuries. Heritage venues were flooded and a large number of archaeological sites were washed away entirely..... The annual winter storms now regularly require rescue work by governments and archaeologists, allow chance finds by members of the public and have necessitated the creation of citizen science schemes to report vulnerable / newly discovered sites." <http://weatherbeatenarchaeology.com/>
- **U.S. National Park Service Director's Policy Memorandum 14-02 *Climate Change and Stewardship of Cultural Resources*** was signed in February 2014 and stands as the primary U.S.

policy document about cultural heritage and climate change. This memo sets out two key directions for work in cultural heritage and climate change, noting that “(1) cultural resources are primary sources of data regarding human interactions with environmental change; and (2) changing climates affect the preservation and maintenance of cultural resources.” The capacity of cultural heritage to yield unique and critical information for climate change adaptation is also recognized in the policy memo in a recommendation to incorporate potential for such information into significance assessments. The memo also recognizes that “every place has a climate story” and that cultural heritage and the stories it anchors are powerful points of connection for individuals and communities around the world.
http://www.nps.gov/subjects/climatechange/upload/PM_14-02.pdf

Threats to Archaeological Sites as a “Distributed Long Term Observing Network of the Past”:

In recent years archaeological sites with good conditions of organic preservation have increasingly become recognized as resources for paleoenvironmental reconstruction with potential similar to stratified datable proxy records recovered from ice sheets, bogs, lakes, and oceanic sediments. In addition to the artifacts and structures left by past humans, these sites contain residues of human subsistence activities, in the form of stratified layers, often several meters deep and spanning millennia, containing the remains of a diverse range of animals, plants, insects, and anthropogenic soils and sediments. These remains are samples from past ecosystems that cannot be replicated, absent the invention of a working time machine. Further conceptual and methodological advances have made it possible to move beyond the human-mediated aspects of the environmental system, to a true ecosystem level. Archaeological data can be used to address questions that fall primarily into the realms of conservation biology, oceanography, ecology, or climatology, in addition to more traditional social science questions. The ability to use organic remains for aDNA studies, stable isotope analysis, trace element analysis, and even stereochemical analysis make it possible for us to look at factors such as trophic levels, changes in stock structure, population bottlenecks, and movements of animal populations. Where modern biological studies often are working with no more than 30 to 40 years of data (perhaps 100- 200 years of data if one includes museum specimens), archaeological sites can contain many thousands of years of continuous record. It is possible not only to document human interactions with the environment, but also to see how they change through time, and then correlate those changes with possible drivers, such as climate change, changes in human exploitation, natural catastrophes (volcanic eruptions, large-scale flooding, etc.). These deposits offer material for projects such as the multidisciplinary investigation of the onset of summer drift ice in early Late Holocene Cold period/ “little ice age” North Atlantic, of the distribution and population structure of sea mammals prior to 17th -19th c industrial hunting, and the effects of large scale fishing prior to the



Figure 4 dense masses of marine fish, bird and sea mammal bone in eroding stratified deposits dating to the early 15th c. CE at the site of Gufuskálar Iceland. (Photo Frank Feeley)

disciplinary establishment of fisheries science. Collaboration between archaeological fieldworkers, new innovative laboratory techniques, biologists and modern resource managers is growing just as irreplaceable key sites are coming under increasing threat globally.

A key early paper recognizing the potential of such rich archaeological deposits as “a distributed long term observing network of the past” appeared in 2012 (Sandweiss, D. and Kelley, A.R., 2012. “The Archaeological Record as a Paleoclimatic and Paleoenvironmental Archive”, *Annual Review of Anthropology*, v. 21, pp.371-409.)

Wider discussions at workshops sponsored by the

Global Human Ecodynamics Alliance (www.gheahome.org) hosted by U Maryland in fall 2013 were followed up by presentations to the *Future Earth* interim directors in Paris in March 2014 and a well-attended session at the *Geological Society of America* meetings (Vancouver 2014) and several sessions at the *Society for American Archaeology* meetings in San Francisco April 2015. The potential for global scale synergy is great, and we are as yet only beginning to fully exploit the potential of these rich archaeological deposits as a distributed observing network. IHOPE will work to facilitate interdisciplinary collaborations and the better integration of the network of archaeological sites suitable for such broad spectrum analyses worldwide.

Coastal erosion, riverine flooding, and wind deflation pose deadly threats to the integrity of stratified archaeological sites, destroying both the cultural and scientific value of these deposits forever. An additional widespread threat in northern and alpine environments is the direct effect of increasing temperatures on ice margins, permafrost, and seasonally frozen ground. Research on the *Qajaa* kitchen midden in the Disco Bay area in Greenland documents that wooden artefacts preserved for more than 4,000 years in the permafrost but now exposed to summer thaw are markedly degraded compared to those excavated from the same deposits in 1982

(Matthiesen *et al.*, 2013). The measured decay rates have been combined with on-site monitoring data in a numerical computer model in order to assess the future thawing and decay of the kitchen midden (Hollesen *et al.*, 2015). The model results show that great parts of the midden may be thawed within the



Figure 6 Eroding fishing sites dating from 9th c. CE to the early Modern period at Siglunes, Iceland (photo Ramona Harrison).



Figure 5 In SW Greenland outside the permafrost area, warming soils and enhanced drainage has produced rapid degradation of once excellent organic preservation over multiple sites. Many middens that produced large zooarchaeological collections in the 1960's now produce unrecoverable “bone mush”. Cooperative midden rescue project 2012 at Igaliku Greenland. (Photo Konrad Smiarowski).

next century with significant negative effect on the preservation conditions. The results suggest a critical shift from a first phase of relatively slow permafrost thaw, driven by climate changes and low heat production, to a second phase of accelerated permafrost thaw when water is drained and increasing oxygen availability markedly triggers a higher internal heat production. If this tipping point is reached the heat production can accelerate the decomposition processes and cause the impact of climate change to be significantly enhanced.

This may well be the last generation to be able to recover even a fraction of the record of the archaeological global recording network. There is a clear need for global scale response to these urgent threats to the long term record and our common heritage.



Figure 7, Slumping stratified archaeological deposits including over 3000 years of well-preserved structures and features collapsing into the sea at the Walakpa site N Alaska. Over 11 m of rich stratified deposits on a several hundred meter front were lost in a single storm. (Photo Anne Jensen)

Response Strategies

The scale and urgency of the threat will require a large scale response backed by sustained funding support on a large scale. Existing structures for rescue and response are already regularly overwhelmed, and conditions will become more acute and urgent in years to come. It is clear that we cannot expect existing research-orientated local and national funding agencies to support the sort of large scale sustained response needed from already-strained basic science budgets. New models for funding, education and recruitment of staff, engagement with the public and a host of practical issues associated with the long term curation of rescued samples that may be fully studied decades in the future must be developed and implemented. Improved knowledge of the nature of feedback mechanisms and processes controlling preservation conditions are needed in order to quantify the rate at which the different threats are causing degradation. New cyberinfrastructure will be required to manage the cascade of new data, develop impact models and better methods to upscale from local to regional scale and to engage the global public and local stakeholders in prioritizing and promoting what will be a global effort lasting decades.

We need to work with global change funders public and private, with professional organizations across the disciplinary spectrum, and with allies in natural sciences, historic preservation, and cyberinfrastructure. We need to improve networked communication among teams and across national and disciplinary boundaries, promoting best practice and creating collaborative bonds. Most importantly we need to bring our urgent message to the public and policy makers through a full range of media and promote active public engagement in the sustained common effort. We have no illusions about the scale and difficulty of the tasks before us, but history places this generation and the next in a crucial juncture with the survival of the basic record of the past. If we do not take up the challenge now we will irrevocably impoverish all future generations. We need your help.

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Figure 8 Coastal Erosion impacts on archaeological sites in Rapa Nui (Easter Island). Photo Adam Stanford Aerial-Cam

Links to Resources

North Atlantic Biocultural Organization www.nabohome.org

Global Human Ecodynamics Alliance www.gheahome.org

US National Park Service <http://ncptt.nps.gov/articles/climate-change/>
(<http://ncptt.nps.gov/blog/training-in-climate-change-and-cultural-resources/>)

Union of Concerned Scientists www.ucsusa.org/assets/documents/global_warming/National-Landmarks-at-Risk-Full-Report.pdf

Scottish Coastal Archaeology and the Problem of Erosion (SCAPE) <http://www.scapetrust.org/index.html>

SCHARP – citizen science project to record eroding sites <http://www.scharp.co.uk/>

Regan Alsup video of heritage impacts and community response to coastal erosion in Brora Scotland.
<https://vimeo.com/90691169>

The Site Stewardship program at the Alutiiq Museum in Kodiak:

<http://alutiiqmuseum.org/research.html>

Collaboration with the USF&WS to reconstruct fragile island environments:

http://www.fws.gov/refuge/alaska_maritime/grazing.html

The Chirikof Island Project:

<http://www.bu.edu/today/2014/what-ancient-dinners-tell-us-about-climate-change/>

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