The Effects of Climate Change on Cultural Heritage in the Polar Regions

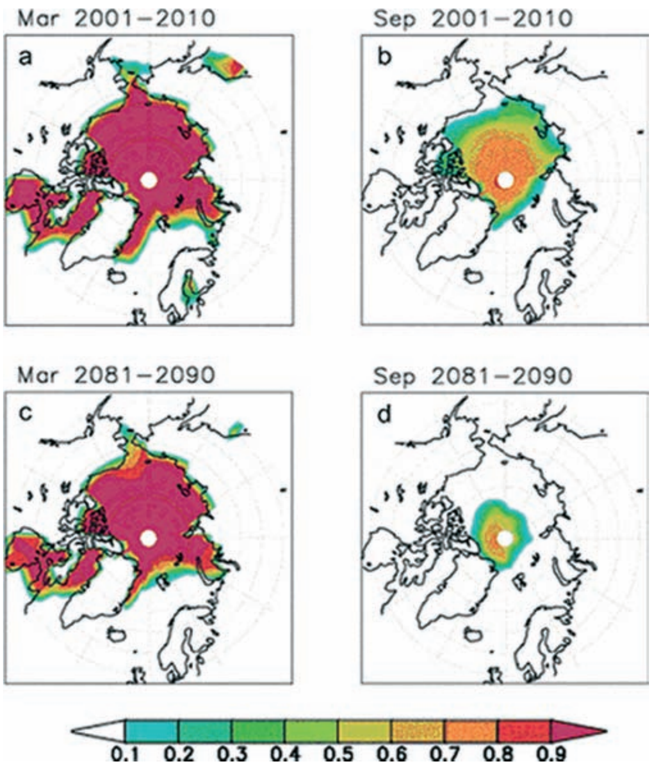
Introduction

It is a now-documented fact that the changes to the climate in the Arctic are more rapid and deeper than in most other regions of the world. Several large international research programmes address the complexity and have already presented results that show serious implications. For example, the project "International Study of Arctic Change" (ISAC) takes as its starting point changes that already affect the lives of native populations and others who live in the circum-Arctic, including changes in fishery patterns, in vegetation growth and in shipping and transport (http://www.aosb.org/isac.html).

The Centre for Climate Research (CICERO) in Norway (www.cicero.uio.no) has compiled the following facts about the latest climate changes in the Arctic:

- The average annual temperature has increased about twice as much as in the rest of the world. Glacier melting, sea-ice melting and a shorter snow season are obvious results of this.

Prognosis for diminishing sea ice in the Arctic Basin
From: JOHANNESSEN, OLA M., BENGTSSON, LENNART, MILES, MARTIN W., KUZMINA, SVETLANA I., SEMENOV, VLADIMIR A., ALEKSEEV, GENRIKH V., NAGURNYI, ANDREI P., ZAKHAROV, VICTOR F., BOBYLEV, LEONID P., PETTERSSON, LASSE H., HASSELMANN, KLAUS & CATTLE, HOWARD P., Arctic climate change: observed and modelled temperature and sea-ice variability. *Tellus A* **56** (4), 328-341.
doi: 10.1111/j.1600-0870.2004.00060.x
ECHAM4-modelled Northern Hemisphere sea-ice concentration in late winter (March) from (a) 2001–2010 and (c) and 2081–2090, and in late summer (September) from (b) 2001–2010 and (d) 2081–2090. The model has been run using the IPCC IS92 emission scenario comparable to IPCC SRES scenario B2.



- 2005 was globally the warmest year since systematic instrument registering of temperatures started in 1880. The Arctic contributed strongly to this and 2005 was an unusually warm year in the Arctic.
- The summer ice cover in the Arctic Ocean has been substantially reduced during the last years. Whole-year ice is now also melting. Between 2004 and 2005 this ice was reduced by 14%.
- Research in both Siberia and Alaska show that the permafrost is melting in the Arctic. In northern Alaska a widespread and quick permafrost thaw has been registered from 1982 to 2006. Scientists see this in connection with record-high temperatures registered in the period 1989-1998.

However, it must be stated that as with all climate scenarios, the hardest thing to predict is the future. We can show what has already happened, but the modelling of future climates and weather patterns is a complicated matter which leaves room for varying and sometimes completely opposite conclusions. The Arctic Monitoring and Assessment Programme (AMAP) writes in its "State of the Arctic report" from September 2006 (see http://www.amap.no/) that: *Many of the trends documented in the ACIA*[1] *are continuing, but some are not. Taken collectively, the observations presented in this report indicate that during 2000–2005 the Arctic system showed signs of continued warming. However, there are a few indications that certain elements may be recovering and returning to recent climatological norms (for example, the central Arctic Ocean and some wind patterns). These mixed tendencies further illustrate the sensitivity and complexity of the Arctic physical system. They underline the importance of maintaining and expanding efforts to observe and better understand this important component of the climate system to provide accurate predictions of its future state.*

The polar bear has been elected by many as the symbol of a warming Arctic and the worst-case scenario that global warming could result in. The polar bear is actually a marine mammal, not a land mammal. It is dependent on the sea ice as its hunting ground for seals, which are the bear's staple food. Catching, for example, reindeer on land or fish and seals swimming in the sea are not viable alternatives. Less sea ice results in a shorter hunting season, and ultimately (worse case), no hunting grounds at all. It can sometimes seem more difficult to bring the challenges facing the Arctic peoples, and not least the cultural heritage of the Arctic, into the public awareness than the fate of the animal "king of the Arctic".

The Arctic Peoples website http://www.arcticpeoples.org/KeyIssues/ClimateChange/Start.html mentions the fact that many non-Arctic people might think that a warming climate is an advantage for those living in the Arctic region. On the contrary, they point out, the Arctic people are well adapted to their traditional climate. A warming climate brings such problems for them as less sea-ice for transport and hunting, more erosion of coastal community shorelines, permafrost movement which disturbs pipelines and building foundations, and more insects which negatively affect reindeer as well as traditional methods of fresh-meat storage.

The warmer ocean and the colder land meet at the coastal zone, and it is in the coastal zone in the Arctic that most human activity and settlement has occurred and still takes place. Cultural heritage and current activities are therefore deeply affected by major changes in the coastal zone, whether it be erosion or land gain. In fact it is erosion that is the main problem for cultural heritage protection around the entire Arctic region, as the two case studies from

San Sebastian, Bjørnøya, erosion of the remains of a mixed site (Photo: Susan Barr)

Ytre Norskøya, excavated 17th century whaler's grave (Photo: Susan Barr)

North America (see Olynyk and Chapple in this volume) describe. During the ice-free summer season, wave action can erode coastal zones up to several metres a year, while the water-land interface during this period warms the newly exposed permafrost surfaces, thus accelerating the erosion process (see the Arctic Coastal Dynamics project, eg. report 2004 at http://www.awi-potsdam.de/acd/ws5-Dateien/5th_ACD_Report_w_links.pdf). With the above-mentioned summer and whole-year ice melting in the Arctic Basin, the coastal erosion will increase.

In the early 1980s in the Norwegian Arctic archipelago of Svalbard, 17th century corpses were exhumed which still had skin and hair intact. Similarly from a graveyard in Alaska in the 1990s it was possible to extract lung tissue for virus analysis from victims of the huge "Spanish 'flu" pandemic in 1918-19 which killed around 20 million people world-wide. The corpses had in effect in part been freeze dried by the cold and dry climate, and in part preserved in the permafrost. A warmer, more moist climate and a deeper "active layer" which thaws each summer and freezes again each winter, will affect such burials as well as other historic organic matter.

The following information from the North Slope of Alaska[2] illustrates some of the points mentioned above:

In the Arctic, the thin layer of soil on top of the permafrost that thaws every summer, the "active layer," will get deeper as the climate warms. Cultural resources that have been permanently frozen will be subjected to annual freeze-thaw cycles. Surface resources that are anchored in the permafrost may be destabilized.
The continuing decline of summer sea ice cover, resulting in more fetch, already is creating considerable increases in coastal erosion, much of which is caused by wind driven waves. A deeper active layer and potentially more or stronger storm systems add to the destructive impacts of wave action.
Here in northern Alaska, the rate of erosion of Nuvuk, the abandoned [native] village at the tip of Point Barrow, has increased considerably in recent years. The graveyard at the same location holds several hundred burials, of which the archaeologists are lucky to save those that begin eroding each year. This site is only 11 miles from Barrow, so relatively easy for teams to access for mitigation. Cultural resources sites at greater remove are not even visited every year.
A more comprehensive inventory of sites needs to be developed, including smaller locations such as temporary camps and supply caches. Sites need to be rated on their potential value to the public and to science, and the level of threat (immediate, mid- and longterm) to each should be identified.

Facing the challenges

Here we come to the next stage of this climate challenge. Is the future only dark for cultural heritage in the Arctic, or is it possible with mitigation to prevent or alleviate the loss of cultural heritage?

The first step is obviously to recognize the challenges. Although we do not know whether the gloomiest scenarios will ever be fulfilled, we do see certain climate-change effects happening right now. We can also imagine that certain effects might increase before the climate trend may turn again and lead us happily back to more "normal" conditions. So, being better safe than sorry, there is no harm in taking mitigating actions right now against the worst-case scenarios of the future. Such actions may mean the difference between saving and loosing important aspects of the cultural heritage during negative climate-change impact or – if the climate actually does not follow the doomsday prophecies – the actions will anyway greatly benefit cultural heritage in the future, climate change or not.

As mentioned by Glenn Sheehan above, an important step is documentation of the sites of all types, large and small. In cases where it seems fairly certain that climate change effects such as erosion will destroy the site within a limited time period, the inventory must conclude with either a complete documentation (with or without an archaeological survey as appropriate) of the site which ultimately will be lost, or measures to prevent or alleviate the erosion threat. Of the latter can be mentioned breakwater or erosion barriers of stone, wood or other materials, or even moving the heritage structure further inland where this may be feasible. Unfortunately some important sites will be impossible to save, but the information from a thorough documentation will still allow the heritage to live on for research, education and in some cases reconstruction purposes. This is a problem and solution challenge which applies to many other regions of the world too and where information exchange on mitigation ideas can be beneficial.

Increased fungal and bacterial growth on organic materials at heritage sites is not a new phenomenon for Arctic sites, but is a phenomenon which is increasing from a relatively marginal conservation issue to become a major challenge. Happily, innovative scientific work is addressing this issue now, and scientists familiar with the issue either in the Arctic or the Antarctic are getting together to compare the problems in both regions and discuss solutions. The same applies to increased chemical reactions caused by chlorines and other salts in the wind-blown spray and increasing rainfall at Arctic (and Antarctic) heritage sites.

As indicated above, the climate challenges facing heritage sites in the Arctic are similar in the Antarctic, although there are varying degrees of impact. The article by Chaplin in this issue, describes climate-change impacts on one of the internationally-significant Antarctic heritage sites. Again it may be mentioned that cooperation on research and mitigation between Arctic and Antarctic scientists is increasing and producing results applicable for both regions.

Hot problems and warm problems

At a recent climate-change workshop at University College London (Noah's Ark project http://www.ucl.ac.uk/sustainable-heritage/noah.htm), the worry was expressed by a southern European delegate that increased summer temperatures will negatively affect tourism to heritage sites in his region that are dependent on the income from tourism for adequate maintenance. This may obviously apply also to other hot regions of the globe. In the polar regions the effect is opposite, but may be negative in another way. Less sea ice opens the way for more tourism access, and cruise tourism to the Arctic and Antarctic can be said to have exploded during the past years. In Svalbard the number of persons put on shore from cruise ships during the short summer season increased 13 fold from 1996-2005. In the south there were 10,000 passengers to the Antarctic Peninsula 10 years ago. In 2006 there were 35,000. This may not sound much compared to more accessible and warmer regions, but in the polar regions the effect can be that delicate sites with at best marginal, but still crucial, vegetation cover may be trampled by well-meaning, but still damaging feet; erosion may be accelerated; and loose objects that have been protected for decades and centuries by snow and ice, may be damaged or removed. Protection of these delicate sites demands great care and understanding from the cruise operators and local guides.

Over climate boundaries

Because of the early-warning effect the more pronounced climate changes in the polar regions, particularly the Arctic, can give to the rest of the world, a large amount of research and data collection is already available on the subject. Similarly, because the climate changes already are affecting heritage sites in both the Arctic and Antarctic, scientists have been addressing the challenges for the past few years. Many of the increasing problems are common for other regions of the world too, and it should therefore be fruitful for scientists involved in climate change and heritage projects to work together over regional and climate zones.

More practical information and descriptions of challenges can be found in the three case study articles by Chaplin, Chapple and Olynyk.

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Ebeltofthamna, erosion of a 17th century graveyard into the sea (Photo: Trygve Aas)

[1] ACIA = Arctic Climate Impact Assessment, a climate research programme that reported in 2004 and 2005.

[2] Provided by email to this author from IPHC US member Glenn Sheehan, Barrow Arctic Science Consortium, Barrow, Alaska.