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The cover image of Asin-badakide-ziibi, the Baptism River, is courtesy of M. Baxley, Bear Witness Media.

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LIBRARIES BURNING

By Phyllis Mauch Messenger

For much of the planet, 2023 was the warmest year on record, and the 12 warmest years have all been documented since 2005.[i] The repercussions of this warming pattern, of undeniable climate change, are both dauntingly real and not yet fully knowable, both immediately problematic and also intensifying over time.

The article republished here demonstrates a commitment to action and hope in the face of climate change. In 2019, Phyllis Mauch Messenger detailed the work of several archaeological projects across the Arctic region focusing on salvaging materials long held in permafrost landscapes that are at risk due to warming temperatures. Messenger explains that this data contributes to understanding the history of human relationships with these places and that their loss would make parts of our human past irretrievable. Now, nearly five years later, the situation seems even more dire, the threats even more pressing, and the work ongoing.

Crew excavating eroding house at Walakpa in 2017.
Image courtesy of the Walakpa Archaeological Salvage Project.

Concerns in the Arctic, however, are not limited to archaeological materials, and concerns about losing fragile datasets due to climate change are not limited to the Arctic. Researchers are sharing their work and their concerns about threats to irreplaceable data in the physical landscape and the ramifications of this loss. Here are a few examples of work that demonstrate the ongoing distress of the Arctic and the ways these concerns resonate beyond the Arctic, too.

Arctic Rivers Face Big Changes

Thawing permafrost and increased precipitation are leading to changes in river ecosystems. As permafrost melts and more waters move through these river systems, researchers posit that these changes wrought by climate change will perpetuate and magnify the effects.[ii]

Rain Comes to the Arctic, With a Cascade of Troubling Changes

Rain events in the Arctic are becoming increasingly common and increasingly problematic. From changing the constitution of ice caps and glaciers to spurring avalanches to hardening snow layers, Arctic rains affect the people and wildlife of these regions and far beyond. These rain events happen because of a warmer climate, and they create conditions for more melting of glaciers and rapid sea-level rise.[iii]

Melting Mongolian Ice Reveals Fragile Artifacts

In the grassy steppes of Mongolia, climate change is melting snow and ice patches and revealing artifacts that change how prehistoric life in these places is understood. Even as some artifacts are recovered, it is impossible to know what data is not recovered and how the absence of these ice patches affects the broader ecologies of Mongolia.[iv]

The Big Data of Ice, Rocks, Soils, and Sediments

What do we do with the data that we rescue from the Arctic's thawing landscape? The work of collecting and curating materials–whether they tell the story of humans or the longer story of the physical planet–is invaluable, critically important, and also materially complicated. The varied ways that data sources, from ice cores to marine sediments, need to be stored in order to maintain integrity brings up questions about classification, indexing, what data needs to be saved, and how.[v]

Partnering with Nonhumans for Climate Action

Innovative technologies offer strategies to counter the loss of sea ice, posing ameliorative solutions to the disastrous effects of climate change. These strategies could reinforce ideas of human control or they could be opportunities to see relationships with nonhumans–like sea ice–as collaborative partnerships.[vi]

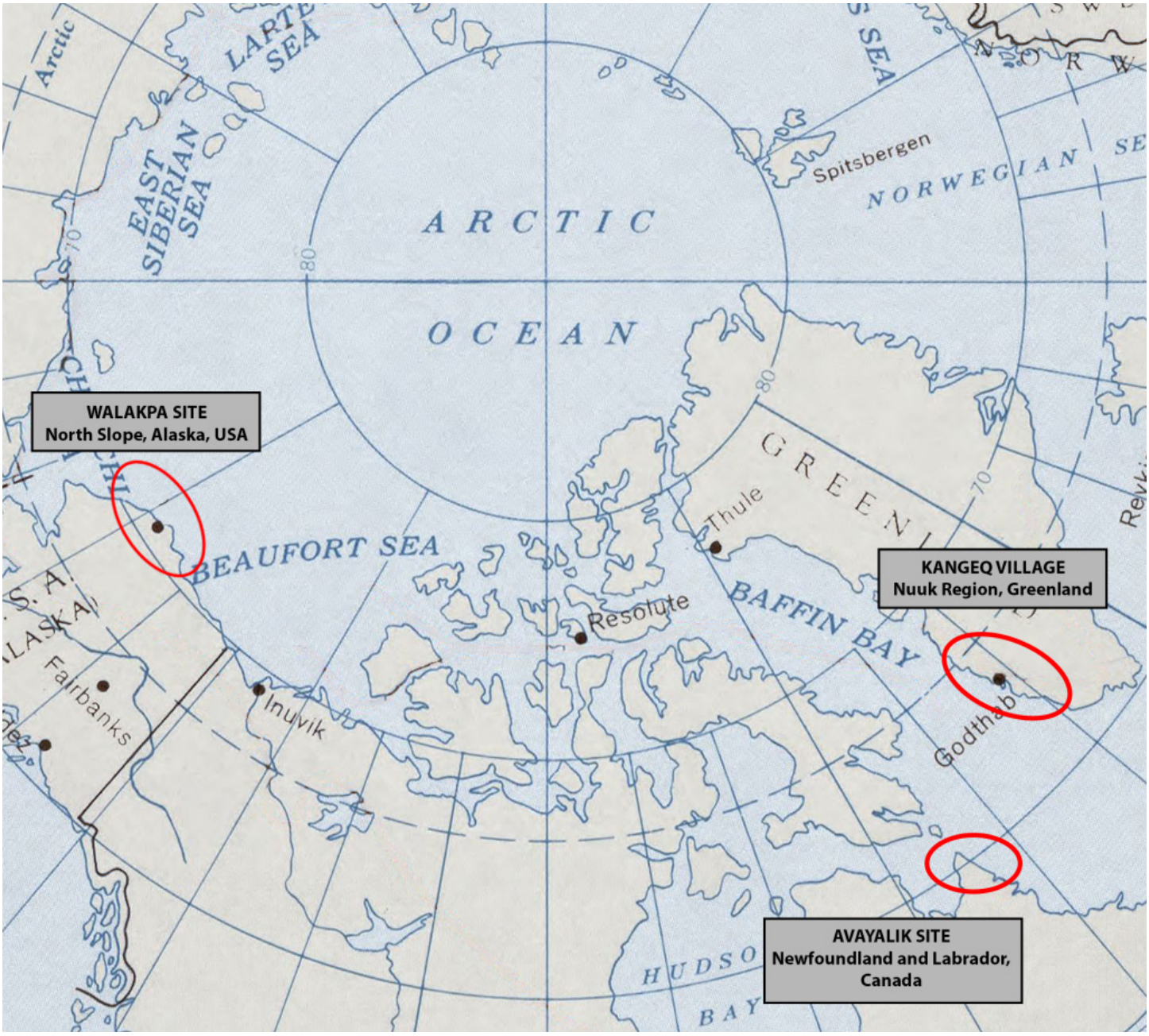
– Laurie Moberg, Editor

The impact of climate change on archaeological and heritage sites in the Arctic region is devastating. New techniques of research and analysis are providing increasingly rich data about the long history of humans in the environment. Evidence from archaeological sites, which has long contributed to this story, is becoming recognized as a "distributed long term observing network of the past" (Sandweiss and Kelley 2012). Just as the value of these sites is being recognized more fully, the sites themselves are being destroyed by thawing permafrost, rising sea levels, and increasingly violent storms. Nowhere is this being felt more intensely than in the Arctic, which is warming two to three times as fast as the rest of

the planet (Hoag 2019). In addition to increased threats from insects, extreme weather, wildfires, and the release of long-buried pathogens, this rapid warming is destroying the archaeological record (Hollesen et al. 2018). These environmental changes are destroying invaluable and irreplaceable evidence of human history.

Archaeologists and other scientists, realizing the extent and urgency of the threat not just in the Arctic but globally, liken it to the burning of the ancient libraries of Alexandria, multiplied many times over (McGovern 2017).

For many years, in situ preservation in the Arctic and elsewhere worked very well. Now researchers from universities, museums, and government agencies, working with Indigenous and descendant communities, are scrambling to collect materials before they degrade and disappear.



This map shows the regions of the three Arctic research sites highlighted in this piece: the Walakpa site, the Avayalik site, and the Kangeq village.

Researchers declare that this may be the last generation to be able to recover even a fraction of the record of the archaeological global recording network. Analysis can come later.

In some cases, forward-thinking scholars and sponsors have managed to cobble together funding and teams to gather ice cores to be stored for future analysis. Similar efforts are being mounted at archaeological sites, with the recognition that only a fraction of known sites can be sampled.

In the 2017 Society for American Archaeology (SAA) President's Forum, the opening session of the 82nd Annual Meeting, SAA President Diane Gifford-Gonzalez described how global climate change is affecting archaeological and heritage sites "at a scale and rate unprecedented in the experience of archaeologists over the last 150 years" (Gifford-Gonzalez 2017). Panelists in the session discussed the need to monitor and document sites along coasts from Alaska to Greenland and Northern Europe. They described innovative strategies to engage local communities in protecting threatened sites and in documenting those that will be lost.

According to organizers of another 2017 SAA symposium on environmental impacts on heritage, "This generation will see the destruction of thousands of sites—some already famous and of recognized heritage value and others that are exposed by one storm only to be destroyed by the next. At the same time, archaeology is increasingly recognized as a global-change science that is making significant contributions to resource management, environmental conservation, and more effective scenario building for a genuinely sustainable future" (McGovern 2017).

Global Initiatives

The urgency of this situation has led to new initiatives to share resources and to identify and disseminate best practices. One such example is the *Integrated History and Future of People on Earth* (IHOPE 2015). This global network of researchers and research projects uses integrative frameworks and long-term, human-scale perspectives to combine earth system science (which focuses on the operation of the whole earth, including the basic elements of air, water, land, and life) with the social sciences, the humanities, and communities of practice.

One of IHOPE's teams focuses on threats to heritage and the distributed observing network of the past. This team includes archaeological fieldworkers, biologists, and modern resources managers working closely with citizen scientists and local communities. They face a dilemma of epic proportions. They have access to new analysis tools that promise to revolutionize what we can learn about the past of humankind, so they must try to collect as much data as possible before it is gone. Yet, for the most part, they do not have strategies in place to document which sites are most at risk or to make decisions about which sites to focus on and which to let go. They must also deal with funding agencies that are used to supporting hypothesis-based research, not quick-turnaround salvage recovery. There are a host of other bureaucratic and logistical hurdles facing these researchers.

Another innovative collaboration that seeks to overcome disciplinary and institutional barriers is the Resilience Alliance (RA). Established in 1999, the RA is an international, multidisciplinary research organization that explores the dynamics of social-ecological systems. RA members collaborate across disciplines and with local communities on issues of resilience, adaptive capacity, and transformation of societies and ecosystems.

They participate in many international projects, including the International Panel on Climate Change.

The RA carries out comparative research and synthesis at a global scale, rooted in local and regional context-specific studies (see, for example, a video on scenario planning for Arctic sustainability in 2050). The organization's online journal, *Ecology and Society*, serves as a resource for other organizations and programs around the world.

What follows is a glimpse of the issues and opportunities currently facing archaeologists who work in the Arctic, using sites in Alaska, Greenland, and Labrador as proxies for the ancient stories in a region that is rapidly thawing and eroding away.

Loss of Sites in Alaska

University of Alaska archaeologist Anne Jensen studies endangered sites in coastal Alaska. She works in close collaboration with recognized Native communities on the North Slope and is the senior scientist for the Ukpeaġvik Iñupiat Corporation. The Walakpa site on the North Slope of Alaska is an example of an iconic site with "spectacular preservation" that began eroding rapidly in 2013 (Jensen 2018). This sudden degradation is due to multiple forces: permafrost thawing, freeze-thaw cycles, and wave action during storms. At Walakpa, well-preserved

Ancient Walakpa wooden structure slumping into the sea. Image courtesy of the Walakpa Archaeological Salvage Project.

wooden structures and 11 meters of stratified deposits dating back over 3,000 years of history of semi-nomadic Alaska Natives are now slumping into the sea.

Until just a few years ago, this house (above) had stood literally frozen in time. It held not only millenia-old cultural data, but biological data, as well: basic zooarchaeological data, stable isotopes, ancient DNA[1], cortico steroids, and trace elements. All these can be analyzed for ecosystem reconstruction and change, climate and habitat reconstruction, evidence of extinctions and bottlenecks, and species response to specific types of change (Jensen 2012, 2015, 2017). Jensen calls this a "tissue archive," similar to the samples of frozen animal tissue that biologists have been collecting for the past 30 to 40 years, but holding thousands of years of data rather than decades. Proto-Inuit peoples hunted animals and plants from land and sea, sampling large areas and bringing these needed resources back to their villages. The preserved remains have the potential to show climatic cycles over these millennia, something that current biological sampling cannot do.

Walakpa house with overhang gone. Image courtesy of Anne Jensen.

Walakpa slump block strata showing remains of a storage pit or ice cellar (reddish layer) and possible earlier abandoned ice cellar below (ice lenses separated by soil). A baleen (whale-bone) bucket is visible in the lowest ice lens, just to the right of the post. Image courtesy of the Walakpa Archaeological Salvage Project.

See video: Threatened Heritage and Community Archaeology on Alaska's North Slope.

After a fall 2014 storm uncovered Walakpa, international volunteer efforts to salvage data from the site began in 2015, with support from the landowner (an Alaska Native village corporation) and many individuals (Jensen 2018). Another storm in 2017 nearly destroyed the site, exposing human remains and more cultural and biological materials. The urgency of the situation and the need to move quickly to begin recovery (including the appropriate handling of human remains) outpaced traditional funding cycles for such a project—exemplifying one of the many challenges facing researchers in the Arctic zone. Things are different now because of climate change, says Jensen (2015). There is an urgency to collecting data, rather than doing hypothesis-driven research. Sites often aren't on federal land, so federal agencies do not have oversight or responsibilities. Reviewers of proposals for funding often don't understand the need for immediate funding, before the next storm hits.

Crew excavating eroding house at Walakpa in 2017. Image courtesy of the Walakpa Archaeological Salvage Project.

In short, funding cycles aren't geared toward this crisis mode.

At another North Slope site, Nuvuk, or Point Barrow, local residents sounded the alarm when eroding coastal bluffs began exposing human remains and cultural materials several decades ago. This was a village site with a long history that had been relocated more than once due to erosion (Krus et al. 2019). Excavations showed that human occupation there had stretched back not decades but over a thousand years, predating when the Thule, or ancestral Inuit, lived there, making Nuvuk a key site for understanding the Thule migration across the North American Arctic to Greenland over the next several centuries (Jensen 2017; see also, Krus et al. 2019, Tackney and Raff 2019).[2]

Current research on hunter-gatherer burial practices at Point Hope, Alaska by Justice and Temple (2019) makes use of materials and research reports from the 1940s, as well as recently uncovered material. These researchers, too, are

3000 years of cultural deposits all over the beach at Walakpa. Image courtesy of Anne Jensen.

sounding the alarm about both ancient sites and modern villages: “As permafrost continues to thaw because of human-induced climate change, coastal areas are eroding, placing villages and communities at risk of complete loss” (Melvin et al. 2017 in Justice and Temple 2019, 237).

For more on Walkapa and Nuvuk, visit https://iceandtime.net/. See also https://www.youtube.com/watch?v=hh_KEQ-ayBI for excavation of a seventeenth-century village in Quinhagak, Alaska, which began eroding away in 2009. Referring to the imminent danger to organic materials normally seen only in museum collections, project director Rick Knecht described the situation as “like museums on fire, libraries.”

Ipiutak paddle in situ at Nuvuk. Image courtesy of the Nuvuk Archaeological Project.

Melting Middens in Greenland

The largest island in the world, Greenland lies east of the Canadian Arctic Archipelago between the Arctic and Atlantic Oceans. Greenland is an autonomous constituent country within the Kingdom of Denmark, though geographically it is part of the continent of North America. The island's 57,000 inhabitants are clustered on shorelines, especially in Greenland's many fjords. Three quarters of the island is covered by a permanent ice sheet. Thus the melting of Arctic ice has a direct effect on Greenland's towns and villages, both past and present. Add increasing coastal erosion to this scenario, and the need to identify sites and remains most at risk becomes urgent.

Researchers face the task of salvaging what they can of the remains from 4,000 years of human occupation in coastal settlements. Until the late twentieth century, these data have been preserved

During the REMAINS of Greenland project, scientists have visited 14 different archaeological sites in the Nuuk region. Here the state of preservation is being evaluated at the heavily eroded site of Nuugaarsuk. Image courtesy of Roberto Fortuna, National Museum of Denmark.

in middens protected by permafrost; they were veritable time capsules of material culture to be added to the stories passed down through generations: how people lived, what they ate, the tools they used, patterns of trade and migration. Over the last several decades, archaeological surveys have identified hundreds of midden sites throughout the fjords and archipelagos of western Greenland. Material remains range from wood, bones, and feathers to animal dung and even human hair. However, fluctuating weather patterns are leading to thawing permafrost and accelerating decomposition of the contents of these middens.

Archaeologists and local heritage managers in Greenland are working to understand patterns and rates of deterioration, what sites are most at risk, and how to engage local communities in documentation of annual changes at archaeological sites. One of the projects designed to carry out this work is REMAINS (Research and Management of Archaeological sites IN a changing environment and Society; see Harmsen, Hollesen, Matthiesen, et al. 2017; Harmsen, Hollesen, Madsen, et al. 2018, Hollesen et al. 2019). Computer modeling suggests accelerated permafrost thaw may lead to higher internal heat production, thus exacerbating the impact of climate change on such sites (Hollesen et al. 2016).

Researchers from REMAINS team are discussing how to evaluate the archaeological state of preservation, the preservation conditions, and asset value of organic deposits. The work of the project has led to the development of a standardized field protocol for site description and risk assessment. Image courtesy of Roberto Fortuna, National Museum of Denmark.

The REMAINS project is carrying out a regional risk assessment for sites in the Nuuk region related to current and future climatic conditions.

One study is assessing current preservation conditions and processes in a kitchen midden in western Greenland and estimating the impact of future conditions (Hollesen et al. 2017). Currently the site is well preserved, with low ground temperatures, permafrost, and a high water/ice content. Extrapolation of data to the end of the twenty-first century, however, suggests that there will be substantial loss of archaeological evidence due to erosion and oxygen exposure.

A well-known example of site deterioration is the village of Kangeq on an island in the Nuuk Fjord, a twenty-minute boat ride from Nuuk, Greenland's capital.

Kangeq was occupied for some two millennia. Residents adapted their hunting and food gathering to seasonal availability of resources on both land and water. Kangeq was a nexus on important trade routes, and served as an official trading station for the Royal Greenland Trade Department for centuries (Harmsen 2017; Ivanov 2017). It was abandoned in the 1970s, in part due to an effort by the government to consolidate social services.

The settlement of Kangeq in Southwest Greenland was abandoned in the 1970s. The site had been occupied for thousands of years. Image courtesy of Jørgen Hollesen, National Museum of Denmark.

Boarded-up houses and an abandoned church still remain at Kangeq. A pool of sludge on the water's edge greets researchers coming to assess the site (see Harmsen 2017). Giant whale ribs, wood, glass, and rusting metal stick out of the pool; it is surrounded by a thick layer of compressed turf, which is actually a midden filled with the bones of what the residents of Kangeq were eating over the centuries. "People were living here for thousands of years, and then suddenly the whole town was deserted," said REMAINS project leader Jørgen Hollesen. "There's so much evidence of human activity—you can still see the playground where the kids used to play" (REMAINS of Greenland https://www.youtube.com/watch?v=xBJlhiP6P6s&t=266s).

Deposits such as those at Kangeq hold rich secrets to Greenland's deep human past. For example, the Saqqaq peoples, who inhabited the area from approximately 2400 B.C. to 800/500 B.C., were part of a broad techno-cultural tradition (Arctic Small Tool tradition or ASTt) and genetically related to ancient populations that originated in the Western Arctic (Siberia/Alaska). Archaeologically, in addition to the Saqqaq, these ancient groups are represented in Greenland by the Independence I (ca. 2400–1300 B.C.) and Greenlandic Dorset (ca.

Remains of the village of Kangeq as seen from the air.
Image courtesy of Jørgen Hollesen, National Museum of Denmark.

800 B.C.–A.D. 1) (Grønnow & Sørensen 2006). Following the Greenland Dorset, the island remained devoid of people for approximately 700 years until the arrival of the Late Dorset (ca. A.D. 700–1300), the last Paleo-Inuit group to settle in Greenland. They probably overlapped briefly with the Greenlandic Norse, whose colonies lasted only a few hundred years. The standard story of the Norse disappearance was that their society collapsed as a result of their failure to adapt to Greenland's climate. But newer evidence paints a much more complex picture of their withdrawal from Greenland, including "demographic pressures, changing social relationships, a lessened demand in European markets for Greenlandic exports such as walrus ivory and skins, and microshifts in seasonal weather and the annual returns of harvests," according to archaeologist Christian Koch Madsen, curator at the Greenland National Museum (Harmsen 2017).

The next wave of settlers was the Thule, who eventually became the modern Inuit Greenlanders. Their attention to seasonal rhythms along the coasts and fjords of Greenland is echoed in the remains of Kangeq. There is much to learn from these ancient cultures, especially with the new tools of analysis available to researchers, but the evidence is disappearing faster than it can be gathered.

Archaeological middens in Greenland often contain large amounts of very well-preserved organic materials. The midden at Kangeg is no exception; here large amounts of wood and bone have survived for centuries. Image courtesy of Roberto Fortuna, National Museum of Denmark.

Site Deterioration in Labrador

Similar problems with site deterioration due to thawing permafrost are ubiquitous in north-eastern Canada, including in the province of Newfoundland and Labrador. In 2016, a team of researchers sailed to Avayalik Island 25 miles south of the northern tip of Labrador to study the current condition of important Paleoeskimo sites that had been studied in 1978. In particular, they set out to determine the state of cultural deposits that were frozen and well preserved in 1978 (Kaplan et al. 2017). One such example is Avayalik-1, a Late Dorset house with multiple structures and middens, walrus caches, and other cultural materials. Under the house were a frozen Middle Dorset house and midden containing organic artifacts and faunal remains, including hundreds of wooden artifacts, strands of musk ox cordage, objects made from baleen or whalebone, and even pieces of worked hide. Analysis of these materials had allowed researchers to begin to develop an understanding of the ecology of the North Atlantic before European whalers removed large numbers of baleen whales resulting in a cascade of changes in the ecosystem. Researchers speculated on trade routes that might have brought non-native materials to the region. They hypothesized that other Middle Dorset sites in Labrador, which had yielded mostly chipped

Avayalik-1, House 1 in 2016, view looking south. Backfilled site was well sodded over. Photograph taken after archaeologists re-gridded the area in preparation for opening sample excavation units in the structure. Image courtesy of Susan A. Kaplan.

stone tools and other nonperishable materials, likely would have had similar assemblages had preservation been as good.

Today, with the myriad of analytical techniques available to researchers, the information that might be gleaned from a site like Avayalik-1 is much greater than it was in 1978. That is, if it still exists and has not slumped into the sea or melted into an indecipherable mass. In the 1970s, archaeologists gathered "only tangible, visible, culturally associated materials" (Kaplan et al. 2017, 139). Today they gather soil and organic samples and faunal remains for aDNA testing, identification of collagen-based materials, and paleo-environmental reconstructions that help us understand how people were using the resources available to them.

Thus it was the growing concern about the effects of global warming on Avayalik-1 that sent researchers back to Avayalik Island. They carried out limited excavations at the site to collect wood and charcoal samples to establish a chronology, gather soil samples and faunal remains for archaeometric analysis (unknown in 1978), and assess the stability of Avayalik-1 and other sites in the area. They documented areas that were thawing and eroding. "The dried-out deposits on the edges of the terrace are actively tumbling downslope, scattering lithic materials once contained in the deposits and displacing structural rocks. Whatever organics were once in the deposits have deteriorated due primarily to the thawing and drying out of the soil" (Kaplan et al. 2017, 145). They placed stakes to document

Profile of 2016 excavation unit in Avaylik 1, House 1. Lower portion of the cultural deposit visible in the north wall of 2N/8E shows faunal remains, a piece of cordage, and a piece of fur protruding from the wall. The light-colored deposit at the bottom of the photograph is sterile deposit. Image courtesy of Susan A. Kaplan.

erosion and photographed the landscape to create a baseline for future studies of coastal erosion.

The analysis of materials recovered from this site in 2016 will no doubt provide a more robust picture of what life was like some 1,500 years ago, in an ecologically rich area accessible to groups living as far away as Baffin Island and Hudson Bay. Perhaps it was even a central gathering place or an important stop on a vast trade route. Time is running out for researchers to gather the fragile organic materials that hold the clues to this and other stories in the Arctic.

Conclusion

This column has focused on the rapidly deteriorating condition of representative sites in the Arctic region. These repositories of irreplaceable data—these libraries—are burning around the world. Coastal sites from the U.S. to Scotland to Southeast Asia and South America are eroding into the sea due to rising tides and more violent storms.

Aerial view of Avayalik-1 taken in 2016 using a drone. The 1978 excavation is visible in the top left quadrant of the photograph. The small cove southwest of the excavation showing active erosion is at the top of the photograph. Dark green areas in the center section of the image are where melting permafrost is pooling. Image courtesy of Jamie Brake.

Researchers have been sounding the alarm and mobilizing for several decades, with increasing urgency. They have joined forces in such international and interdisciplinary collaborations as IHOPE, the Resilience Alliance, and the REMAINS project. Archaeologists are raising awareness among their peers in conference sessions, calling for coordination and collaboration across sectors and geographic regions to share resources, pool expertise, and identify and disseminate best practices. They are working with local communities, training them to observe changing conditions and carry out salvage projects. They are developing protocols for documenting which sites are most in danger or most necessary to save, given their potential to help tell the stories of human migrations and ecological-human relations. They are seeking funds to triage sites accordingly.

Researchers who work at these ancient repositories of biological and environmental data know they are nodes in long-term ecological observing networks. The alarm bells are ringing; the question is, how much can be saved before it is too late?

Footnotes

[i] NOAA National Centers for Environmental Information, "2023 was the Warmest Year in the Modern Temperature Record," Climate.gov, January 17, 2024, https://www.climate.gov/news-features/featured-images/2023-was-warmest-year-modern-temperature-record#:~:text=The%20year%202023%20was%20the,decade%20(2014%E2%80%932023).

[ii] Michael A. Rawlins, Ambarish Karmalkar, "Arctic Rivers Face Big Changes with a Warming Climate, Permafrost Thaw and an Accelerating Water Cycle – the Effects will have Global Consequences," The Conversation, March 5, 2024, https://theconversation.com/arctic-rivers-face-big-changes-with-a-warming-climate-permafrost-thaw-and-an-accelerating-water-cycle-the-effects-will-have-global-consequences-224869.

[iii] Ed Struzik, "Rain Comes to the Arctic, With a Cascade of Troubling Changes," Yale E360, February 20, 2024, https://e360.yale.edu/features/arctic-rainfall-climate-change.

[iv] William Taylor, "Melting Mongolian Ice Reveals Fragile Artifacts that Provide Clues about How Past People Lived," The Conversation, August 11, 2021, https://theconversation.com/melting-mongolian-ice-reveals-fragile-artifacts-that-provide-clues-about-how-past-people-lived-164657.

[v] Shannon Mattern, "The Big Data of Ice, Rocks, Soils, and Sediments: Inside the Material Archives of Climate Science," *Places Journal,* November 2017, https://placesjournal.org/article/the-big-data-of-ice-rocks-soils-and-sediments/.

[vi] Julianne Yip, "Partnering with Nonhumans for Climate Action," Sapiens, January 5, 2021, https://www.sapiens.org/culture/arctic-sea-ice/.

[1] For an overview of ancient DNA, or aDNA, see Hofman and Warinner 2019. For a discussion of collaboration between genetic researchers and Alaska Native communities on the North Slope, including best practices for projects involving ancestral remains or living peoples, see Tackney and Raff 2019.

[2] For discussions of recent research on the Thule migration and Inuit expansion east across North America, see Gulløv and McGee 2017 and Friesen and Arnold 2008.

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