SPECIAL FOCUS:
GLOBAL CLIMATE CHANGE

ICOMOS Climate Change Initiatives: A Cooperative Project with International Committees

Global Climate Change is a topic being discussed in a major way at the international level, involving governments, development banks, environmentalists, businesses, etc. A British study released on 30 October 2006 "conclude[d] that rapid and substantial spending to combat global warming is needed to avert a catastrophic reduction in worldwide productivity on the scale of the Great Depression that could devastate food sources, cause widespread deaths and turn hundreds of millions of people into refugees" (Kim Murphy, "Warming Forecast: Economic Disaster", *San Francisco Chronicle*, October 31, 2006, page A1). The field of natural heritage has been an important component of these discussions and yet cultural heritage issues have been woefully underrepresented.

In September 2006 in Edinburgh, ICOMOS's Scientific Council voted to accept Global Climate Change (GCC) as the topic for interdisciplinary scientific research. A brief was prepared in November 2006 as a document presenting the Scientific Council's strategy and program to contribute to the work of ICOMOS in relation to the theme of Global Climate Change. The Scientific Council and its membership of International Scientific Committees of ICOMOS have developed this initiative to bring together the various professional and scientific fields of the organization to bear on this increasingly threatening subject. It is being implemented by the Scientific Council in coordination with other initiatives of ICOMOS or its National Committees, particularly in the context of Resolution #35 of the 15th General Assembly adopted in Xi'an (China) in October 2005, and/or in support of ICOMOS's contribution to research undertaken by the World Heritage Center relative to climate change and World Heritage, in accordance with the decisions of the World Heritage Committee.

Background

Among the international cultural heritage community, Global Climate Change was first suggested as a topic for interdisciplinary research at the International Scientific Committee (ISC) retreat in Bergen, Norway, in September 2004. During ICOMOS's 15th General Assembly held in Xi'an, China in October 2005, Resolution 35 on Climate Change was unanimously adopted. During the Scientific Council meeting in Rome in June 2006, GCC was adopted as an Inter-ISC scientific theme by the International Committee on Risk Preparedness (ICORP), the International Polar Heritage Committee (IPHC), and the International Scientific Committee for Earthen Architectural Heritage (ISCEAH). It was agreed that a preliminary report would be presented at the Scientific Council meeting in Edinburgh in September 2006. This led to its adoption by the Scientific Council.

The World Heritage Committee has also shown interest in this topic. During the Committee's 29th session, the World Heritage Center (WHC) was asked to convene a working group of experts to explore the impacts of climate change on World Heritage (Decision 29 COM 7B.a). As a result, a special expert meeting of the World Heritage Convention *(World Heritage and Climate Change)* was convened in Paris at UNESCO's headquarters on 16-17 March 2006. The meeting, supported by the government of the United Kingdom and the United Nations Foundation, was held between the World Heritage Committee, World Heritage Center, the Advisory Bodies (ICOMOS, IUCN and ICCROM), and experts from around the world. This led to the development of a document, "Predicting and Managing the Effects of Climate Change on World Heritage" (WHC-06/30.COM/7.1, available on the web at http://whc.unesco.org/uploads/news/documents/news-262-1.doc) which was issued at the 30th Session of the World Heritage Committee in Vilnius, Lithuania in July 2006, as well as the adoption of Decision 30 COM 7.1.

In early November 2006, the United Nations Environment Program (UNEP) hosted the 12th Conference of the Parties to the UN Framework Convention on Climate Change and the 2nd Meeting of the Parties to the Kyoto Protocol in Nairobi, Kenya. UNEP and researchers from the Stockholm Environment Institute have recently issued a report, *The Atlas of Climate Change: Mapping the World's Greatest Challenge* (available for purchase through www.earthscan.co.uk and www.ucpress.edu). Achim Steiner, UN Under-Secretary-General and UNEP Executive Director, stated that "We must … use our intelligence and scientific know-how to assist managers of culturally important sites like buildings and archaeological finds. Losses here as a result of climate change may impact on the livelihoods of local people and, especially in developing countries, add to poverty…" Koichiro Matsuura, Director-General of UNESCO, further said in reference to World Heritage Sites, "Protecting and ensuring the sustainable management of these sites has, therefore, become an intergovernmental priority of the highest order" ("National Parks, Ancient Artifacts, Monuments and Barrier Reefs at Risk from Global Climate Change", UNEP Press Release, 7 November 2006). UNEP's climate change website for the UN Climate Change Conference is http://www.unep.org/themes/climatechange/UNFCCC/.

UNEP and the World Meteorological Organization established in 1988 the Intergovernmental Panel on Climate Change (IPCC). Its role is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. IPCC does not carry out research nor does it monitor climate-related data or other relative parameters. It bases its assessment mainly on peer-reviewed published scientific and technical literature. IPCC publishes periodic assessments of the nature and impact of climate change. The Third Assessment was issued in 2001. The Fourth Assessment is being published in successive parts during 2007. All its publications can be found on the IPCC website (http://www.ipcc.ch/).

The Scientific Council Initiative

From the preliminary GCC report prepared by IPHC and ISCEAH and submitted to the Scientific Council at the Edinburgh Scientific Council meeting in September 2006, as well as from the WHC report, it is obvious that there are and will be serious ramifications of GCC to cultural heritage. The WHC report also confirms that

IUCN is way ahead of ICOMOS in terms of its research on this topic. This is most likely a result of the fact that the environmentalists have been studying the effects of Global Climate Change on natural heritage for several decades. The WHC report, however, identifies key areas of concern for GCC's effect on cultural heritage. These include:

a) The uncertain state of conservation for sensitive archaeological materials preserved underground once the equilibrium of burial is altered due to changes in the hydrological, chemical and biological processes of the soil.
b) Increases in soil moisture resulting in greater salt mobilization having damaging effects on historic buildings, which tend to be less isolated from the ground and to be constructed of more porous materials than their modern equivalents.
c) Migration of pests in altitudes and latitudes subjecting timber and organic construction materials to increased biological infestation.
d) Increased flooding causing deterioration to materials that cannot sustain prolonged immersion and potentially encouraging damaging microorganism growth (mould), in addition to the risks posed by the eroding effects of rapidly flowing water.
e) Structural damage caused by increased strength of storms and wind gusts.
f) Moveable heritage subjected to higher RH, temperatures and UV exposure.
g) Implications to societal systems and resulting population migrations due to environmental conditions, like drought, which are no longer conducive to sustaining traditional ways of life (agriculture, human health, and infrastructure). This would amount to a loss of local populations who effectively sustain and maintain various cultural sites (WHC-06/30.COM/7.1, pages 29-32).

In addition to this list, we add:

h) Economic impacts due to loss of cultural tourism. Conversely, impacts to fragile materials due to increase of cultural tourism at previously less accessible sites.
i) Resulting losses to intangible heritage, cultural landscapes, vernacular construction technologies, and sustainable construction and repair practices.
j) Increase of freeze/thaw cycles and their effect on porous building materials.
k) Differential settlement causing structural damage due to changes in soil compaction through dewatering or increase in ground water levels.

Goals

As a first step, the goals of the Scientific Council initiative are for the International Committees to perform the research necessary to produce a report of case studies linked to the scientific data on GCC. The results are published herein as a special "section" of *Heritage at Risk*.

Our next step is to organize a scientific symposium at the Advisory Committee meeting, scheduled for the fall of 2007 in Pretoria, South Africa, in which the focus will be to propose conclusions and recommendations for adaptation to the effects of GCC in reference to cultural heritage sites. At this point, initiatives for creating and implementing Inter-ISC cooperative adaptation projects will also be proposed and adopted.

Following this, a second meeting may be organized for the late spring of 2008 bringing together interested parties and reviewing the preliminary results of the Inter-ISC cooperative adaptation projects and strategies.

Research

Each International Committee and interested National Committee designated a representative who joined the Inter-ISC Global Climate Change (GCC) working group and cooperated on the reports. The GCC working group began researching GCC's effects on cultural heritage in their particular area of expertise or geographical location.

International Committees and interested National Committees were encouraged to interact with relevant national and international organizations studying GCC. (Several universities have programs studying GCC including the Center for Sustainable Heritage at the University College London, and Yale, Michigan State and Duke University in the US. The International Committee of the Blue Shield is an organization which also comes to mind.) Scientific data for GCC exists but has seldom been collated and interpreted towards its effects on cultural heritage. Anecdotal evidence needs to be qualified by scientific climatic data, if we are in any way to influence decision makers. This data is a product of long-term monitoring.

Although case studies cited are not specifically about World Heritage Sites, the final product of the Inter-ISC Cooperative Project produces material that is useful to and informs the research of the WHC.

Report Structure

Generally, the reports were structured as follows. Sites were identified and designation status indicated (WH site, nationally or locally designated, etc). Following this a description of the general conditions of the place was included. The reports then described the anecdotal evidence, physical evidence, and meteorological data. Risk preparedness strategies, if they are in place, are evaluated.

Some of the questions reports sought to answer are:

- What is the current situation?
- What is the predicted future climate change?
- How rapidly is it changing?
- What are additional causes (other than general climate change), like pollution, lack of risk preparedness and adaptation, etc?
- What are the consequences of climate change impact in the short, medium and longer term?
- Is the site being recorded either for posterity or to monitor change?
- What is the proposed adaptation remedy (if any)?
- What are the site managers actually doing to cope with the predicted impacts?
- What else needs to be done and when?

In addition, reports were asked to be mindful of differences between Kyoto Protocol non-signatory (Australia, USA, India, China, etc) and signatory countries. What are signatory countries doing differently to prepare for the effects of climate change on their cultural heritage sites and what are the results of these actions? From these case studies, can strategies be developed to lobby non-signatory countries?

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Global Climate Change: Every Cultural Site at Risk?

Despite the 150,000-year pedigree of modern humans, the ice age that ended about 12,000 years ago forms a left parenthesis to virtually all of the major constructive activity of humankind. As much as we may cherish our surviving architectural and archaeological heritage, its destiny, like ours, is dust. Yet it is precisely this ephemerality that makes us appreciate the richness of human existence and the consequent value of preserving diverse exemplars of past cultural expressions. It is, therefore, with no trace of fatalism that we confront an environmental challenge beyond our collective experience, one rooted in divisive power politics, yet requiring unified action on a previously unimaginable scale.

Growing scientific consensus on the existence of global warming has led to a shift in public and scholarly discourse toward consideration of its likely effects. While it is clear that the impending challenges to heritage preservation posed by global climate change will pale next to the human and environmental costs, it is nevertheless incumbent upon heritage specialists to anticipate and adapt to these problems to the extent possible. In keeping with the theme of Heritage at Risk, my aim is to outline the major adverse impacts of global climate change on cultural heritage.

It is ironic that the combustion of carbonized life-forms - themselves victims of past environmental catastrophe - constitutes the principal threat to present-day life on earth. The accumulation of "greenhouse gases" - carbon dioxide, methane and nitrous oxide - caused by the burning of fossil fuels, and to a lesser extent, deforestation, trap heat within the earth's atmosphere. The ability of the earth to retain heat is critical to its long-term equilibrium, but too much heat retention leads to rising mean global temperatures, or global warming. Among the evidence for a recent warming trend is the observation that eleven of the last twelve years rank among the twelve years with highest average global surface temperature since 1850, when reliable records began (IPCC 2007a).

The scope and complexity of the probable effects of global warming defy precise estimation. The repercussions will cascade across time and space, varying with local conditions and future production or reduction of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC), the leading relevant international scientific research group, couches their projections in terms of competing scenarios. To provide such multi-track analyses specifically for cultural heritage is beyond the available data and the capabilities of the author. Here we simply consider direct, environmental and indirect, social impacts.

The main climate change parameters affecting cultural heritage are temperature change, atmospheric moisture change, sea level rise, wind, desertification, pollution and biological infestation (WHC 2006). Rising temperatures are melting polar and high altitude ice and snow and are causing the thermal expansion of seawater, resulting in an uneven global increase in moisture. This supercharging of the hydrologic cycle results generally in higher humidity, greater precipitation, higher sea levels, and more groundwater. Yet patterns of oceanic and atmospheric circulation cause some regions, particularly in the Tropics and Subtropics, to experience drier conditions accompanied by heat waves, drought and wildfires. A further outcome of higher temperatures and atmospheric moisture content is an increase in the frequency and severity of storm events. The resulting changes in seasonality, the availability of food and habitat, biodiversity, nutrient cycling, stress, disease vectors and other factors will have increasingly profound consequences for the composition, distribution and survival of biotic communities around the world.

According to the IPCC, global mean temperatures are expected to rise by 1.4 to 5.8° C by 2100 (WHC 2006). This increase will result in more extreme seasonal heating and cooling, altering the severity and periodicity of freeze/thaw and wet/dry cycles. This leads to problems for buildings such as biochemical deterioration, damage due to water infiltration and freezing, and frost damage. Structures at the Indus Valley site of Moenjodaro, Pakistan, for example, are suffering damage due to thermal stress. The stratigraphy and integrity of archaeological sites are prone to deterioration caused by freeze/thaw-related ground movement and to decomposition due to the introduction of microbes to previously frozen environments. A recent 2° C temperature increase observed in mountainous southern Siberia, for instance, portends the thawing and destruction of the contents of 1,500-year old Scythian burial mounds (WHC 2007).

Atmospheric moisture change threatens cultural heritage in a multitude of ways. It is associated with increased humidity, rainfall and flooding; glacial lake outburst floods, changes in ground water and water tables; and altered soil chemistry. Resultant problems include rising damp, salinisation, erosion, subsidence, waterlogging, mold, ground heave, corrosion of metals, and deterioration of materials due to relative humidity shock. Increasingly heavy rainfall is implicated in subterranean erosion of Palatine Hill in Rome, and structural deterioration of earthen architecture at early Buddhist temple sites in Ladakh, India; the colonial town of Coro, Venezuela; and the archaeological sites of Chan Chan and Túcume in Peru (WMF 2007). Subsurface archaeological remains are also increasingly affected by erosion, chemical alteration, and the introduction of waterborne agents to previously desiccated or anaerobic environments. The melting of coastal sea ice is subjecting archaeological sites and historic structures in Arctic North America to high levels of storm surge and wave action, causing their loss due to erosion.

Climbing global temperatures are predicted to result in a sea level rise of .09 to .88m by 2100 (WHC 2006). Not only does this spell disaster for low-lying coastal areas and islands, but it also presents sites and structures with dangers due to storm surge, erosion by wave action and the incursion of salt water. Well-known examples of World Heritage Sites for which sea level rise is a looming menace include historic Venice and Westminster Palace, the Tower of London and the historic ensemble at Greenwich in London. Shoreline heritage properties in places such as Great Britain, western North America, Australia, New Zealand, Oceania, and western Africa are increasingly subject to damage by coastal erosion.

Changes in the frequency, severity and timing of extreme weather events associated with GCC will expose structures to potentially damaging wind and wind-driven salt, sand and rain. These can erode surfaces, penetrate porous materials, and cause static and dynamic loading (WHC 2006). In a 2005 survey of World Heritage States Parties, the most frequently cited threat to cultural properties was hurricanes, storms and lightning (WHC 2006). Recent severe storm episodes impacting immovable heritage include Hurricane Katrina, which damaged or destroyed thousands of historic buildings in southeastern USA, the 2006 flash flooding of the twelfth-century site of Sukhothai in Thailand, the 2002 inundation of the historic center of Prague, and the 1994 flooding of the Citadel of Alessandria in northwest Italy (ICOMOS 2005).

The chief danger to historic structures and archaeological resources in some areas will be the lack, rather than the surfeit, of water. Heat and drought cause evaporation and lowering of water tables, drying out structural materials and exposing them to salt weathering. Salt efflorescence is a major problem at Moenjodaro in the Indus Valley, Pakistan, for example. Notable examples of the desertification of heritage sites include the fifteenth/sixteenth century mosques of Timbuktu, Mali and the Chinguetti Mosque, Mauritania (WHC 2007).

According to the recent World Heritage Report on climate change and world heritage, the deleterious effects of global climate change and airborne pollutants on stone and metal is mutually reinforcing. Increasing levels of atmospheric sulphur dioxide and nitrogen oxides (one of which is nitrous oxide, a greenhouse gas), caused by the burning of fossil fuels, are producing higher incidences of acid rain. While acid rain is not causally related to global warming, the effects of acid rain combine with the effects of climate change to hasten processes of decay. Airborne pollutants and acid rain are known to be damaging monuments at the Pre-Columbian site of El Tajin in Mexico, the petroglyphs of the Dampier Rock Art Complex in Australia, and grave markers at the Cimitero Acattolico in Rome, Italy (WMF 2007).

Global temperature increases lead to the spread of insects and other potentially damaging organisms into previously inhospitable areas, putting organic materials at risk. In addition to the spread of invasive pests, global warming will facilitate the proliferation of potentially harmful indigenous organisms, including fungi, mold and insects, as they expand their range and adapt to changing conditions. The wooden structures of Omo Hada in Indonesia and the woodwork of buildings in the Sonargon historic complex in Bangladesh are both included in the World Monuments Watch List of the 100 Most Endangered Sites due to biological/insect infestation. Although these cases cannot be attributed to climate change, they represent situations likely to be encountered at ever-higher latitudes in the future. It is likely that rising oceanic temperatures will permit expansion of the wood-eating teredo worm, whose intolerance of cold waters explains the remarkable preservation of shipwrecks such as the Swedish warship Vasa.

The effects of global climate change will inevitably extend to landscapes and their associations with heritage properties. Not only is there the potential to impair the settings and constitutive values of significant places, but there is also a risk of losing traditional building materials. The original relationship between the design, materials and use of historic buildings, on one hand, and local climatic conditions, on the other, is susceptible to environmental perturbations that may result in abandonment, demolition or unsympathetic alteration.

While the direct, environmental impacts of global climate change are profound, the human responses to these changes may pose the greatest threat to cultural heritage. The eventual loss of glacial meltwater, the incursion of salt water and increased evaporation of fresh water will expose hundreds of millions of people to shortages of potable water. Extensive changes in ecosystem functioning will differentially impact agriculture, fisheries, animal husbandry, forestry and other forms of food production. Ecological changes will result in the widespread movement, behavioral change and/or extinction of plant and animal species, with far-reaching consequences for human subsistence practices. Rising sea levels threaten millions of people living on low islands and in coastal areas, such as the mega-deltas of Asia and Africa. Increased incidence of environmental disasters, including floods, fires, droughts and hurricanes, as well as malnutrition, cardiovascular, respiratory and infectious diseases make up a sampling of the health hazards associated with global climate change.

It is sobering to reflect on the consequences of even one of these scenarios, let alone a combination of them. Economic destabilization, disinvestment, modified land use, local and regional conflict and mass migration are plausible outcomes. Current patterns of socio-cultural dislocation associated with rural-urban migration, industrialization and economic polarization will be exacerbated by these shifts, leading to increases in looting, the insensitive exploitation or ideologically-motivated vandalism of heritage sites, the redevelopment of urban cores and the relative devaluation of land for its intangible qualities.

Tragically, the negative consequences of global warming will be felt most strongly in the countries least equipped to deal with them: rainfall patterns are shifting precipitation away from the equator, toward the poles; one quarter of the African continent is already in the process of desertification (WHC 2007). While wealthier nations are investing in water desalinization facilities, flood barriers and drought-resistant seeds, African countries - which collectively are responsible for just 3% of total greenhouse gas emissions - lack the resources for such protective measures (Revkin 2007).

There is growing appreciation among heritage professionals that the fates of tangible and intangible heritage are intertwined. Given the differential persistence of indigenous cultural groups in the remoter parts of less-developed countries, and the disproportionate impact of global climate change on many of those same countries, there is reason for alarm. Just as global warming puts already marginal ecosystems and species at greatest risk, so too does it especially imperil those cultures and sites with the least room for maneuver.

Everywhere, global environmental change will prompt new human adaptive strategies that may conflict with traditional beliefs regarding the social role of sacred sites, historic structures, cultural landscapes and archaeological remains. These new imperatives could undermine the viability of traditional lifeways, sacrificing long-held knowledge of crafts, industries, conservation methods, and much more along the way. In places such as Amazonia, much of which is destined to become savannah in the coming decades; the Arctic, where melting ice and rising sea levels are drastically altering subsistence regimes; or Oceania, where the homelands of some Pacific island societies are threatened with inundation by rising sea levels, the very survival of indigenous cultures is at stake.

It is easy to conceive of cultural heritage as a prostrate victim before the onslaught of relentless, inimical *Climate Change.* Yet I would argue that the regenerative power of heritage to unify, inspire and galvanize individuals will be a key to our success in confronting this challenge. The effects of global warming will alternately interrupt and reinforce the centrifugal and centripetal tendencies of globalization, elevating the importance of cross-cultural cooperation and understanding. The trial of climate change holds the challenge for heritage professionals to embrace the political nature of their work and the opportunity for them to meaningfully integrate the conservation of natural and cultural heritage. Heritage sites have the power to provoke public introspection, reawakening cultural memories of crises met, and by reminding us of our varied pasts, suggest the possibility of alternate futures.

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Landscape Heritage, Biosphere Change, Climate Change and Conservation A General Approach and an Agenda

Introduction

I began writing this discussion paper in an attempt to find a rational approach and way of structuring the complex question of how Global Climate Change might affect the landscape heritage, the cultural heritage in general, and their conservation. The purpose of this was to find an approach that will assist the processes of thinking, researching, teaching; providing guidance on the subject; and finding practical solutions to the challenges that are posed by the phenomenon of Global Climate Change. But it also has another purpose which is to help open up a discussion about how Global Climate Change, landscape heritage and conservation relate to the wider topic of Biosphere Change and what are the main current priorities for the landscape heritage sector.

Biosphere Change

At an early stage in thinking about the question of a rational approach, it became evident that the subject of Global Climate Change is in fact part of a larger phenomenon and needs to be seen in this wider context and not simply on its own. The larger phenomenon is that of Biosphere Change. The Biosphere consists of the surface layers of the Earth and its atmosphere and Biosphere Change includes such things as environmental deterioration (incorporating the effects of pollution and over-population), environmental improvement, ecology, the ecology of humans, the quality of life for both humans and non-human life, and of course, Global Climate Change.

The current changes that are taking place in the Biosphere are due to many factors, mostly it would seem connected with humans and human activity. The changes appear to be accelerating in the direction of severe environmental deterioration on a global basis.

Global Climate Change

It is a widely held opinion that Global Climate Change is now one of the most significant factors that is causing negative Biosphere Change; that Global Climate Change is being caused by Global Warming; and that humans and human activities are now a primary cause of Global Warming. The primacy of the human contribution to Global Warming is widely accepted but it is not a universally held view.

The increase in Global Warming is generally measured in terms of the increase in Global Mean Temperature and this has been adopted as a way of measuring the extent of Global Climate Change and of indicating the nature of the effects that it will have on the world. A rise of 1 degree Celsius in the Global Mean Temperature represents the range of 0.5 – 1.5 degrees C; a rise of 2 degrees represents a range of 1.5 – 2.5, and so on (Stern 2006 p. 65). The increase is that which is calculated to have taken place since the period 1750-1850. From a global perspective, this period is referred to as being 'pre-industrial'.

The Stern Review comments on the effects of rising Global Mean Temperature in the range of 1 to 6 degrees C. It is thought that above 5 degrees, 'the "socially contingent" effects could be catastrophic' (Stern 2006 p. 69).

Landscape Heritage (including gardens and parks)

A suggested primary definition of landscape is as follows: *'A landscape is a concept, a real or imaginary environment, place, image or view in which the land, and natural and semi-natural elements, are prominent, dominant or the only ones. Landscapes may, and often do, include humans and man-made components as well. They are the product of the appearance, uses and perceptions of places that are part of the outdoor environment.'* (GARLAND Guidelines: 1. Topic: Landscape. 15 May 2007).

In relation to those of a physically real kind, and at the broadest level of characterisation, the main general types of landscape can be described as being:

1. Uncultivated Landscapes (Natural and Semi-natural Landscapes);
2. Cultivated Rural Landscapes;
3. Urbanised and Industrialised Landscapes;
4. Gardens, Parks and Designed Ornamental Landscapes.

'Uncultivated Landscapes' covers the range from 'wilderness' to land that is managed by humans but not cultivated in the sense of being ploughed, or having the surface broken up or planted with non-local plants. Wilderness is a natural landscape in which the effects of human intervention are entirely absent or minimal.

'Cultivated Rural Landscapes' refers to land that has been settled by humans and where arable cultivation (i.e. ploughing, or having the surface broken up) and the growing of non-local plants are a main feature of the local economy and way of life.

'Urbanized and Industrialized Landscapes' are landscapes where urban and industrial developments are prominent or dominant. These terms appear to be inconsistent with Garland's definition, above, but are useful when the land, natural or semi-natural elements are less than prominent, but where one wishes to emphasize or call attention to their existence.

'Gardens, Parks and Designed Ornamental Landscapes' are usually found within Cultivated Rural Landscapes and Urbanised Landscapes. The characteristics that make them distinctive are the high level of ornamental work, aesthetic modification and improvement, and horticultural activity that they exhibit. (GARLAND Guidelines: 1. Topic: Landscape. 15 May 2007).

Heritage is made up of those things that are inherited or inheritable. It includes those that we inherit from other people as well as those that come from the past in general. The people from whom we inherit may be living or dead. Heritage also includes the things that we, in turn, pass on to others either in the present or the future.

The things that are inherited may belong to either the natural or the cultural dimensions of life and environments, or to both at the same time. The word 'cultural' signifies those things that are of human origin or the result of human activity. The historical dimension is one aspect of both the natural and the cultural; it places things in time and relates them to the different contexts that exist during the course of time.

Heritage includes not only tangible (physical) objects, but also intangible ideas, responses and skills. This definition accepts that we can add to heritage on a continual basis and at the same time we can conserve and care for those things that we inherit and that are of value in one way or another. These two approaches to heritage do not necessarily exclude each other, where they do come into conflict with each other, specialist knowledge and assessment will be needed to find a resolution.

Landscape heritage is a combination of natural heritage and cultural heritage. It embraces both dimensions.

Structuring our Thinking about Biosphere Change and Landscape Heritage

Global Climate Change affects every aspect of nature and life. Its effects will be all pervading on a global basis because it will bring significant and fundamental changes to the processes by which the Biosphere currently functions. It has become usual in Western civilization for people to operate on the basis that these processes are normally fairly stable, constant, orderly and predictable. However, phenomena such as significant rises in Global Mean Temperature will cause life to become increasingly more unstable, inconstant, disorderly and unpredictable; in other words more chaotic.

Another important factor is that changes may take place slowly and incrementally over a seemingly long period in relation to an average human lifetime, and this can lead to them being underestimated or even ignored by humans. An apparently long period for humans may however be a very short period in terms of the natural adaptation of species and other natural processes. The survival of species may be made more precarious by the relative rapidity of the changes.

Biosphere Change is a very large and complex subject and a basic, reliable and generally usable way of structuring it is required both by specialists and everyone else so that it can be dealt with on a rational and logical basis, a 'scientific' basis in fact.

The concept of 'Nature' is a good starting point for structuring the subject of Biosphere Change in relation to its effects on landscape heritage. Nature may be thought of as consisting of two main ingredients, i.e.:

1. Non-living Nature (Inanimate Nature).
2. Living Nature (Animate Nature).

Non-living Nature includes: energy, temperature, atmosphere, water, climate, rocks, and minerals.

Living Nature is made up of the scientifically recognized Kingdoms of living things. There are at least five of these (New Encyclopaedia Britannica 2003, vol. 14, pp 1094-1095):

1. Monera (including bacteria, archaebacteria, blue-green algae)
2. Protista (Algae other than blue-green algae, slime molds, protozoa)
3. Fungi (Molds, mushrooms and toadstools)
4. Plantae (Typical green plants from mosses and liverworts to flowering plants of all kinds)
5. Animalia (Animals, from sponges and mezozoans to mammals)

From a human perspective, and because humans are now such a dominant and environmentally influential life-form, it is often useful to think of living nature as also having two main ingredients, those of human life and non-human life. Amongst the factors that distinguish human life from non-human life are the exceptionally high ability of humans to:

1. Observe objects and phenomena very closely and remember them;
2. Think abstractly and imaginatively;
3. Think and act on a rational basis;
4. Reason and act on the basis of what is 'good' and 'bad' for them;
5. Engage with their environment and particular places, and modify them;
6. Make inanimate objects;
7. Communicate feelings, thoughts and ideas.

Collectively, the factors that distinguish humans from other forms of life can be referred to as the 'cultural factors'. It might be argued that, in origin, the cultural factors are natural; some would say that they are divine. Whatever their origin, at some point in human evolution, it has become a very prominent and semi-independent ingredient of humans. This semi-independence gives rise to a duality in humans which might be regarded as being a partnership between primary human nature and the cultural factors. These are the two main ingredients of Humanity, but the concept of 'Humanity' usually implies that the cultural factors are dominant.

This leads to the question of whether Humans are to be regarded part of Nature or not. It is clear that they are part of it, but at the same time there is a very important part of them that is not the same as the rest of Nature. This important difference needs to be recognized, and this is why it is a useful convention to think of humans as being a distinctive form of life. Within this context, Nature might be defined as 'that which exists or occurs without being consciously planned by humans, either as individuals or as groups.'

The subject of Biosphere Change may be considered under the sub-headings provided by the three main ingredients of Nature described above. They may be referred to as the three primary components of the Biosphere. They are:

1. Non-living Nature (Inanimate Nature);
2. Non-human Life;
3. Human Life (Humanity).

Each of these represents a main vehicle through which the dynamic forces that determine the course of events in the Biosphere operate. Of course, these three primary components interact with each other.

Opening up a Discourse on Biosphere Change

A discourse on Biosphere Change in relation to landscape heritage, and indeed in relation to other forms of heritage, can be opened up by applying four Key Questions, individually or in combination, about each of the Primary Components of the Biosphere. Three of the Key Questions are about the effects of Biosphere Changes and the fourth is about the action that might be taken. The four questions are:

Key Question 1: What effects will, or might, Biosphere Changes have on each Primary Component of the Biosphere in terms of the nature of the effects and their relative significance?

Key Question 2: What additional effects ('knock-on' effects) will, or might, changes in one Primary Component of the Biosphere have on each of the others?

Key Question 3: What additional effects ('knock-on' effects) will, or might, changes in one Primary Component of the Biosphere have on Biosphere Change in general?

Key Question 4: What action can, or should, be taken to control and manage Biosphere Change and its effects?

NB In general terms, the effects might be beneficial, neutral, or detrimental.

Each of the four Key Questions needs to be asked and answered within a stated 'context' and this might be defined in terms of a number of different Context Defining Factors which might be used on their own or in combination with others. These factors include such things as the following:

- The Primary Component of the Biosphere, or individual elements of it, to which the Key Questions are being applied. (It would be helpful to have a structured concept of the nature of each Primary Component. The structure might be a hierarchical one.)
- The aspect of Biosphere Change, or individual elements of it that are to be considered. (It would be helpful to have a structured concept of the nature of the aspects of Biosphere Change. A hierarchical structure might be appropriate.)
- The magnitude of the increase in the Global Mean Temperature on the scale of 1 - >5 degrees Celsius. In the Stern Review, a table is given that indicates the nature of the global changes that will occur with rising Global Mean Temperature at intervals of 1 degree Celsius (Stern 2006, Table 3.1, pp 66-67). It might be useful to think of each of these levels as a separate 'context'.
- The mental and intellectual context (or the point of view) from which the Key Questions are being asked. The point of view might, for example, be professional, academic or at the level of general interest. In each case it might be specified more closely by reference to particular already named subject areas or fields of interest.
- The global region in relation to which the Key Questions are being asked. There are different ways of defining global regions. Possibly a combination of factors will be needed. For example: continents, oceans and latitude zones. (Tropical: 0 - 22.5 degrees Lat.; Sub-tropical: 22.5 -45.0 degrees Lat.; Temperate: 45.0 - 67.5 degrees Lat.; Polar: 67.5 - 90.0 degrees Lat.)
- Climatic type.
- The type of place in terms of its extent (eg international region; national region; locality; and individual site).
- And in relation to Key Question 4, the type of action that is under consideration, such as: Legislative and administrative action; Education, training and awareness raising; Recording; Investigation and Research; Direct intervention; Indirect intervention.
- Others?

The Cultural Dimension and Heritage Conservation

The term 'conservation' is used here in the UK sense, meaning a rational approach to protection that is based on clear principles and but which can be flexible, as opposed to inflexible, where circumstances allow flexibility. This can lead to a range of actions such as preservation, restoration, reconstruction, adaptation and recording.

For humans, cultural factors and the Cultural Dimension of Heritage Conservation are of special significance. These factors include the mind and the soul of individuals, and they require nourishment and support, just as much as the human body. For this reason the different aspects of the Cultural Dimension must be taken fully into account in relation to Biosphere Change and environmental management.

The scope of the mental dimension stretches from basic perception and cognition to aesthetic, intellectual and spiritual interpretations. It includes such things as:

1. Human responses to life as individuals, groups and communities;
2. Human emotions and rationality;
3. Human aspirations and satisfaction with life.

The prime professional responsibility for conservators and conservationists working in the field of movable works of art (such as paintings, sculpture, furniture), or with settlements, buildings, structures and architecture, is usually the conservation of non-living objects. However, in the field of landscape heritage, their prime responsibility also includes living things (eg plants and animals) as a very important component. The landscape heritage is a combination of living and non-living phenomena. This difference provides a basis for a significant distinction between three types of conservation, which are as follows:

1. Conservation that is primarily concerned with non-living phenomena;
2. Conservation that is primarily concerned with living phenomena (both human and non-human life);
3. Conservation that is concerned with both non-living and living phenomena at the same time.

Conservation of landscape heritage belongs to the last, ie item 3. In general, conservation of landscape heritage has much in common with both the conservation of the natural heritage and the conservation of non-living artefacts, but it also deals with living artefacts.

A General Method for Opening up a Discourse on Biosphere Change in Connection with Landscape Heritage and Conservation?

The various points made above provide a basis for a general method for identifying, analyzing and assessing the effects of Biosphere Change and the action that might be taken. The method can be formulated, in brief, as follows:

1. Note the four Key Questions and select which are to be applied;
2. Define the context within which the Key Questions are to be asked. Two of the main Context Defining Factors are the component of the Biosphere and the aspect of Biosphere Change that are to be considered;
3. Apply the appropriate Key Questions to the selected context;
4. Assess the results and prepare a statement about the conclusions that can be drawn;
5. Compare and contrast the results for the selected context with those for other contexts, and prepare a statement about the conclusions that can be drawn;
6. Agree to a course of action and implement it;
7. Repeat the process for other contexts.

The number of contexts that might be addressed using this method is extremely large, and this raises the question of where to begin?

Different organizations and individuals could begin with the contexts with which they are already particularly familiar. This would make use of their existing and particular expertise. It might, however, lead to a patchy coverage of the overall range of contexts, so the results would need to be kept under review so that gaps and also the more important results that emerge can be identified, widely disseminated, and then addressed.

Another approach would be to encourage planned programs of investigation and action which would examine particular contexts or groups of them.

An important group of contexts has been identified by the Council of Europe's 'European Landscape Convention'(2000). This convention is about landscapes in general, and not specifically about landscape heritage. Nevertheless, it is highly relevant. In Article 6, nine 'Specific Measures', are listed under five main headings. These specific measures are ones that each party to the convention is expected to implement. They are all forms of action and therefore relate to Key Question 4. They are as follows:

Awareness-raising
Each Party undertakes to increase awareness among the civil society; private organisations; and public authorities of the value of landscapes, their role and changes to them.

Training and education
Each Party undertakes to promote:
1. Training for specialists in landscape appraisal and operations;
2. Multidisciplinary training programmes in landscape policy, protection, management and planning, for professionals in the private and public sectors and for associations concerned;
3. School and university courses which, in relevant subject areas, address the values attaching to landscapes and the issues raised by their protection, management and planning.

Identification and assessment
With the active participation of the interested parties and with a view to improving knowledge of its landscapes, each party undertakes:
1. to identify its own landscapes throughout its territory;
2. to analyse their characteristics and the forces and pressures transforming them;
3. to take note of changes;
4. to assess the landscapes thus identified, taking into account the particular values assigned to them by the interested parties and population concerned.

These identification and assessment procedures shall be guided by the exchanges of experience and methodology, organised between the Parties at European level.

Landscape quality objectives
Each party undertakes to define landscape quality objectives for the landscapes identified and assessed, after public consultation.

Implementation
To put landscape policies into effect, each Party undertakes to introduce instruments aimed at protecting, managing and/or planning the landscape.

The specific measures identified by the European Landscape Convention are relevant and important in connection with the combined context of Biosphere Change, Landscape Heritage and Conservation. But:
1. What aspects and effects of Biosphere Change need to be addressed as a matter of priority by these specific measures?
2. To what extent are these specific measures already being put into practice?
3. What improvements are needed and how might they best be made?
4. Where are the resources that will be needed come from?

These questions provide an initial agenda for fuller discussion.

Summary

This paper has put forward some ideas for consideration. These include:
1. That Global Climate Change should be seen in the wider context of Biosphere Change.
2. A rational approach and way of structuring the complex question of how Biosphere Change might affect the landscape heritage and cultural heritage in general.
3. That landscape heritage is a combination of natural heritage and cultural heritage; it embraces both.
4. That the Cultural Dimension is important to humans.
5. That conservation of landscape heritage has much in common with both the conservation of the natural heritage and the conservation of non-living artefacts, but it also deals with living artefacts.
6. A method of opening up the exploration of the subject of Biosphere Change. This includes four Key Questions.
7. A method of opening up the exploration of the subject of Biosphere Change in relation to landscape heritage and conservation. This includes four useful Key Questions.
8. That developments in knowledge and understanding of the relationships between Biosphere Change, landscape heritage and conservation need to be kept under review and the outcomes of the process of review need to be widely disseminated and addressed.
9. That the Specific Measures advocated by the European Landscape Convention provide a useful starting point for a planned programme of investigation and action.
10. An initial agenda for further discussion and action in relation to Biosphere Change, landscape heritage and conservation.

A discussion of the above points and an agenda for making progress is needed.

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Archaeological Heritage Management, Climate Change and World Heritage in the 21st Century

Archaeologists are confronted every moment of their working lives with the impacts of climate change over the past millennia. With differing levels of intensity and duration, the climate of the earth has always been changing and offering challenges to human society. When archaeologists or prehistorians conceptualize past societies, they cannot ignore environmental and climatic settings. And when they view descendent communities, again they cannot help but consider the impact of environmental change on the lifestyles of peoples who live close to nature. Changes in climate have altered the shapes of continents, induced human speciation, spurred on technological change, and caused adaptations and accommodations in human behavior and social institutions. Change demanded by radical fluctuations in climate has shaped environments and in turn has punctuated human evolutionary history (Eldredge and Gould 1972). Humans have sought spiritual guidance, developed technologies and have altered social systems to cope with the impacts of climate change on their environments. Some of those adaptations have been relatively successful and others have been dismal failures (Diamond 2005). Stress on environmental resources is of major importance. There is no doubt that an overriding factor in dealing with climate change is the interplay between the cultural and natural realms in providing the framework for the choices and responses that societies make when confronted with constraints resulting from competition for resources.

Climate change has made us what we are! What we will be depends upon the choices that we make!

Although politicians and scientists may argue over the root-causes of global warming, there is no doubt that it is taking place and will continue to do so (Chapman 2002: 241). The natural heritage world has an ongoing interest in climate and its impact on flora and faunal biodiversity, and on landforms. Information is available, for instance, on the impacts on alpine fauna of receding snowlines, bleaching of coral reefs and on increased dangers from wild fires (UNESCO World Heritage Centre 2007: 168-191). Cultural heritage specialists have only recently offered viewpoints of likely impacts, with those provided for the built environment (Cassar 2005) being more specific than those offered for archaeological remains (Pearson 2006).

The best point of departure for a consideration of the impact of climate change on heritage management, although it does not deal explicitly with archaeological remains, is the work of the University College of London, Centre for Sustainable Heritage that was sponsored in 2002 by English Heritage. *Climate Change and the Historic Environment* by May Cassar offers a thoughtful consideration of the measures that need to be taken to ameliorate the impacts of climate change on heritage resources (refer also to Cassar and Pender 2005; and, UNESCO World Heritage Centre 2006b). Climate change will highlight long standing conservation issues and actions to monitor and undertake timely maintenance will be essential. Cassar asserts that difficult decisions will need to be made as to which properties can be preserved and that emergency preparedness will be essential.

Fluctuations in water levels can be devastating to all manner of heritage resources. Changes in the moisture regimes of soils will adversely impact the preservation of organic archaeological materials. Marked seasonal fluctuations, increases in annual temperatures and greater fluctuations in diurnal temperatures will weaken ancient building materials. Gradual processes of deterioration will increase in magnitude if climate change accelerates, and little-to-no time may be available to prepare for sudden and devastating events. The Mississippi Heritage Trust reports that: 'the historic buildings on the coast have suffered extreme damage and in some cases blocks of buildings in historic districts have been wiped clean by Katrina's storm surge!' Impacts on populations that are supported by heritage places are poorly understood, but expanding on the example of the impact of Katrina on New Orleans, it is quite likely we will see an increase in looting as law-enforcement systems become strained coping with natural disasters. The Trust's web-site lists scores of heritage buildings that have been awarded funds under the Hurricane Relief Grant Program. Although there is no direct linkage between climate change and the incidences and severity of hurricanes, Katrina did catastrophic damage to the tourism industry of New Orleans and could well be an exemplar of the likely impacts on coastal World Heritage places and on the communities that are dependent on those places for their economic support.

One of the most dramatic predictions is based on a case study of the World Heritage listed Palace of Westminster and Tower of London. Although these two places are not listed for their archaeological value, no doubt there would be a negative flow-on effect for the management of the archaeological heritage should the worst case scenario eventuate: for the Thames Barriers to become overwhelmed by tidal floodwaters. Prior to the construction of these barriers, it was anticipated that they would be used two to three times a year but, following their initial use in February of 1983, they are now being used six to seven times a year (UNESCO World Heritage Centre 2006a: Box 7). Just one overtopping of the barrier would severely impact the economy of the United Kingdom, causing a loss of £30 billion and catastrophic damage to the World Heritage properties.

Less easy to define in terms of an economic loss, archaeological resources will be impacted not only by climate change but by the measures that will be taken to mediate against severe events and the costs that will need to be paid to deal with the impact of major events on the built environment. Flooding and drainage efforts will be marked in coastal reaches. As engineering works are designed to drain low-lying areas or stabilize coastal reaches, these measures will impact known archaeological sites as well as archaeological resources yet to be discovered. In addition to coastal areas, archaeologists in general terms have considered likely impacts on wet-preserved inland sites with fragile organic remains (Chapman 2002) and on the erosion of coastal sites (Pearson and Williams 1996; Pearson 2006). However, there is a need for site-specific case studies reflecting current baseline conditions and predicted impacts.

Economic strictures will bring about competition for funds needed to mitigate the impacts of climate change. Also, the economics of climate change are such that, in the near future, it is highly unlikely that new funds will be generated to meet immediate needs by governments that are in denial of climate change. It is more than likely that funds allocated to other sectors of governmental activities will be diverted as a band-aid to politically visible projects. For example, it is not altogether unimaginable that heritage managers could find that a portion of their annual budget will have been reallocated to subsidize more politically visible projects, such as alternative energy research and development. At best, heritage funds would remain steady through time instead of increasing to help heritage managers cope with the effects of climate change.

Maintenance and monitoring, and vulnerabilities and threats

Maintenance and monitoring, and identification of vulnerabilities and threats are seen as one of the more urgent responses to climate change with a need to commission baseline studies such that deterioration can be monitored (Cassar 2005: 1). At the present time, funding constraints are such that few monies will be available for field surveys, including baseline studies and condition assessments, long-term artifact curation, and site stabilization/conservation. Difficult decisions may have to be taken with regard to future inscriptions of World Heritage sites. For instance, should assessors factor in to their evaluations the likely impacts of climate change, much as they might do in some circumstances for the impacts of tourism, to the outstanding universal values of the place (Cassar and Pender 2005: 615; and, Labadi 2007: 187-190)?

Vulnerability assessments will need to involve stakeholder communities from the outset (UNESCO World Heritage Centre 2006a: Box 9). *World Heritage and Climate Change* (World Heritage Centre 2006a) offers succinct lists of 'Principal Climate Change Risks and Impacts on Cultural Heritage' and 'An Eight-Step Approach to Guide Vulnerability Assessments.'

One hundred and sixty two World Heritage sites are inscribed on the basis of their natural values. Some of these places are known to contain archaeological and historical resources. The World Heritage listing of the Willandra Lakes Region of New South Wales, Australia is designed to protect both natural heritage values as well as evidence of human occupation in the form of skeletal material and archaeological remains. Other World Heritage sites may contain yet undiscovered archaeological and historical resources of outstanding universal value. Kluane/Wrangell-St Elias/Glacial Bay/Tatshenshini-Alsek, of Alaska and British Columbia, is an example of a World Heritage site where significant archaeological remains may be revealed if the rate of snow-melt continues to expose previously unexposed land surfaces. The place is the ancestral homeland of the Champagne and Aishihik First Nations, and it is inscribed on the World Heritage list for its natural values (Criteria ii, iii and iv).

Concern has been expressed over the retreat of glaciers, flooding and erosion caused by increased melt water, and changes to alpine and near-alpine environmental regimes (UNESCO World Heritage Centre 2006a: sections 20-21). The Kluane/Wrangell-St Elias/Glacial Bay/Tatshenshini-Alsek case study addresses an issue that has yet to be discussed in the literature: the very likely possibility that places inscribed because of natural values may have to be re-evaluated to determine if climate change has caused hitherto unrecognized or unaddressed manifestations of cultural, social or historical value to emerge.

Ice Patches

An 'ice patch' is just that: a patch of ice at a relatively high altitude where caribou in the past have congregated to avoid biting insects and to escape the heat of summer. Thick scatters of dung inter-bedded with snow mark these places (Strand 2003). Herds of caribou made a tempting target for indigenous hunters; they were exploited in the distant prehistoric past and in more recent historic times. Colder times buried the ice patches under layers of snow. Warmer times have melted the permanent snow cover and revealed dung fields with scatters of artifacts employed by the ancestors of the First Nations to exploit the clusters of caribou (Dove *et al.* 2005). Thirty-five of the ice patches, some as close as 30 kilometers to the Kluane/Wrangell-St Elias/Glacial Bay/Tatshenshini-Alsek, have yielded organic remains spanning some 8,000 years (Farnell *et al*. 2004; Hare *et al.* 2004).

Dating to 8,300 years ago, the 'ice patch' archaeological remains represent some of the earliest organic materials found in prehistoric contexts in the Americas (Dove *et al*. 2005: 1). Wooden spear and arrow shafts are the most commonly encountered artifacts with a variety of other kinds of materials also being found. In addition, bone and dung specimens provide information on the prehistoric distribution of large species such as buffalo, mountain sheep and Wapiti as well as the diet of the caribou.

Around A.D. 700 there was a shift from hunting with spears or darts to the use of bows and arrows. This transition is abrupt and graphic, as long slender spears with large projectile points of flaked stone are replaced by shorter and lighter arrows with points made from deer antlers. 'Ice patch' data provide the best documentation in North America of the shift in hunting from spears to bows and arrows. Fragile high-altitude finds are subject to rapid deterioration once they are exposed to natural elements and organic materials must be recovered shortly after exposure by melting snow, if optimum (or any) preservation is sought.

Southern Yukon First Nations peoples are particularly concerned and directly involved with the recently revealed prehistoric cultural materials. Community leaders are actively working with archaeologists to recover artifacts and are using the opportunity presented by the archaeological finds for community-building. Elders are asked to recall their hunting lore and stories that have been handed down from the past to be recorded by community members. One of the most dramatic spin-offs of the community archaeological research are youth educational programs that feature week-long science camps and surveys of the 'ice patches.' A well-illustrated newsletter is a feature of the joint community and Parks Canada work (*Ice Patch* 2002 and 2005).

Overview

Melting of the snow cover of 'ice patches' and the subsequent exposure of fragile organic archaeological materials of considerable importance could become more widespread in alpine and near-alpine environments, as global climate change continues on the present warming trend. This 'ice patch' case study is offered as an exemplar of what should be monitored for in the neighboring World Heritage site of Kluane/Wrangell-St Elias/Glacial Bay/Tatshenshini-Alsek. Discussion of this case study is intended to extend the present dialogue among archaeologists, inspire scientific research to predict and address impacts resulting from climate change, and to inform heritage managers of the kinds of changes they will need to deal with should the climate continue to change.

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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.
- 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.

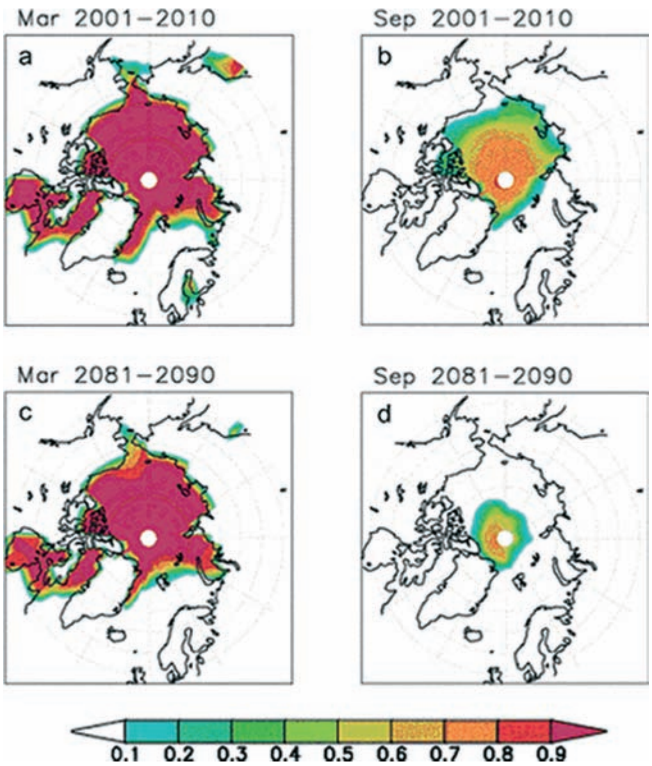
However, it must be stated that as with all climate scenarios, the hardest thing to predict is the future. We can show what has already happened, but the modelling of future climates and weather patterns is a complicated matter which leaves room for varying and sometimes completely opposite conclusions. 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

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.



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.

Susan Barr
President
International Polar Heritage Committee (IPHC)

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.

Case Study: Captain Robert Falcon Scott's 1910-13 British Antarctic Expedition Hut at Cape Evans

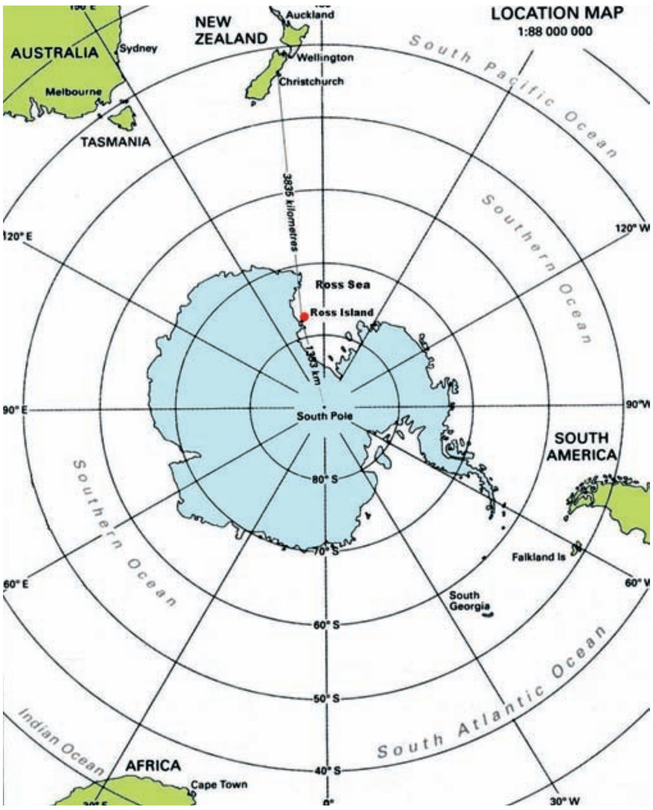
Vast amounts of data about former changes in the climate of our planet lie locked in the ice of Antarctica, a continent that has been the focus of climate studies dating back to the "heroic-era" expeditions at the beginning of the last century. These studies provided the first observations and climate data in these high southern latitudes and built the foundation for today's scientists who are literally drilling for information about the climatic conditions on Earth millenniums ago. These days Antarctica often makes headlines as a place that is reacting dramatically to global climate change - events that may be precursors to changes that are currently only predictions.

It's ironic, therefore, that Antarctica is the location for a few of the most unique historic sites on Earth that are now threatened by global climate changes.

While threats also occur to sites in more temperate climates, Antarctic sites face some problems that are quite different. They can also differ from problems identified in Arctic regions. The severity of the threats varies from place to place, but there is one site that suffers more than most and it serves well to illustrate the issues involved.

Captain Robert Falcon Scott's hut is situated on Ross Island about 25 kilometres north of New Zealand's Scott Base and the large US base of McMurdo. Listed as Historic Site Number 16 in the Antarctic Treaty System register, the hut is also included within an area designated as Antarctic Specially Protected Area (ASPA - 155). This gives it some protection from 'man-made' threats, but it is in no way immune from natural forces.

Map: Antarctica and Southern Ocean (Credit: International Polar Heritage Committee)



Historic significance

It is from this hut that Scott launched his bid for the South Pole from which he and 4 companions never returned. Four years later it served as a refuge and source of provisions for Sir Ernest Shackleton's "Ross Sea Party" that was stranded there when their ship was blown out to sea in a storm. Believing that Shackleton had begun his trans-Antarctic expedition they continued to lay depots towards the South Pole to support him on the second stage of his journey out to Ross Island. The Ross Sea Party had no way of knowing that Shackleton's "Endurance" had been trapped and crushed in the Weddell Sea ice and that he and his men were fighting for their lives on the other side of the continent.

Recorded and observed climate changes

While a large amount of climate data has been collected at the nearby bases, this was not available to the writer in an analysed form prior to the deadline for this publication. It is however known that there are many different micro-climates in the region and these could influence the validity of such data if it was applied to Cape Evans. There is however a wealth of anecdotal evidence that supports the submissions made below.

Potential impacts

As a result of observations in recent years this site is facing a number of new and very real risks. Predictions of future climate change remain uncertain but give no cause for complacency.

The effect of increased snowfall and snowdrift build up

In recent years a significant increase in the winter build up of snow on and around the hut has been observed. The cause of this can possibly be attributed to increased precipitation as well as possible wind pattern changes that combine to increase snow drift.

This build up of snow has two serious adverse affects, the first being the increase of mechanical loading on the structure. In summer 2006-07 it was estimated that over 100 tonnes of snow were removed from in and around the hut. Much of this was taken from roof areas, in particular over the stables where it has cracked rafters in both of the last two years.

A second complication arises during warmer periods in summer when temperatures rise above zero and this snow melts. Increased quantities of snow create increased melt-water and this has begun to run through the hut where it freezes and builds up when cooler conditions occur. This water and ice not only causes damage to artefacts

Scott's hut at Cape Evans is located on a shingle beach less than 50 metres from the water's edge and no more than 2 metres above high water level. Little more than a kilometre to the north the Barne Glacier terminates in a massive wall of ice up to 50 metres high that floats out onto the sea. (Credit: Paul Chaplin)

in the hut, but the expansion effect of freezing is further source of mechanical damage to structural materials and objects in the hut.

For many years there has also been a separate process of "ice heave" caused by smaller amounts of melt-water running under the hut and freezing. The "heaving" effect of this on the structure has caused deformation of the flooring. This problem has been closely monitored but increased quantities of water are exacerbating it.

Temperature change

It can be easily understood that one effect of increases in average temperature in polar regions is an increase in the number of freeze/thaw cycles that occur. This contributes to a breakdown of many building and other materials. Wooden structures tend to absorb free water from the surrounding snow and ice, and when this re-freezes, it expands and begins to break down the surface fibres. Increased average temperatures, therefore, are likely to accelerate the mechanical breakdown of a wide range of materials.

Increases in ambient air temperature can also exacerbate the effects of solar warming. Solar energy is transmitted through the roof and walls of the hut causing an increase of internal temperature and when this occurs relative humidity (RH) increases. Objects within the hut do not warm so quickly, so when higher RH internal air contacts them, condensation forms on the cold surfaces. This dampness causes a breakdown of materials such as paper (labels on metal cans) and it provides a "fertile" medium for forms of biological decay. When interior temperatures cool again, the condensation freezes and contributes to the freeze/thaw problems and mechanical damage already mentioned.

Increased forms of biological decay

There is a popular belief that freezing conditions prevent biological decay, but this is far from the truth. Many forms of organisms continue to function in sub-zero temperatures and when temperatures periodically rise above freezing during summer months, bacteria, fungal and other organisms flourish. This not only causes decay in these wooden structures but in the many other materials, such as paper and fabrics, that can be found in the huge variety of artefacts remaining in the hut. Even a slight increase in average temperatures can magnify this problem.

In recent years there has been a significant increase in the build up of snow on and around the hut during winter. September 2003. (Credit: Scott Base Winter Staff)

Wind action

While actual changes in wind patterns in this area have yet to be analysed, it appears that this factor has contributed to the increased snow drift referred to above. Any change, therefore, raises the possibility that existing problems with windblown salt spray could be exacerbated. Salt acts as a catalyst in the oxidation of ferrous materials and this has always been a problem with iron fastenings and other components in the hut structure. Ferrous content of the artefacts within, such as food cans and implements, are also adversely affected.

Inundation/Flooding

One of the most dramatic illustrations of global warming often seen on the media is the spectacular collapse of ice-shelves and glacier faces. It is not difficult therefore to imagine the effect of the collapse of a huge mass of ice into the sea near the hut, and we have surely all seen examples of the mini tsunami that this can cause.

Scott's hut is located on a shingle beach less than 50 metres from the water's edge and no more than 2 metres above high water level. Little more than a kilometre away to the north is the Barne Glacier which terminates in a massive wall of ice up to 50 metres high that floats out onto the sea. In winter the hut is "shielded" by the sea-ice but for several weeks in summer there is only a short stretch of open water between it and the glacier.

As yet there have been no recorded dramatic collapses from this glacier, but if global warming continues, a major collapse from the face of the Barne Glacier is a real possibility. Such a collapse could easily create a wave capable of sweeping up the beach and destroying the hut and its contents. It goes without saying that any increase in global sea levels not only increases this risk, but creates a risk of its own.

Site management

The organisation responsible for this, and other sites in the Ross Sea region, is the Antarctic Heritage Trust. AHT, an international organisation based in New Zealand, has charitable status in several countries. It has a proven record of successful conservation projects and is acknowledged as a competent organisation achieving internationally recognised conservation standards in its work.

Despite such competent management, however, there remain some very real practical and economic considerations with work at Antarctic sites. These only serve to compound the effects of Global Climate Change. *(See "Cape Adare" in this issue of Heritage at Risk)*

The Trust has a continuing annual programme of remedial work and monitoring, and more detailed analysis of climate data is being done in an attempt to quantify and anticipate problems.

Paul Chaplin
Secretary General
International Polar Heritage Committee (IPHC)

Objects within the hut do not warm as quickly as the air inside the hut so when the higher RH air contacts them condensation occurs on the cold surfaces. Freeze/thaw problems and dampness can cause a breakdown of materials such as paper (labels on metal cans) and it provides a "fertile" medium for forms of biological decay. (Credit: Paul Chaplin)

York Factory – National Historic Site of Canada Kichewaskahikun (Cree) ("The Great House")

Nearly four thousand years before the first Europeans arrived in North America, the Hudson Bay area was home to successive waves of Aboriginal peoples such as the Predorset; Dorset; Thule; Cree; Dene; and Inuit people. After the last ice age, both the glaciers and the Tyrell Sea retreated, leaving the rebounding newly exposed land available to plant and wildlife colonization. Aboriginal people traveled into the area and different groups made use of seasonal cycles of game, fish and berries. These people led a nomadic existence, harvesting ringed seals in Hudson Bay, and caribou inland.

European explorers came seeking the Northwest Passage, believed to be a path to the spice-rich Orient. Instead, they found a wealth that rivaled the Far East. The Hudson's Bay Company (HBC), formed in 1717 to take advantage of this wealth, and the subsequent fur trade, changed the face of North America.

The remnants of the Hudson's Bay Company settlement at York Factory are now threatened with the effects of climate change and a receding shoreline.

Historic image of York Factory with its complex of associated buildings and structures, circa 1925 (Library and Archives Canada, PA-041571)

The Hudson's Bay Company

The Hudson Bay Charter was established on May 6, 1670 when King Charles II of England granted all the lands drained by waters flowing into the Hudson Bay to the "Company of Adventurers of England trading into Hudson's Bay," thus creating the Hudson's Bay Company (HBC).

The economic fortunes of the day were in furs and trading involved cooperation, assistance and partnership between the "old inhabitants", of the land, the Métis, First Nations and non-native people. This trade prospered for over 200 years.

As the HBC expanded its operations, trading posts were established on Hudson Bay and inland in places such as York Factory, Fort Severn, Norway House and Cumberland House.

York Factory became the gateway between Europe and all of western and northern Canada for the HBC, and now is renowned as the most significant HBC historic site in North America.

York Factory

Three centuries of history are commemorated on the shore of Hudson Bay. York Factory is significant for its critical role in the French-English struggle on Hudson Bay for control of the fur trade, as an important HBC trading post and entrepôt,[1] and for its role in the expansion of the fur trade into the interior of western Canada. As the longest operated HBC post in North America, York Factory is of national significance because of the importance of the fur trade in Canadian history, the international dimensions of the trade and the interaction of aboriginal peoples and their trading partners.

York Factory is located near the mouth of the Hayes River approximately 250 kilometres southeast of Churchill, Manitoba. Its location on the Hayes River near Hudson Bay, and with access to the Nelson River, was a deliberate choice on the part of the HBC. This location was accessible by ocean-going vessels, which would anchor at Five Fathom Hole, and provided safe harbour. From here, goods were transferred to York Factory and smaller boats for inland trade via navigable rivers.

As early as 1670 an attempt was made by the Company to establish a post at the mouth of the Nelson River, but fierce winds hindered landing and the crew sailed back to England. By 1682, however, three groups of traders from New England, England and France had established a series of fur-trading forts in the area of the Hayes and Nelson rivers to compete for control of the territory and fur trade of western Hudson Bay. In 1684, the HBC built York Fort on the north shore of the Hayes River, eight kilometres upstream from the Bay.

Between 1694 and 1697, the French and English battled for control of the original York Factory. Under the command of Pierre Le Moyne d'Iberville, the French captured York Factory in 1694, lost it to the English in 1696, recaptured it the following year, and renamed it Fort Bourbon. It remained under French control until the signing of the Treaty of Utrecht in 1713, which awarded HBC exclusive trading rights on Hudson Bay. York Factory quickly

York Factory, 2005 (Heartland Tours, Manitoba)

Aerial view of York Factory and the bank of the Hayes River, 2005 (Heartland Tours, Manitoba)

became the Company's single most important trading post on the Bay, although its monopoly was successfully challenged by traders from New France who had established a series of posts far to the south in the Lake Superior and Lake Winnipeg regions.

Despite diminishing fur returns, the HBC made no serious attempt to construct any inland posts or to challenge its competitors from New France. With the fall of Quebec in 1760, new merchants — largely Scottish and Métis traders who later formed the North West Company — assumed control of the Montréal-based fur trade and succeeded in capturing much of the trade of the Aboriginal peoples who had traditionally made the long journey to York Factory to exchange pelts for European guns, kettles, knives and blankets.

In order to meet its competitors head-on, the HBC abandoned its sleep by the frozen sea, and in 1774, with the building of Cumberland House in northeastern Saskatchewan, the Company began the construction of a series of inland posts.

York Factory played an important role from the 1680s until approximately 1850, first as a major trading post and then as the main Hudson's Bay Company entrepôt providing the vital link between the vast fur resources of the interior of the continent and the markets of Europe. In 1810, it became the headquarters for the Hudson's Bay Company's newly established Northern Department. Aside from administrative and financial functions, York Factory also served as the entry point for most Europeans bound for Rupert's Land. York Factory, particularly as headquarters for the Northern Department after 1810, represents the HBC's role as an imperial factor in British North America.

Over the next century, York Factory changed from a fur-trade post to a warehousing and transshipment depot with considerable administrative responsibilities. As headquarters of the Company's vast Northern Department, York Factory, at its peak in the mid 19th century boasted over fifty buildings and a large complement of officers, clerks, tradesmen and labourers, as well as a seasonal workforce of Native traders and hunters. It was the political, economic and social hub of western Canada fur trade society. At the same time, York Factory was a vibrant community, home to many Cree people of western Hudson Bay. From their initial position as middlemen and traders of commodities, the role of the Home Guard Cree after 1820 gave way to a market function based principally upon the sale of their labour. The immediate area around the Factory was inhabited by the Cree who trapped, hunted and fished for the Company. A native community was situated one kilometre downstream of the fort. There were also communities scattered throughout the immediate vicinity of York Factory, for example, Ten Shilling Creek, Crooked Bank, and Kaskattamogan just to name a few. To this day, their descendents consider York Factory their homeland.

After 1850, the post diminished in importance and was abandoned by the Hudson's Bay Company in 1957. Ownership was transferred to the Government of Canada in 1968. York Factory was commemorated as a national historic site of Canada in 1936.

The design of York Factory was both simple and utilitarian and typical of what the Hudson's Bay Company regarded appropriate for its posts.

The buildings of the fort were originally laid out in an "H" shape with the depot building or "Great House" (known in the Cree language as "Kichewaskahikun"), the guest-house, and a summer mess house forming the centre bar. The wings of the "H" were composed of fur stores, provision shops, trading rooms, officers' and servants' quarters. The formality of this scheme was reinforced by the main gate in the encircling wooden palisade being directly in line with the entrance to the depot.

Other structures within the palisades included a doctor's house, Anglican church, clergyman's residence, school, hospital, photographic room, library, cooperage, blacksmith shop, bake house, middlemen's dwelling, and net house. Outside of the formality of this public area of the fort, the inter-relationship of the other structures further from the river, such as the manufacturing shops and dwellings, was not based on as rigid a plan. Subsidiary buildings were arranged around a network of boardwalks much like the streets of a small town. The boardwalk system in place today replicates the historical circulation patterns and, in combination with the vestigial remains of an extensive system of drainage ditches, provides evocative echoes of the historic landscape.

Today, the site includes the "Great House" (depot), archaeological remains of more than seventy buildings and large features, more than 3,000,000 artefacts, and the cemetery.

York Factory is threatened

Canada's most important fur trade heritage site is in trouble. Dramatic and ongoing erosion of the Hayes riverbank has substantially reduced the distance between the river and the heart of York Factory. Erosion of the north bank of the Hayes River has meant that the remains of two earlier York Factories have completely disappeared. It is estimated that the present site, which dates from 1788, will be largely lost within 100 to 150 years. The rate of erosion is about 3 metres/5 years. Artefacts and archaeological features are eroding away and, in time, the "Great House" will be affected. Engineering alternatives to stop or drastically slow down erosion are being looked into, but may not be feasible. Documenting and some recovery of the site before it is lost may be the only viable choice.

York Factory is just within the southern edge of permafrost in Canada. Permafrost temperature monitoring in the region since 1993 indicates rises of up to 2°C (Lemke 2007 p370). On this regional scale, increases in the thickness of the active layer (the upper layer that is subject to freeze-thaw cycles) and the northern retreat of permafrost is expected to continue. As explained by Lemke et al (2007 p369) 'Thawing of ice rich permafrost can lead to subsidence of the ground surface as masses of ground ice melt[,] and to the formation of uneven topography known as thermokarst, generating dramatic changes in ecosystems, landscape and infrastructure performance.'

While climate is an important factor determining the distribution of frozen ground, local factors are also important, such as vegetation conditions, snow cover, physical and thermal properties of soils and soil moisture conditions. Permafrost and drainage are interrelated threats. The York Factory site faces permafrost instability from combined effects of warming, increased water drainage, and loose soils. Parks Canada, with great concern for York Factory, has begun monitoring of the area. Systematic permafrost monitoring is being explored that would contribute to planning the salvaging and documenting needs for the site, as well as contribute to regional permafrost studies. Experts in areas of geotechnical engineering, permafrost and cold climate heritage management are assisting in research and planning and developing a management strategy that gives direction for the protection and presentation of York Factory.

We hope the rest of the ICOMOS scientific community will continue to follow, with interest, the plans for this exceptional Canadian site.

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Mell Chapple
ICOMOS Canada

[1] Entrepôt is defined as an intermediary centre of trade and transhipment.

Summary of the Significance of and Threats to Cultural Resources Located at the Historic Settlement Area on Herschel Island Territorial Park of Yukon

The Historic Settlement Area on Herschel Island was designated as a National Historic Event of Canada in 1972 and is part of Yukon's first Territorial Park, established in 1987. The events recognized in its national designation were the whaling industry, the establishment of Canadian sovereignty in the western Canadian Arctic, and the meeting of cultures. It is part of an area called Ivvavik/Vuntut/Herschel Island that is on Canada's tentative list for nomination as a World Heritage site. Ivvavik and Vuntut are each Canadian National Parks located in the very northwest corner of Yukon and Canada.

Sir John Franklin met ancestors of today's Inuvialuit when he visited the island in the summer of 1826 and gave it its English name. There is archaeological evidence here of the Thule culture which would mean at least 1,000 years of human use and occupation. Inuvialuit continue to use the island as a seasonal base for traditional hunting and fishing.

In 1890, American whalers, pursuing diminishing stocks of Pacific Bowhead whales, followed them over the north coast of Alaska into the Beaufort Sea of the Arctic Ocean. The fleet established a "settlement" at the deep and sheltered harbour of Pauline Cove on Herschel Island. At first, ships were simply frozen fast in the ice of the cove to provide shelter over winter in order to get the earliest start possible to the next whaling season. The first structure was built on land in 1892. Today, there are a dozen buildings standing that date back as far as 1893.

There are also archaeological remains of prehistoric, semi-subterranean houses and over 100 grave sites nearby.

As reported in the 2004/5 edition of Heritage at Risk (pp 266-7), cultural resources in the historic settlement area are threatened by climate change. The specific effects are rising sea level, coastline erosion, decaying permafrost, and changes to the hydrologic regime. The western Canadian Arctic and Alaska are seeing the greatest increases in yearly average temperature in the world.

Sea level in the Beaufort region has increased by 10 to 20 centimetres in the past century and is conservatively predicted to rise another half a metre in the next century. The Settlement Area is on a low lying spit of land. A rise of this extent will bring water up to the doorsteps of most of the historic buildings and submerge all archaeological sites.

Another effect of warming is the disappearance of sea ice and increasingly violent late summer and fall storms in the Beaufort Sea. These phenomena are directly related to accelerated shoreline erosion due to increased wave action caused by high winds and the fetch provided by the recession of fixed sea ice.

Permafrost and ice lenses are found below ground throughout the island. Solifluction; the downward slumping of the thawed, active layer of soil over the frozen ground beneath has caused coffins to tumble and be pushed out of the ground on the south facing slopes behind the Settlement Area. This deterioration of the permafrost, coupled with a predicted increase in precipitation will inevitably effect the hydrologic regime and surface runoff rates and patterns.

June, 1991 aerial photograph of the Historic Settlement Area with the Northern Whaling and Trading Company (NW&TCo) Store near the shore at centre left and Pauline Cove at right (Credit: Government of Yukon Territory)

Further building relocations have not been required; as of winter 2006/07 however, building foundations that were once dry and frozen are now becoming waterlogged throughout the Historic Settlement Area. This seems to be related to ground thaw and possibly a rise in the water table or land subsidence. Along with shoreline and permafrost monitoring, this introduction of moisture is being monitored for increased freeze/thaw activity and fungal attack that could damage structural integrity.

The development of a Strategic Salvage Plan which will prepare for a worst case scenario for cultural resources on Herschel Island is underway. A team of architectural conservationists, an archaeologist and a palaeontologist from the Government of Yukon will be visiting the island in July, 2007 to study the current situation and collect field measurements to contribute to the plan. The plan will attempt to ensure that as much of the scientific information and cultural values pertaining to the site as possible are retained and at least fully documented for posterity. It will also outline a staged and prioritized reaction as well as cost implications should the predicted progress and extent of climate change, and its effects on the coastal regime be fully realized.

It seems certain that the period of history we are now living in can be added onto the many layers of change over history and onto the exceptional cultural and natural values that Ivvavik/ Vuntut/Herschel Island (Qikiqtaruk) embodies and offers the world. The lessons to be learned are many.

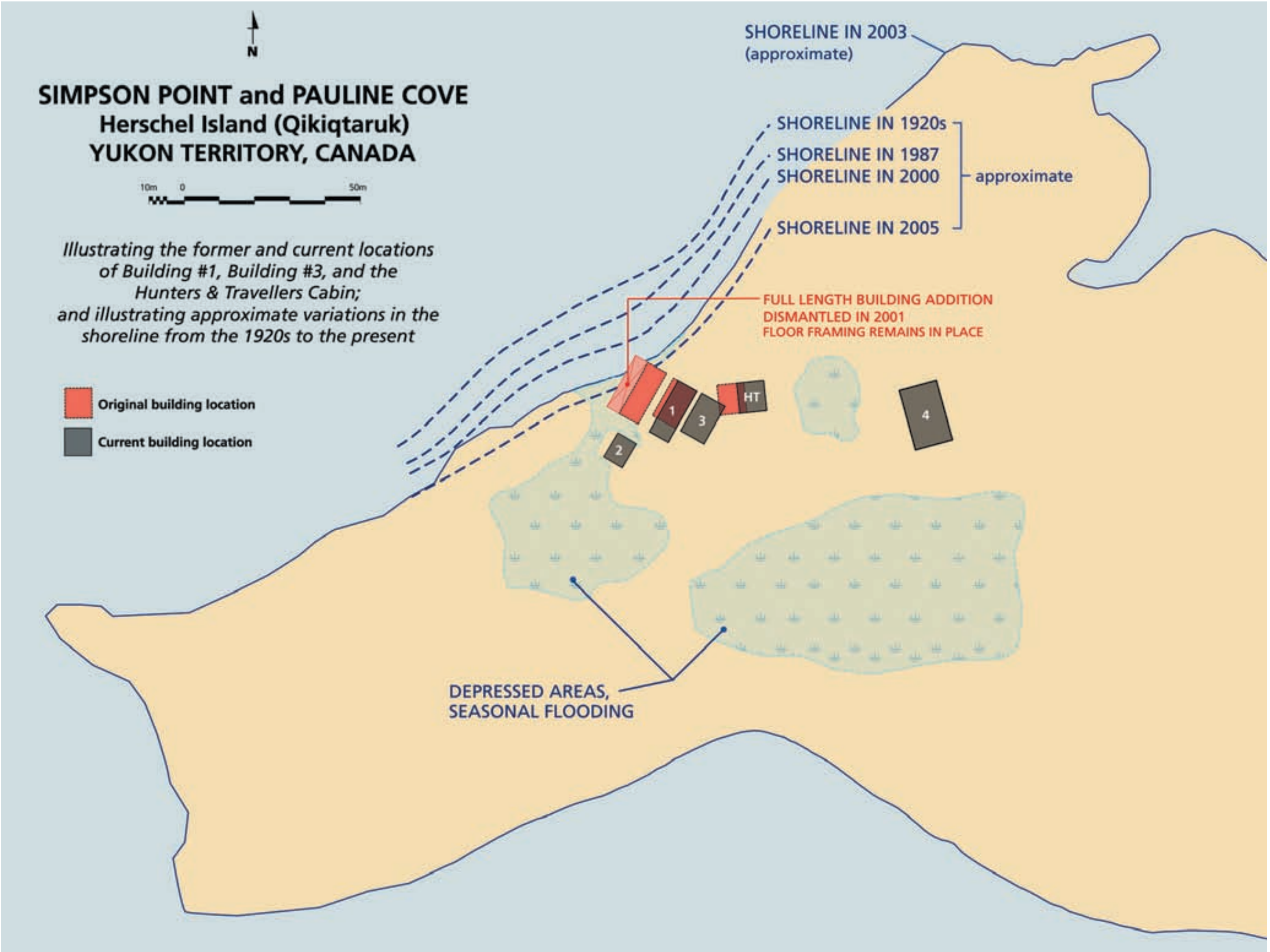
Visit www.yukonheritage.com and go to the publications section to see an overview of the heritage of Herschel Island in the two online publications: *Herschel Island - Qikiqtaruk and Qikiqtaruk - Inuvialuit Archaeology on Herschel Island.* Further information can be found at http://www.virtualmuseum.ca/Exhibitions/ Herschel/English/menu.html.

M. Douglas Olynyk
Historic Sites Manager
Yukon Government

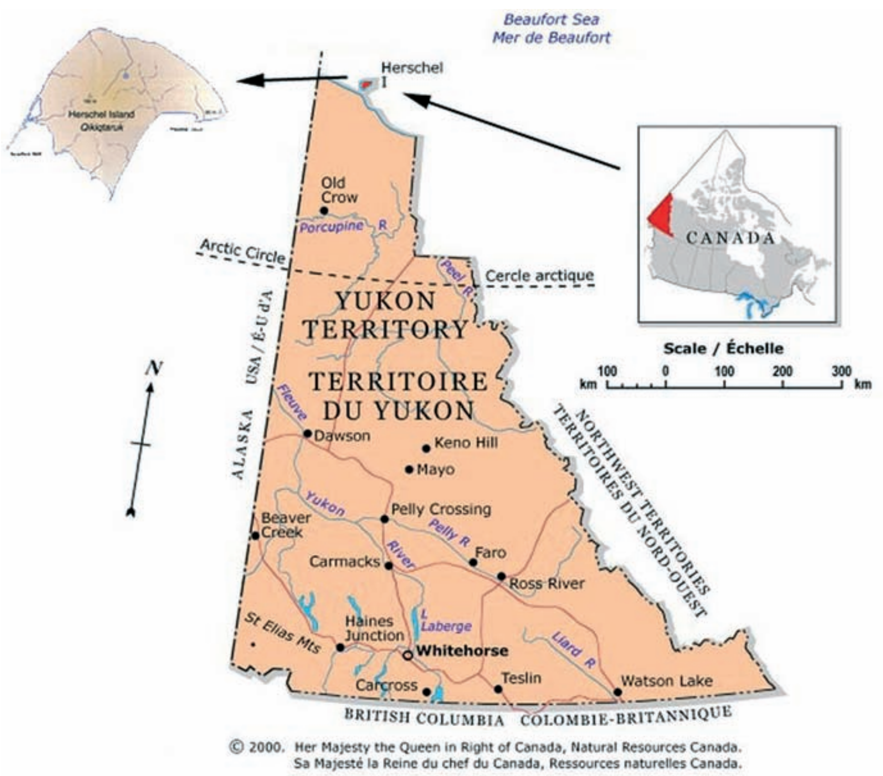
June, 2001 - the NW&TCo Store shed addition after being crushed by sea ice the previous fall (Credit: Government of Yukon Territory)

July, 2003 - the NW&TCo Store after the shed addition was removed and the building raised (Credit: Government of Yukon Territory)

August, 2003 - the NW&TCo Store after being moved five metres back from the shore. This building and the Canada Customs Warehouse and Hunters and Travellers Cabin to the left had to be moved an additional five metres in the summer of 2004 (Credit: Government of Yukon Territory)

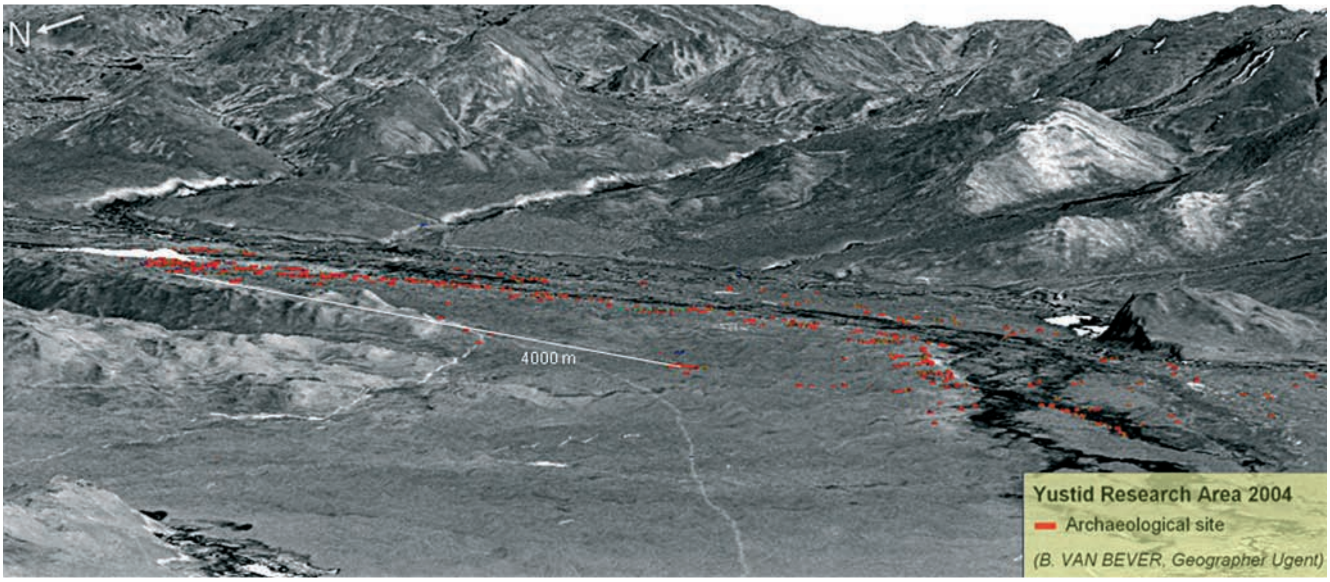


Plan showing building relocations as of 2006. Building #1 is the NW&TCo Store, Building #2 is the Canada Customs Warehouse (Credit: Government of Yukon Territory)

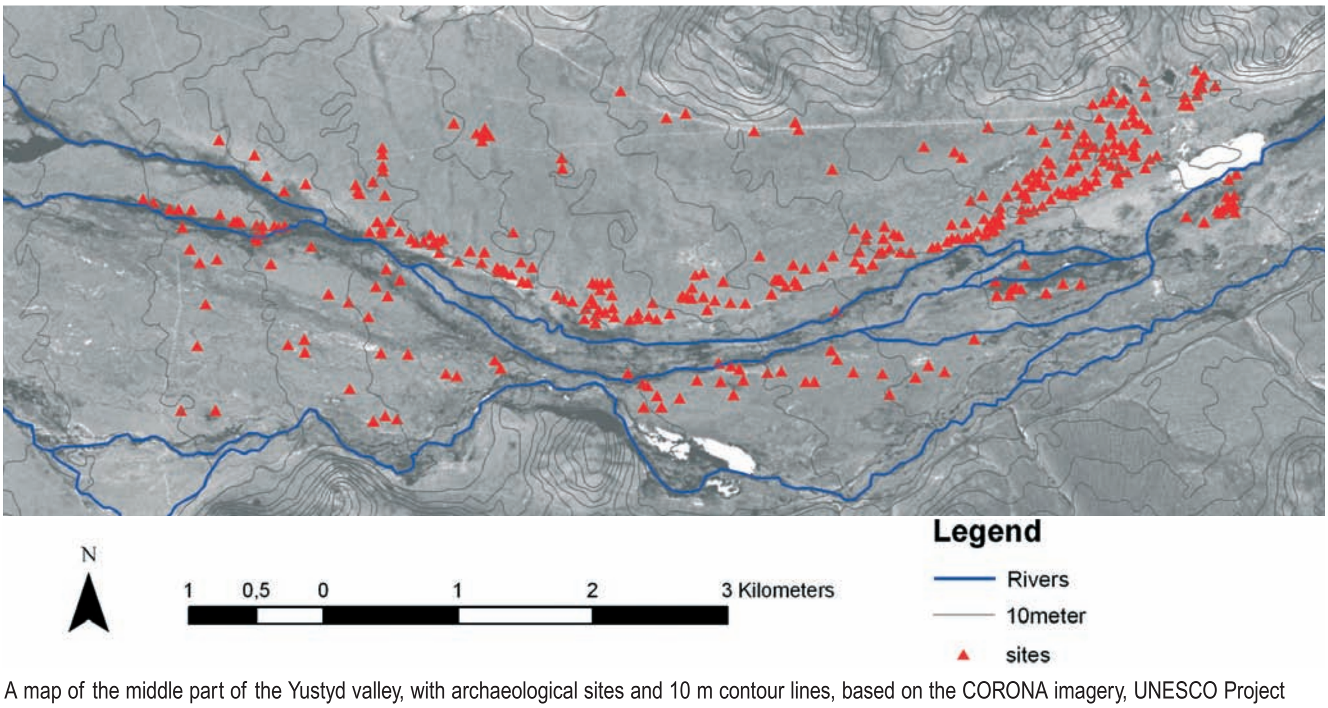


Yukon Territory showing location of Herschel Island

Impact of the Climate Change on the Frozen Tombs in the Altai Mountains



3-D view on the valley of Yustyd, based on the CORONA image, UNESCO Project (UNESCO Copyright)



A map of the middle part of the Yustyd valley, with archaeological sites and 10 m contour lines, based on the CORONA imagery, UNESCO Project (UNESCO Copyright)

The jagged, towering Altai Mountains stretch 2,000 km across China, Mongolia, Russia, and Kazakhstan. The Russian section of this mountain range was inscribed as a natural site on the World Heritage List in 1998. The area inscribed includes Altaisky Zapovednik and a buffer zone around Lake Teletskoye; Katunsky Zapovednik and a buffer zone around Mount Belukha; and the Ukok Quiet Zone on the Ukok Plateau. The region represents the most complete sequence of altitudinal vegetation zones in central Siberia, from steppe, forest-steppe, mixed forest, sub-alpine vegetation to alpine vegetation. The site is also an important habitat for endangered animal species such as the snow leopard. Although the Altai Mountains of Siberia were inscribed for their natural value on the World Heritage List, their cultural value should by no means be underestimated.

The Altai Mountains, indeed, bear unique testimonies to the Scythian civilization that inhabited the Eurasian Steppe during the first millennium BC. They developed a distinct nomadic way of life that was homogenous throughout the Eurasian Steppe, from the Black Sea area to the Mongolian Plain, and interacted with the neighbouring civilizations of China, India, Iran, Mesopotamia and Greece.

As Scythians have left little structural heritage and no written records, there are only two sources of information providing us with knowledge on this nomadic civilization. The first is historical records left by the Greek historian, Herodotus, who devoted the fourth book of his *Histories* to the Scythians. The second is archaeological sites, i.e. Scythian burial mounds, the so-called kurgans, and the artefacts contained in them.

Conserved in their original state, the kurgans in the Altai Mountains are of the utmost importance. The local climate, as well as the peculiar way the kurgans were constructed, created ideal conditions for their preservation; as rain seeped down into the tombs, it froze and never thawed. As such, all the buried material (metal, gold and pottery), even organic material (wood, leather, clothes, textiles and even mummified human bodies and horses' bodies) was kept intact over the millennia. To this day, the only frozen tombs discovered anywhere in the world are those that have been found in the Altai Mountains.

Many 19th-century scholars were prejudiced against Herodotus' record, in spite of numerous archaeological discoveries showing that as a witness he was conscientious and trustworthy.

Now, the organic material yielded by the frozen tombs of the Altai has confirmed Herodotus' accounts of Scythian culture. Occupation, dress, weapons, as well as customs such as the embalmment of the corpses of chieftains, burial with a concubine, purifying after burial, and scalping of slain enemies are confirmed by study of the artefacts from the frozen tombs in the Altai Mountains. This information could not have been determined by the research made on the Scythian kurgans in the Black Sea region alone.

The material culture yielded by the excavation of the frozen tombs, in particular the organic material, sheds light, not only on the Scythian themselves, but on the other civilizations with which the Scythians were in contact: the Persian and Chinese textiles yielded from frozen tombs in the Pazyryk are older than any surviving examples in Persia or China.

Furthermore, the frozen tombs also revealed previously unknown connections between different regions during the second half of the first millennium BC. For example, the clothes discovered from the research project led by the Sino-French IPAX-CNRS team in the middle of the Taklamakan Desert (*Djoumboulak-Koum*) show striking similarities to those yielded from the frozen tombs belonging to the Pazyryk culture (6th to 3rd century BC) of the high Altai Mountains, thus demonstrating a connection that already existed between East and West long before this route became known as the Silk Road.

The first discovery of a frozen tomb dates back to 1865 by the academician V.V. Radloff in Berel and Katanda, but scientific research started with S. Rudenko's excavations that took place from 1945 to 1949 in Pazyryk and Tuekta on a series of large burial mounds and several small ones. The discovery of frozen content in Pazyryk provided a good understanding of how ice formed within the tombs. In addition, frozen tombs yielded not only organic material such as carpets and wooden material, but also embalmed bodies that had been perfectly preserved. The research on these frozen funerary chambers considerably broadened scientific knowledge of the Scythian culture, and provided the name for the so-called 'Pazyryk Culture' (6th to 3rd century BC).

However, it was only in the 1990s that multidisciplinary scientific research using modern techniques began in this area. In 1993, the Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Science (Polosmak, N. 1994), excavated a kurgan in the High Ukok Plateau; this was the first barrow found that contained solely a woman, a beautifully tattooed corpse later known as the "Ice Maiden." Her attire was one of the oldest pieces of female clothing ever found from a nomadic society. Her blouse was made of non-local silk from undomesticated silkworms, providing evidence of long-distance trade with India.

The French CNRS (Francfort, H-P. 2002) and the Margulan Institute of Kazakhstan (Z. Samashev), in collaboration with the Ligabue Research Centre of Venice, excavated from 1998 to 2000 a rich frozen burial ground known as Berel 11 (4th to 3rd century BC). The excavation of Berel 11 yielded two mummified bodies, though decomposed, along with thirteen sacrificed, fully harnessed horses, thus providing rich material for anthropological and paleopathological research on mummies, as well as for DNA study. The examination of organic matter that had been ingested by the horses provided information about the flora history of the region, and even indicated in which season the tombs were constructed.

The most recent research was jointly conducted from 2004 to 2006 by the German Archaeological Institute (DAI) (H. Parzinger), in collaboration with the Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Science (V. Molodin) and the Institute of Archaeology of the Mongolian Academy of Science (D. Zeveendorzh) in Bayan Olgy, the southern part of the Altai Mountains, northwest of Mongolia. Of particular value, kurgan Olon Kurin Gol 10 contained a completely intact burial chamber with a mummified blond warrior fully dressed and equipped with a full set of weapons. Through a dendro-chronological study carried out on the logs of the burial chamber, the findings of the excavation were identified as belonging to the Pazyryk culture (early 3rd Century BC). The research provided precious information regarding the extent of the Pazyryk culture in the Altai Mountains, found until today only in the northern part of the Altai. This will also contribute to considerably enlarge the current knowledge on the relations of the different nomadic peoples that existed at that time, between Southern Siberia and other regions in its vicinity.

Now, the permafrost layer of the Altai Mountains is endangered by climate change and as such frozen tombs are endangered. In particular, mountain permafrost is most sensitive to climate change; its average temperature remains usually within one or two degrees of freezing point. Temperature data from Mongolian mountain regions available for the last 30 years show a rise in permafrost temperatures by 0.1°C per decade in the Khentei and Khangai and 0.2°C per decade in Kovsgol mountain regions. Glacier research shows that the glaciers in the Altai Mountains have been melting for decades. Rough estimates showed that the glaciers have lost up to 27 % of their mass in the last 100 years. Average retreat rates are 9-20 m per year. Further degradation of glaciers is almost certain, and closely linked to the melting of the region's permafrost layer.

Consequently, significant reduction or disappearance of the permafrost is predicted for the middle of this century in the Altai Mountains. The most significant impact will be observed near the lower boundary of alpine permafrost, where the frozen grounds are very sensitive to climate change. Many frozen tombs in the Altai are situated within this area of sporadic and discontinuous permafrost, and are therefore extremely vulnerable, and will consequently thaw as a result. This will lead us to lose invaluable, undiscovered research material that sheds light on the important culture that flourished during the first millennium BC.

Taking into account the above-mentioned clear indication of the thawing of permafrost in the Altai Mountains that preserved the frozen condition of the Kurgans for millennia, archaeologists, in close co-operation with climatologists, geographers, and geocryologists, requested the attention of UNESCO and its assistance on this urgent issue. The result of this initiative was the UNESCO project, "Preservation of the Frozen Tombs in the Altai Mountains' (UNESCO/Flanders Funds-in-Trust), established in 2005.

The strategy proposed by the project was to first establish an accurate inventory of the remaining kurgans in the Altai Mountains, along with accurate maps produced through advanced satellite imagery technique. The second step would be to identify and locate frozen tombs, and this became possible now thanks to sophisticated geophysical survey techniques, and also specialized geocryological techniques, combined with satellite imagery that can produce a map of permafrost zone. The third step would be to monitor the permafrost

Olon Kurin Gol 10, burial chamber (Copyright: DAI)

layer to determine how quickly the frozen tombs are thawing. The UNESCO World Heritage Centre, under the above-mentioned project, has initiated a monitoring programme to see how quickly the permafrost zone is thawing in the Russian part of the Altai, and will publish its result in its final report end of 2007.

However, climate change is a global phenomenon, and it is obvious that our efforts to prevent frozen tombs from thawing would preserve only a limited number of frozen tombs, if any. Consequently, in order to save as much invaluable research material lying in the frozen tombs as possible, excavations should be considered. In such cases, excavations should be carried out by means that are fully respectful of the local population of the Altai Mountains.

The scope of the current UNESCO project is at present limited to the first step, along with the permafrost monitoring programme. Therefore international academic and scientific communities should be mobilized to ensure that the invaluable research material is at best preserved, or at least documented. For this purpose, co-operation at all levels between the countries concerned would be crucial in order to ensure harmonized procedures and obtain the best synergy. In addition, to manage the frozen tombs, the establishment of an archaeological park in the areas in which frozen kurgans are concentrated is highly to be recommended.

This will, first of all, serve as an open-air museum for educational purposes; secondly, contribute to the sustainable development of the communities concerned; and thirdly, through the systematic monitoring of the frozen tombs within the boundary, prevent the irreplaceable loss of the precious undocumented material.

Finally, it would be highly desirable that the four countries concerned — China, Kazakhstan, Mongolia and Russia — consider that the protection of the Altai Mountains encompassing these precious frozen tombs along with other archaeological heritage making up the unique landscape of the Altai Mountains, through nomination for inscription on the World Heritage List.

The World Heritage Committee, conscious that the World Heritage List should be properly balanced and truly representative of the heritage of humanity, adopted a Global Strategy in 1994 to address the issue of 'non-represented civilizations/culture' on the World Heritage list. In 2000 it requested that ICOMOS proceed with an analysis of the sites inscribed on the List, and elaborate a subsequent action plan to fill the gaps within the World Heritage List.

A deliberation on the significance of the Scythian culture and its outstanding universal value as well as its impact on other civilizations should be highly encouraged both at the levels of the concerned governments as well as academic institutions, and would be in line with the above-mentioned Global Strategy; as the place that the Scythian culture occupies in the history of humanity remains a blank spot in the World Heritage List. Future trans-national co-operation between concerned countries for this purpose will be crucial for the appropriate protection of the Altai Mountains.

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A Persian rug found in one of the Pazyryk Kurgans excavated by S. Rudenko, 5th-4th c. BC (State Hermitage Museum)

Climate Change, Fire and Cultural Heritage in Australia

Climate change will have, and is already having, a very wide range of impacts on cultural heritage sites around the world, ranging from permafrost melting causing building instability in polar and circumpolar regions, to increased desertification causing burial of sites beneath moving sand in Saharan Africa and other arid regions (see examples in World Heritage Centre 2007). Many regions around the world will experience coastal inundation caused by sea-level rise combined with an increased severity of adverse weather events, and polar regions will see the withdrawal of protective sea-ice, putting at risk cultural heritage places in low-lying cities and rural areas and along undeveloped coastlines.

In Australia there is similarly a range of observed and potential climate change impact. A series of regional models have been developed that allow some degree of refinement in looking at possible impacts across the continent. These draw on and expand the IPCC TAR 2001 reports, and are informed by local data collection and modelling (Intergovernmental Panel on Climate Change 2001; Pittock 2003; Allen Consulting Group 2005; Hennessy, Holper & Pittock 1995.). This modelling suggests the following possible outcomes for Australia, allowing for a range of global emissions scenarios:

- an increase in annual national average temperatures of between 0.4° and 2.0°C by 2030 and of between 1.0° and 6.0°C by 2070 — with significantly larger changes in some regions by each date;
- more heat waves and fewer frosts;
- possibly more frequent El Niño Southern Oscillation (ENSO) events — resulting in a more pronounced cycle of prolonged drought and heavy rains;
- possible reductions in average rainfall and run–off in Southern and much of Eastern Australia with rainfall increases across much of the Tropical North — as much as a further 20 per cent reduction in rainfall in Southwest Australia, and up to a 20 per cent reduction in run–off in the Murray Darling Basin by 2030;
- more severe wind speeds in cyclones, associated with storm surges being progressively amplified by rising sea levels;
- an increase in severe weather events — including storms and high bushfire propensity days; and
- a change in ocean currents, possibly affecting our coastal waters, towards the end of this period.

This paper will concentrate on just one example: the impacts of fire already observed and likely to increase as a result of climate change, in Kosciuszko National Park. Kosciuszko National Park, together with other parks in adjacent states, is a part of the Australian Alps, a mountainous region, low by global standards (Mt Kosciuszko, the highest on mainland Australia, is just 2,229 m), but containing Australia's major examples of alpine environments. The Alps have been used for extensive seasonal grazing and mining prior to their reservation for environmental conservation and recreation, and are the site of Australia's largest hydro-electricity development, the Snowy Mountains Hydro-Electric Scheme. These land uses have left many small huts in the landscape, where people lived for the summer season or shorter periods while working or moving through the mountains. Many of these huts are now used for recreational accommodation by walkers and skiers, and as a group they form a greatly valued part of the cultural heritage of Australia.

In 2003 wildfires (called bush fires in Australia) destroyed 19 out of the 83 surviving huts and hut ruins in the Kosciuszko

Burrungabugge Hut, which was destroyed by the 2003 bush fires and not reconstructed. This hut itself replaced another hut burnt down in 1983.

Franklin Chalet, built in 1938 as an early ski lodge near Canberra, the national capital, and destroyed by the 2003 bush fires. The decision has been made, because of declining snow cover in this area limiting future use of a building this size, and the extent of total reconstruction necessary to recreate a building of this size, not to reconstruct the Chalet, but to preserve elements as a memorial and build a new multi-purpose shelter on an adjacent site.

Geehi Hut, burnt out in the 2003 bush fires and in part restored and in part reconstructed in 2004

National Park (see Kosciusko Huts Association website lists). The 2003 fires were among the most disastrous in Australia's history, being spread over a large area of the southeast of the continent, and impacting on natural bushland, agricultural land and urban areas alike — in Canberra, the nation's capital, some 500 homes were destroyed.

In their 4th Assessment Reports, 2007, the Intergovernmental Panel on Climate Change (IPCC) draws attention to the evidence for climate change already taking place. In relation to fire frequency and intensity, it notes the observation of more intensive and longer droughts since the 1970s, with increased drying linked to higher temperatures, decreased precipitation, changed sea-surface temperatures, and wind patterns all being associated with the drying events. The report on the physical science basis for climate change predicts as 'likely' to 'very likely' more warmer and fewer cold days, warmer and more frequent hot days, and an increase in the frequency of warmer spells and heat waves as being 'very likely' to 'likely' (IPCC 2007a: 8, 9). These are the conditions that lead to increased fire danger.

The IPCC working group II (IPCC 2007b: 11) identified that "Production from agriculture and forestry by 2030 is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire." This clearly has implications for the many timber huts and other historic sites located in these forest and agricultural lands as well as in native forests in national parks. The fires that so severely impacted on Kosciuszko National Park huts in 2003 (and in 2006 in the neighbouring Alpine National Park, Victoria) are likely to become an increasing occurrence in Australia. The IPCC report indicates that other regions will experience similar increased risk, the frequency of wildfires in Southern Europe, peatland fires in Central and Eastern Europe, and forest fires in North America are all predicted to increase in coming decades.

Several challenges face the managers of cultural heritage sites in the light of global climate change projections such as these. One challenge is to raise awareness that the impacts are not limited to broad-acre forestry, agricultural and reserved conservation lands, but will (and are) impacting on cultural heritage as well. Another challenge is to develop adaptation responses that will reduce or remove the threats posed by climate change to cultural heritage places. A range of adaptive responses could be envisaged. A precursor to developing and implementing adaptive responses might be to carry out a systematic recording and assessment of the range of cultural places in localities or environments projected as being particularly at risk. This would have a two-fold outcome — it would help identify the elements or attributes of places and classes of places that might be threatened by particular climate change outcomes (eg likely to be impacted by wind, heavy rain, soil cracking, sea or flood inundation, changed soil chemistry/salt incursion, soil erosion, changing land use etc), and allow targeted adaptive responses to be designed: and it would also properly record those places where adaptive responses are not feasible, and where the place might be damaged or lost under changed climatic conditions.

In the Kosciusko case, the losses to fire have heightened the awareness of the vulnerability of the huts, and set in train a number of actions to increase their protection from fire (such as creation of fire breaks or fuel reduction programs, and provision of fire-fighting equipment at relevant locations) as well as to ensure they are fully recorded to allow restoration/reconstruction if that should become necessary in the future.

The IPCC report II (2007b) states that "The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g. land use change, pollution, overexploitation of resources)." This is a risk not only to the natural heritage of the world, but also to the cultural heritage that is an integral part of an environment in the grips of dramatic global climate change.

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(all photos by Michael Pearson)

Heritage and Global Climate Change: Summer Fires in Greece. The Case of Olympia

The presence of fires is linked to climate change

During the summer of 2007, millions of stremmas[1] of forests and agricultural land, spanning from the Iberian shores to the Turkish hinterland, were engulfed by fires. It was one of the largest catastrophes in the Mediterranean in the last century.

The dramatic changes that have been observed on the forest fire map of the Mediterranean over the last 15 years has led to the conclusion that global warming is the main cause of the frequency and intensity with which fires appear today. Moreover, research carried out by the Athens Observatory in collaboration with NASA has shown that climatic change can lead to changes in soil humidity and an increase in the frequency of thunderbolts. The combination of these phenomena with other factors, such as the disturbance of water levels, can lead to an increase in the number of fires.

Summer fires in Olympia (www.viewimages.com)

Climatic change cannot be seen simply as a future scenario in Greece

We saw signs of this in the winter and experienced a terrible summer. Three drawn-out and severe heat waves struck Greece in the summer of 2007. The first data provided by the Hellenic National Meteorological Service have indicated that 2007's three summer months were the hottest of the last 50 years. At the same time, this increase in Greece constitutes a link in the chain of temperature increases that have been observed over the last thirty years. The greenhouse effect has already arrived at our doorstep.

The first heat wave (19-28 June 2007) mostly affected eastern and southern Greece, with extremely high temperatures reached in Athens and the eastern Peloponnese. The Athens Observatory registered 44.8 degrees Celsius, the highest temperature since the end of the 19th century. The second heat wave (18-25 July 2007) mostly affected western and northern Greece, with record-breaking temperatures in several towns (Serres, Thessaloniki, Corfu). The third heat wave (21-26 August 2007) mostly affected western Greece and clearly contributed to the increase in intensity of the destructive fires in the western Peloponnese. The descending strong northeast winds led to an increase in temperatures above 40 degrees Celsius. However, it is not just the three heat waves that have caused alarm. The average maximum temperature was also very high in the summer of 2007. This is not an isolated phenomenon. In total over the last ten years, the average maximum temperature in Athens exceeded 34 degrees Celsius six times, something that would have been rarer in the past.

The hot summer that we experienced in 2007 was one of the worst in the last decades and had a terrible outcome: millions of stremmas of forest and agricultural land were burnt, villages destroyed and lives lost. According to the data provided by the Forest Authority of Greece, approximately 2.300.000 stremmas were burnt in the Peloponnese. The greatest catastrophe took place in Ileia where 950,000 stremmas and more than 4,500,000 olive trees were burnt.

The summer fires in Greece have destroyed communities and cultural landscapes, have cost the lives of at least 64 people and have angered Greek citizens. A whole population – not just those affected by the fires in the specific areas – gradually became aware of a threatening and doubtful future, and summers in Greece will no longer be as carefree as they used to be.

A recent study by the Athens Observatory presents a very bleak picture in terms of the consequences of climate change. Scientists estimate that, despite efforts by the European Union to limit the increase in temperature by two degrees Celsius, the average increase will be at least 3.5 degrees Celsius over the next few years. The consequences of climate change for Greece in four different fields – energy, agriculture, water sources and coastal areas – was explored by the Team for Energy Planning, Climate Change and Sustainable Development in the context of research conducted by the Athens Observatory. The results of the study are extremely worrying. There will be insufficient energy levels, agricultural production will vary tremendously with a possible reduction by 40%, substantial coastal areas will be flooded as a result of a rise in sea level by at least 60 cm, whereas our capital, Athens, will face severe water shortages, as water reserves will be 40% less than today's requirements. Scientists stress that these observations confirm the urgency for measures that slow down the phenomenon of climate change and address its consequences. It is not only the heat wave and the high temperatures that indicate that the climate has changed, but the frequency with which these extreme phenomena occur.

However, climate change is not the only cause of fires

Fires break out in many parts of the world, but the fires in Greece are unique in that they are the result of an amalgamation of other factors, including bio-natural, political, social and cultural.

In the course of the 20th century, poverty, war and financial politics led to the abandonment of the countryside by many of the people that knew how to manage the land; they had grown up in the countryside and had a sound knowledge of the methods with which to control their often rocky and precipitous terrain. Mass successive migrations led to the abandonment of a large part of the Greek countryside. Young people left the fields, the animals, the olive groves and the vegetable gardens for a better future abroad or in Greek urban centres. Certain of these abandoned areas have been overtaken by forests. However, there are also many areas where olive and citrus groves remain abandoned and vulnerable to fire.

The local populations have lived with fires for millennia, but now their traditions and their knowledge regarding the control and protection of the land are threatened by a combination of inappropriate political decisions and methods, and uncontrollable climatic consequences.

Following the fires of the 1990s, Greece has increased its fire fighting forces over the last nine years. However, it is a tragic fact that the intensity and extent of the 2007 fires exceeded the ability of firemen to protect the population, let alone our cultural heritage and ecosystems.

Addressing the problem; suggestions by scientific bodies

On a general level, scientists are proposing that there should be a 20-year plan, since they estimate that climate change will intensify over the next few years. An important series of suggestions for the restructuring of the areas affected by the fires was put forward by seven technical and social bodies on 3 September 2007. They point out that the consequences of climate change and floods will intensify over the following years and, therefore, measures should be incorporated into a 20-year framework and should not only address problems of the immediate future.

In addition, the Technical Chamber of Greece in collaboration with ICOMOS Hellenic, the Economic Chamber of Greece, the Plenum of Law Associations in Greece, the Greek Medical Association, the Geotechnical Chamber of Greece, the Union of Legal Workers of the Council of State, and the National Technical University of Athens stressed the need for a long-term plan to restructure the areas affected by the fires, based on the history of each area, the needs of the inhabitants, the existing economy and the presentation of the cultural heritage. New scientific methods should be proposed, whereas a speedy tourist development of the burnt areas should be avoided at all costs.

General view of Olympia" (Credit: Hellenic Ministry of Culture – General Directorate of Antiquities & CulturalHeritage, Directorate of Prehistoric and Classical Antiquities, Department of Greek and Foreign Scientific Institutions, Organizations and International issues)

Olympia: a heart wrenching cry for our cultural heritage

From 23 August 2007, the fires threatened to burn our most precious assets, our cultural heritage in the Peloponnese. This included the Arcadian landscape, Byzantine churches and monasteries, Apollo Epicurius at Bassae (a World Heritage Site), the Antiquities in Ilieia and especially the archaeological site of Olympia (also a World Heritage Site[2]).

There was damage to the area surrounding the Olympia archaeological site. The Kladeos stream, a tributary of the Alpheios River, was burnt to a great extent, whereas the Kronios Hill was burnt entirely. The park and the surroundings of the International Olympic Academy were destroyed. Furthermore, some slopes near the ancient stadium were also burnt.

However, in the context of this overall disaster it is important that there was no damage to the archaeological museum of Olympia, nor to the rest of the buildings, stadium or the ancient monuments, which were a priority. Thus, the archaeological site of Olympia has remained intact. Furthermore, there was no damage to the buildings of the Academy which belong to the International Olympic Committee, with the exception of the fire in the park.

The automatic fire extinguishing system 100 m north and northeast of the museum, which worked – even in high temperatures – to keep the area around the museum damp, enabled fire-fighters, volunteers and archaeologists to contain the fire and stop it from reaching the museum and from destroying one of the most important monuments of humanity. But, unfortunately, the fire was of such intensity that the electronic fire protection system that had been installed for the 2004 Olympic Games was not sufficient to combat all of the fire alone.

The fires are now followed by another, equally immense danger: the flooding of the Alpheios River and its tributaries (Kladeos, Altis, Neda, etc.). This is a danger that affects the entire archaeological park which is located in the burnt areas of the Ileia Prefecture. This park is home to many important antiquities.

Immediate restoration measures for ancient Olympia

The Hellenic Ministry of Culture announced immediately the measures for the restoration, protection and further enhancement of the archaeological site of Ancient Olympia. The following measures are in progress or completed:

- The cleaning of the low burnt vegetation in the area surrounding the perimeter of the archaeological site has proceeded – wherever this was required – and the burnt lawn in the perimeter of the stadium is also being replaced. The cleaning and removal of the low burnt vegetation between the architectural members, which originate from excavations conducted by the German Archaeological Institute and which are being stored south of the stadium, is now complete.
- The conservation of the architectural members that were damaged in the fire is well advanced by the Directorate of Conservation of Ancient and Modern Monuments with the participation of permanent staff of the 7th Ephorate of Prehistoric and Classical Antiquities. New, temporary conservator positions became available. In order for this to be carried out, the conservation works are scheduled for completion in December 2007.
- The cleaning of the covered storage area of the German Archaeological Institute is now complete. Following discussions with the German Archaeological Institute, it has been agreed that a new, larger storage area will be constructed in the same location.
- The National Agricultural Research Foundation shall function the technical consultant for the restoration of the landscape and the reforestation of the Kronios, Zouni and Kalosaka Hills and the Park of the International Olympic Academy.

In collaboration with the Ministry of Culture and the Ministry for the Environment, Physical Planning and Public Works, a project is under construction to provide anti-flooding and anti-erosion measures in areas of archaeological interest that have been affected by the recent fires. For the further protection of the archaeological site, the Hellenic Ministry of Culture had implemented the following:

- Construction works for the procurement of water (boreholes, technical works on a flat section of the adjacent river for water collection, construction of water reservoirs in suitable locations).
- Monitoring of the area via satellite (Athens Observatory).
- Creation of a PUP-UP system[3] in areas of low vegetation (stadium slopes).
- Expansion of the existing fire protection system in the complex around building perimeters.

The Nymphaion (taken from Greece – Prehistoric and Classical Monuments, edited by the Hellenic Ministry of Culture)

Concerning the enhancement of the archaeological site and the restructuring of the surrounding area, the following decisions were taken:

- The establishment of a committee within the Credit Management Fund for the Execution of Archaeological Projects for the further restoration of the Temple of Olympian Zeus, the restoration of the monument of Ptolemy, as well as the enhancement of monuments affected by the fires in the wider region. The issue was submitted to the Central Archaeological Council on 4 September 2007.
- Construction of a modern sports centre in the Municipality of Ancient Olympia.

In regard to the inspection of the remaining areas of archaeological interest that were affected by the fires, the following decisions were made:

- As a first step, the Hellenic Ministry of Culture is taking immediate measures for the protection of the affected sites and monuments (immediate replacement of supports). The 6th Ephorate of Byzantine Antiquities in Ilieia has already been provided with guidelines and funding for the immediate restoration of Panagia Church at Anilio in Zacharo and the monastery of Isova, monuments in the upper region of the Prefecture that were greatly damaged.
- Within this context, proposals for the formulation of basic principles for the restoration of affected monuments and archaeological sites and for the establishment of necessary teams for the implementation of the aforementioned works will be submitted to the Central Archaeological Council for discussion and assessment.

International solidarity

While visitors are once again able, since 28 August 2007, to admire the ancient stadium and the sculptures in the Olympia museum, there are crews that are undertaking restorations and anti-flooding measures.

The ancient spirit remains alive; it was not extinguished on Kronios Hill, but in fact it was rekindled by the moving offers of solidarity from ICOMOS International and the concerned countries: Turkey, Israel, Russia, Germany, Italy, France, Spain, Portugal, USA, Canada, distant Japan, and China where the Olympic Games of 2008 are due to take place. We are truly grateful.

Sofia Avgerinou Kolonia
ICOMOS Hellenic

[1] 1 stremma is equivalent to 1,000 square meters.

[2] *THE ARCHAEOLOGICAL SITE OF OLYMPIA*
WH Inscribed in 1989 (Criteria I, II, III, IV, VI)
The archaeological site of Olympia extends over the valley of the rivers Alpheios and Kladeos in a natural environment of outstanding beauty and harmony. It is a site endowed with a rich intangible heritage and evidence of human activity starting in the 4th millennium c. BC. On it developed the Panhellenic sanctuary of Olympian Zeus. In the Altis, the sacred grove that began to take shape in the 10th-9th c. BC, masterpieces of sculpture have been discovered in a good state of preservation, amongst them the famous Hermes of Praxiteles and the Nike of Paionios, as well as outstanding architectural monuments like the Palaestra. These buildings served cult, athletic, administrative and social purposes, and attest to the scale of influence of the sanctuary and its prestige throughout the entire ancient world. Today, they are reference points in the history of art. The Olympic Games were instituted here, making Olympia a unique universal symbol of Peace and Competition at the service of Virtue. Here, too, prominence was given to the ideals of physical and mental harmony, of noble contest, of how to compete well, of the Sacred Truce. In modern times, the Olympic flame is lit every four years in the area of the temple of Hera, in a ceremony that provides an ideological basis for the modern Olympic Games. On the buildings in the sanctuary are imprinted some of the most important steps in the history of art, particularly regarding the Doric order which was to evolve into a worldwide symbol of monumental expression. The early history of Doric temple-building can be traced in the Heraion, while the temple of Zeus, with its famous pedimental sculptures, is the most perfect example of the Severe Style. In this tranquil natural and cultural landscape can still be heard the echoes of myths in which leading roles are played by Zeus, Herakles and Pelops, which have been a source of inspiration and provided iconographic models for world art.
Hellenic Ministry of Culture, General Directorate of Antiquities, Directorate of Prehistoric and Classical Antiquities, Department of Greek and Foreign Scientific Institutions, Organizations and International Issues, Greece, World Heritage Sites, UNESCO, Melissa Publishing House, Athens, 2007.

[3] A type of fire suppressant system.

New Orleans, Hurricane Katrina, and Global Climate Change

The effects of Hurricane Katrina in New Orleans represent an interesting case study of the complexities of global climate change and our built heritage.

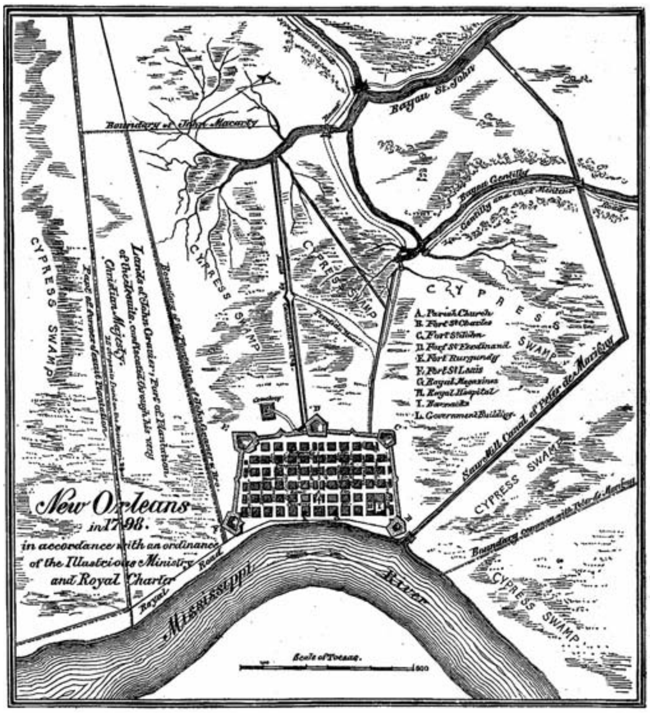

Fig. 2 Map prepared in 1798 shows the Vieux Carré surrounded by cypress swamp. Canals had been provided at this early date to drain water northward into Bayou St, John and ultimately Lake Pontchartrain.

Introduction

More than any other weather event, Hurricane Katrina has caused Americans to seriously consider the human role in global climate change. Though it is not possible to link any specific meteorological event with climatological change that takes place over decades or centuries, climate change has become a familiar topic of speculation with friends and colleagues when discussing the weather. Most Americans, regardless of political persuasion, now acknowledge that human activity is accelerating this phenomenon.

In unveiling its *2008 World Monuments Watch List* of the world's 100 most endangered heritage sites (which includes New Orleans) the World Monuments Fund states that "human activity has become the greatest threat to our cultural heritage." Human activity has been understood in the heritage community as the wear and tear our presence takes in the form of construction, traffic, our wastes, etc. - on our built heritage. But if human activity melts the polar ice caps thus raising the sea level and warms the oceans making hurricanes stronger and more frequent, then the two are linked. But to frame the discussion of Hurricane Katrina and New Orleans only in the context of climate change oversimplifies the story. This discussion must also include why we choose to live where we do and how we try to shape our environment.

Fig. 1 One month after Hurricane Katrina the Tremé Historic District was still deserted. Water marks show that the flooding was approximately 30 cm above the first floor. Though devastated the decayed charm of the neighborhood and its vernacular Caribbean character is still easily discernible.

New Orleans and its Fight with the Mississippi

New Orleans, located on America's Gulf Coast, has been described by local scholar Peirce F. Lewis as the "inevitable city on an impossible site." The city is also one of America's greatest outdoor museums and boasts a treasury of architectural styles of local origin as well as magnificent examples imported from other parts of the world and adapted to the subtropical climate, unique geographical conditions, and culture. However New Orleans' charming qualities are not defined by specific building examples but by their collection into evocative streetscapes and neighborhoods as shown in Figure 1.

For Jean Baptiste Le Moyne de Bienville, the area between Lake Pontchartrain and the bend in the Mississippi River seemed ideal for *Nouvelle-Orléans* in 1718. It was a rare bit of natural high ground along the flood-prone banks of the lower Mississippi. This location was picked because the Rriver did not have a mouth into the ocean but simply disappeared into a great swamp. Ships heading down river would unload their goods in New Orleans to be trans-shipped across Lake Pontchartrain to the sea.

The high ground had been formed by natural levees adjacent to the river. These slight ridges are composed of coarse sand and silt (deposited during annual floods) and became the site of the old New Orleans' *Vieux Carré* ("Old Square", better known as the French Quarter) as shown in Figure 2. Finer silts were carried farther northward into the cypress swamps adjacent to Lake Pontchartrain. These northern soils were soft and wet, with alternating layers of sand, silt, soft clays, and organic decaying matter.

It would be difficult to find a location where the natural drainage is worse than New Orleans, owing to a lack of slope in the land and the poor soil. As early as 1725, initial plans emerged to control New Orleans' frequent flooding. The French governor Étienne Périer ordered each property owner along the river bank to construct and maintain a levee two feet (60 cm) high. This plan may have offered protection from water coming into the city but revealed the problem with levees – they prevented rainwater from naturally running off into the Mississippi and would also eventually have to incorporate drainage canals and pumps.

In 1763 the Louisiana Territory was ceded to Spanish control. The territory reverted back to French control by 1801, and was sold to the United States in 1803 bringing an end to the colonial era. New Orleans and the Mississippi Coast cities grew rapidly with influxes of Americans, French and Creoles. New Orleans had a leading role in the slave trade, while at the same time having a prosperous community of francophone *gens de couleur libres* (free persons of color) who had arrived principally from the West Indies. This mix of black and white; slave and free; rich and poor; and English, French and Iberian cultures would give New Orleans its distinct character.

Antebellum Era

The period between 1830 and the American Civil War was the most glamorous and prosperous era for New Orleans. The area hosted wealthy cotton and sugar cane planters, and all related commerce was centered on New Orleans. At this time the practice of erecting structures on masonry piers became prevalent in the region. By raising houses slightly, insect problems were greatly curtailed, chronic dampness was abated, and frequent flooding of the ground after rainstorms was not as great a concern. Flooding was inadequately controlled by levees and a series of drainage canals into which flood waters were pumped and diverted to the northern cypress swamp and Lake Pontchartrain.

Victorian Era

Improvement of the mouth of the Mississippi River for seagoing navigation was first undertaken by Congress in 1837, but the venture proved elusive and costly. Dredging begun by the 1850s had been halted by the American Civil War. It was not until 1867 that dredging operations were resumed. In 1879 a channel to the sea constructed by the renowned construction engineer, James B. Eads, was opened, and direct shipping was open to the sea. This would affect the future pattern of silt deposition along the Mississippi delta.

Though it continued to grow, New Orleans had begun its decline – the advent of the US Railways had removed its trade monopoly between the Northeast and Midwest. Wood-framed construction that supported the Victorian building era following the American Civil War is what makes up most of New Orleans' remaining built heritage. Improvement of the levees along the Mississippi River, and construction of levees along the shores of Lake Pontchartrain began in 1879. However, development of the city was still restricted to the natural levees along the river earning New Orleans the moniker, "the crescent city", as shown in Figure 3. In what would prove to be a chronic pattern, the city's poorest citizens settled along the fringes of the lowland swamp, in what was referred to as the "back of town."

The Twentieth Century

In 1882 one of the most disastrous floods ever known devastated the entire delta area. Major floods again occurred in 1912 and 1913. But methods of pumping ground water into canals had greatly improved by the early twentieth century. The bulk of the city's northern boundaries opened for development with the introduction of A. Baldwin Wood's revolutionary centrifugal pump, as shown in Figure 4. Wood's pumps with their mechanisms raised above the water level for ease of maintenance allowed the drainage and con-

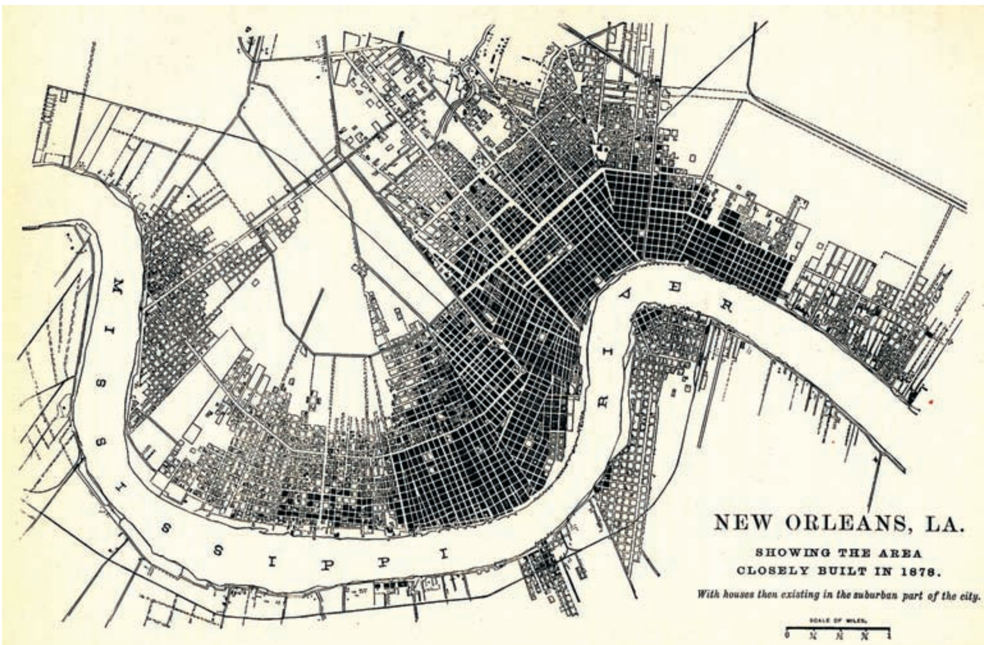

Fig. 3 Map prepared in 1878 shows the growth of the "crescent city" along the northern shores of the Mississippi Rover. The Vieux Carré is north of the tight bend in the river. Though the cities growth now encroaches upon the swamplands, these areas were populated by the poor.

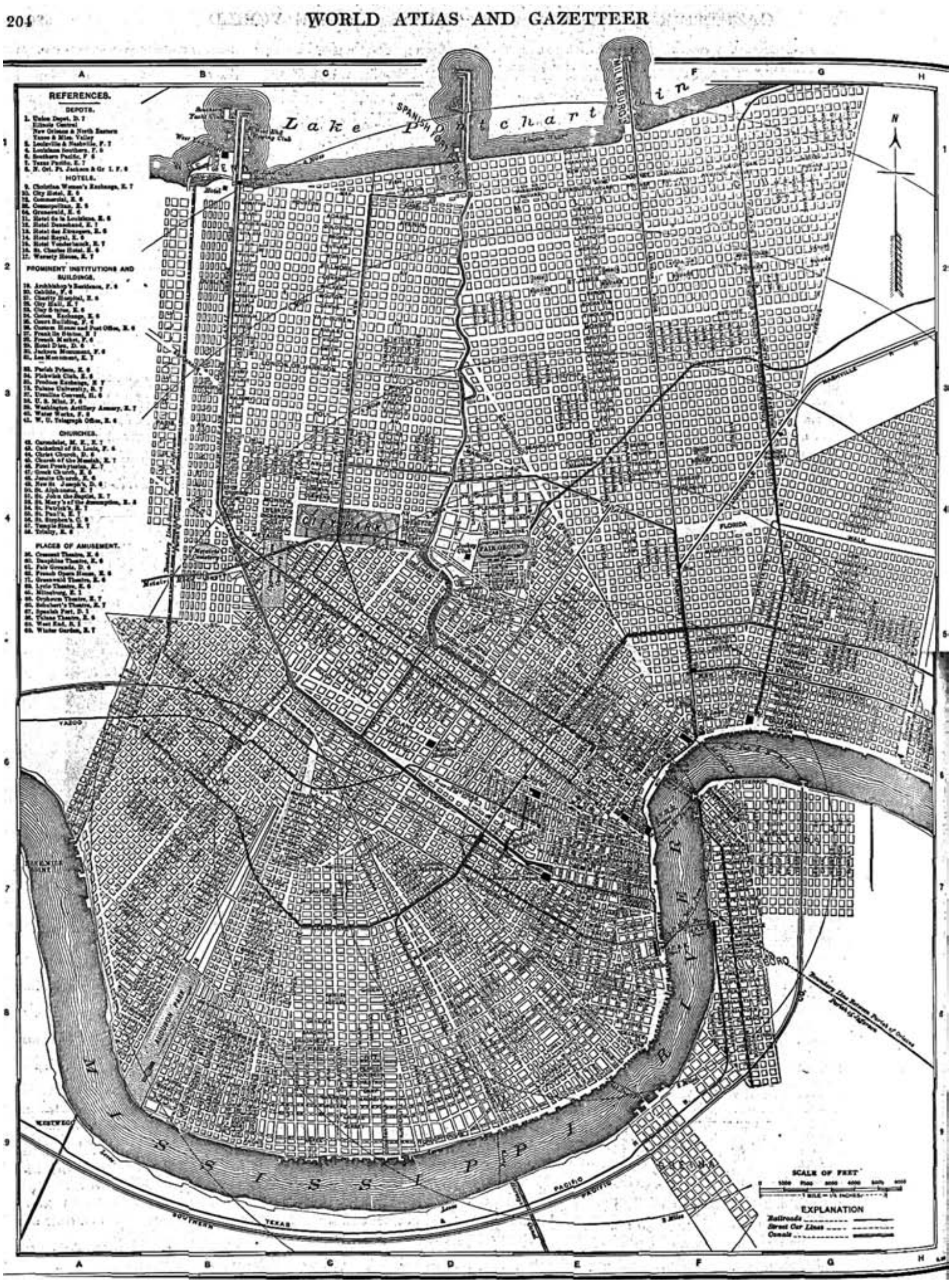

Fig. 4 Map prepared in 1909 shows the growth of New Orleans that now reaches the shores of Lake Pontchartrain. Development in the former swamp areas was realized only after the use of the A Baldwin Wood pumps that proved powerful enough to drain these areas.

sequent development of the city's vast swamps. By 1913, some 17 large pumps generated by eight pumping stations managed 2,810 cubic feet of water per second. Finally, it seemed that New Orleans had won its battle with the river.

Yet the Mississippi River posed another challenge for New Orleans – it had been on the verge of jumping courses in the nineteenth century and again in the twentieth. The second diversion threatened above Baton Rouge along the Atchafalaya River in 1951 and would have left New Orleans aside a swampy, stagnant channel. The Army Corps of Engineers intervened in both instances forcing the river to stay in its present channel and protecting New Orleans' status as an important shipping center. This control of the river would also affect future deposition patterns of the delta.

The control of the Mississippi River and existence of a functioning water management system had led to complacency on the part of local government concerning the habitation of many of its citizens below sea level. The faith in the flood-protection system can be seen in the evolution of building standards which abandoned residential structures on piers and allowed for slab-on-grade construction. Complacency of the state and federal governments is evidenced by the lack of maintenance of the levee system in the time leading up to Hurricane Katrina.

Present Day

By the post-World War II era it was understood that New Orleans' seeming victory over its chronic flooding problems had came at a cost: the city was sinking. After the flooding of New Orleans caused by Hurricane Betsy in 1965, the US Army Corps of Engineers embarked upon another project to once again strengthen and raise the height of the levees. However the sinking of New Orleans along with its levee system is principally caused by three man-made factors:

- Soil subsidence of the silty Delta soil that was partly natural but was exacerbated by the overburden of building construction and levee systems;
- Pumping the northern swamps dry caused significant subsidence. Such soil is highly susceptible to decreases in volume, when it is dewatered. Newly dried areas of town were soon as much as 10ten feet below sea level and continue to sink;
- Construction of levees surrounding New Orleans had prevented the natural deposition of silt from the yearly floods in New Orleans. In effect, areas outside of the levees were becoming higher in comparison as layers of muck and silt collected.

Further consequences of this human activity were seen regionally – loss of coast-line from hurricane storms due to weak depositions, deeper penetration of surges inland from numerous canals to the sea that were dug to facilitate the petrochemical industry, and soil deposition from the pumping of oil from beneath the soil.

The Effects of Hurricane Katrina

Hurricane Katrina was the fourth hurricane of the 2005 Atlantic hurricane season and the third-strongest hurricane on record to strike the United States. It made landfall near New Orleans on 29 August 2005. Its storm surge as high as nine meters devastated the Gulf Coast of Mississippi to the east of New Orleans. However, neither the surge or wind speeds were as great in New Orleans and the damage was principally caused by failure of the levee system. Heritage streetscapes – collections of wood-framed residential structures raised on masonry piers – suffered more from flood than wind damage, as shown in Figure 5.

Three major breaches occurred on the Industrial Canal, one along the 17th Street Canal, and two along the London Avenue Canal. Flooding from the breaches put 80 percent of the city under water for days and, in the lower Ninth Ward, for weeks. The failure mechanisms investigated by engineers following the flooding included overtopping of levees by the storm surge, consequential undermining of levee foundations or other weakening of the levees by water, and the storm surge pressures exceeding the strength of the levees. Debate over the actual causes – technical, political, and sociological – will undoubtedly continue for many years.

Conclusion

The 1878 map of New Orleans, drawn by T. S. Hardee, shows a city whose populated area is confined to a strip of the east bank of the Mississippi River. This is the area that stayed at or above water during the flooding from Hurricane Katrina. It is a sad reminder that New Orleans is totally dependent on its pumps and levees to survive and much of its land is nothing more than reclaimed swamp.

Models predict that the process of climate change in the form of global warming may continue for decades or centuries even if we stabilize the factors that are causing this problem today. Figuring out how to live with climate change is more urgent than determining how to prevent it. New Orleans' historic districts must now struggle to restore homes while preparing for future challenges posed by rising sea levels and the likelihood of stronger storms.

New Orleans, with its displaced citizens who are primarily poor, is a microcosm of what can be expected in the future from the effects of climate change. Rajendra Pachauri, chairman of the Intergovernmental Panel on Climate Change, the scientific body that shared the 2007 Nobel Peace Prize with Al Gore, stated "It's the poorest of the poor in the world, and this includes poor people even in prosperous societies, who are going to be the worst-hit."

Stephen J. Kelley, AIA, SE

Fig. 5 Image inside of a church in the Ninth Ward after the flood had subsided. Wind damage can be seen on the roof and sediment from the flood has "raised" the level of the ground by about 3 cm.