weathering change

newsletter of **the northern climate exchange** summer 2005

Rapid landscape change and its human effects

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Rapid changes in mean temperature of 10°C or more have occurred repeatedly throughout the past million years or so. A picture has recently emerged from ice cores, lake sediments, and ground temperature profiles in the North of short episodes of rapid change in the past 10,000 years, some taking place within 10 years or less. These abrupt changes certainly affected ecological and even social systems. Though we may not know exactly what pushed the annual average temperatures preserved by proxy in the ice of Greenland up by as much as 7°C over a decade or so, there are a range of possible causes – from solar radiation forcing, to albedo feedback and ocean circulation patterns.

Sophisticated computer models show that climate change is likely to be especially marked in Alaska and the Western Arctic: current conditions bear this out. However, models deal with average change and not with the extraordinary events that are so important on a local scale. Extreme events generally involve surprise. Thus understanding climate change requires consideration of many temporal and spatial scales, now and then, and here and there from global to local.

Rapid environmental changes on a variety of spatial scales can also be generated by non-climatic events, such as earthquakes and volcanic eruptions (see table). Some of these can drive or influence climate locally and even globally, as when volcanic emissions from the 1991 eruption of Pinatubo in the Philippines altered for a brief period global atmospheric circulation patterns and induced a temporary cooling. The Storegga submarine slump off the Norwegian continental shelf 7,300 years ago led to a catastrophic tsunami with run-ups of at least 20 metres on land in the northeast Atlantic. And of course there was the earthquake-driven Indian Ocean tsunami of December 26, 2004. Even under a stable climate regime, there are weather extremes such as hurricanes and cyclones that can cause rapid changes along coasts, in river valleys, and on steep hillsides. Likewise there are background hydrological processes that dissolve soft rocks underground causing surface subsidence, or that transport sediment in rivers.

The condition of the environment at any time reflects not only human influences, but also the natural processes that can be viewed as running in the background. Industrial, urban, and agricultural activities certainly have direct impacts on the environment, and these influences generally become more marked as populations increase and economic growth proceeds. However, away from obvious sources of disturbance (e.g. towns and cities, waste disposal sites, mines, farms, forest harvest areas), it may be difficult to separate even the direct effects of human actions from those due to natural processes. Moreover, in remote and less populated areas there may be indirect, far-travelled human influences, such as the long-range aerial transport of acid and toxic contaminants now affecting many people in the Arctic.

Rapid landscape change in the North exemplifies many contemporary key issues: extraordinary departures from the average; surprise and unpredictability; importance of the local scale; and the value of insights of local people.

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A note from the editor

This issue of *Weathering Change* has been dedicated to a conference held from June 15th –17th in Whitehorse called Rapid Landscape Change. The three-day meeting reviewed current research on the effects of climate and landscape change in the North throughout the Holocene era, and on the chronology and nature of past environmental events. It sought insights from past landscape changes and the way ancient peoples responded that might be useful for today's changing environments.

The Rapid Landscape Change conference was the fifth in the Dark Nature project (previous meetings were in Mauritania, Mozambique, Argentina, and Iran). It was the first to feature the specific problems of northern regions. The sixth and final conference in the International Council for Science Dark Nature project will be held in Como, Italy, September 6-10, 2005. You can find the website for that conference at http://scienze-como.uninsurbia.it/ambientale/sitodn.

I must thank all of the conference participants for not only contributing to the success of the conference but also to the success of this *Weathering Change* issue. I hope that this issue adds to the continued research and interest into rapid landscape changes. In the face of a changing climate it is important that we understand how past landscapes changed so that we are better able to understand how we must adapt for the future.

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In the Arctic and Subarctic, the ancestors of the Dene, the Inuit, Inuvialuit, Inupiat, and other northern peoples must have been forced, over the millennia, to adjust their way of life to many changes in climate, landscape and ecosystems. These influenced the way in which the earliest peoples spread out across the Arctic and Subarctic, and even southward. Now their descendants again face rapid environmental change, this time linked at least partly to human-driven climate warming, in which the Arctic is the vanguard. Though there are many places where Arctic landscapes have changed little in thousands of years, as shown for example by undisturbed pre-Dorset house sites located near beaches for 4,000-5000 years, elsewhere the land changes. Coasts erode, inland rivers switch channels and migrate, glaciers surge and melt, slopes fail, and floods occur and re-occur. Many of these changes can be seen in the Arctic and Subarctic today (as on Herschel Island and at Shishmaref in Alaska).

The choices for those who survive severe landscape change include relocation to a new place nearby, migration to new territory, or eventual return to homeland afterwards, adapting as required to new conditions. A return to home territory affected by natural disasters is quite common. This is evident today in the coastal zones of Sumatra, Sri Lanka, and Thailand, as fishermen and townspeople rebuild on the coastal plains swept by the tsunami of December 26th. The reasons are easy to understand – a need to return to a traditional way of earning a living (e.g. fishing), a lack of other places to settle, a strong attachment to the (only) land they own. A return to risky land today may also be related to poverty, to ownership – their land whatever the condition – or simply to acceptance (or ignorance) of risk and vulnerability, as in cities like Tokyo, Vancouver, and San Francisco. Indeed, abrupt landscape changes may be especially harmful to firmly established and relatively immobile societies, and to modern built environments such as cities.

History is full of examples where societies and settlements were harmed or failed in the face of environmental change. Much effort is now being spent to advance our understanding of the many ways that landscapes change and how these affect human behaviour. As we move into a period of rapid climatic and environmental change, there may be lessons for the near future from the record of the past. Recognizing more clearly the role of non-human causes of environmental change might make a difference in the way people think about the world around them and in the kinds of policies that are adopted to deal with change.

Rapid landscape changes that can occur even when the climate is stable.

Driver	Landscape Change
WATER	surface and groundwater quality, groundwater level, karst activity (sub-surface dissolution)
HAZARDS	earthquakes, eruptions, landslides, avalanches, floods, surface subsidence
RIVERS	streamflow, sediment movement and storage, channel migration
LAKES	levels and salinity
COASTAL	shoreline movement, relative sea levels
ARID LANDS	dune movement, dust transport, wind erosion
SOILS	texture, quality (e.g. fertility), erosion
CRYOSPHERE	glacier advance/retreat, frozen ground activity
WETLANDS	areal extent, hydrology

The human implications of climate change in Nunavut

JAMES FORD, DEPARTMENT OF GEOGRAPHY, UNIVERSITY OF GUELPH

In light of community concerns about risks associated with climate change, I worked with the communities of Arctic Bay and Igloolik, Nunavut to find out how people are experiencing, responding to, and coping with climate change. The project, part of ArcticNet theme 4.2: Reducing Human Vulnerability to Environmental Changes in the Canadian Arctic, conducted 112 interviews with a cross-section of community members in 2004/2005. Interviews were complemented with experiential trips on the land and analysis of secondary sources to add historical context.

There is widespread feeling among Inuit in both communities that the climate is changing. More unpredictable weather, more storms, stronger winds, thinner ice, later ice freeze-up and earlier breakup, were among changes indicated. As they perceive it, these changes have increased the risks associated with harvesting and have reduced access to hunting areas. However, both communities are effectively managing these changes. Coping strategies involve risk minimization, risk avoidance, risk sharing, modification of the timing and location of harvesting activities, and modification of the equipment used to harvest.

Inuit adaptability should not come as a surprise; indigenous peoples in the Arctic have always lived with fluctuations in environmental conditions. Adaptability is facilitated by:

- ***Traditional Inuit knowledge and land-based skills.*** Hunters have an intimate knowledge of the Arctic environment through their own experience and from knowledge and skills handed down the generations. This enables risks to be managed; hunters know the dangers of hunting, precursors to certain hazardous conditions, survival techniques for bad weather, and what preparations to make. The knowledge base is continually evolving and being updated and revised in light of observations of climate change.

- ***Strong social networks.*** The sharing of traditional food underpins food security as changing environmental conditions make certain hunting areas inaccessible to those who lack the equipment, knowledge, or time. Social networks also provide mechanisms for the rapid and effective community dissemination of information on dangerous conditions and the pooling of risk.

Hunting at the floe edge is becoming increasingly dangerous with unpredictable weather and wind

- ***Flexibility in harvesting behaviour.*** The opportunistic nature of harvesting allows advantage to be taken of specific local conditions and new situations as they emerge.

- ***Institutional support.*** Government monetary transfers and support from land claims institutions provide finance to cover the purchase of equipment (personal locator beacons, immersion suits, GPSs) necessary to cope with more dangerous hunting conditions.

Changes in the physical environment are being managed in conjunction with opportunities and challenges posed by changes in social, cultural, technological, and economic conditions. On the one hand, new opportunities have emerged. VHF radios enable safer travel; if difficulties are encountered help can summoned. And the diversification of food production away from a total reliance on country food has reduced vulnerability to changes in resource availability and accessibility. Overall, however, societal changes are straining the mechanisms through which Inuit manage climatic and environmental conditions. There are emerging vulnerabilities among younger generations due to erosion of land-based knowledge and skills necessary for safe hunting, a weakening of sharing networks in the community, increasing dependence on technology, and reliance on outside financial support.

Hunters are taking along more safety gear in case the weather suddenly changes or they get into difficulties

Acknowledgements:

Many thanks to the residents of Arctic Bay and Igloolik without whom this work would not have been possible. The research was supported by ArcticNet, a seed grant from the Integrated Management Node of the Ocean Management Research Network, and the Social Sciences and Humanities Research Council of Canada.

The past holds lessons

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The past holds lessons for those concerned with how humanity should tackle the challenge of climate change, and should encourage us to re-examine some of our assumptions about adaptation.

Across the globe, diverse societies and communities are facing the challenge of human-induced climate change. Efforts at mitigation through reductions in greenhouse gas emissions are likely to fall far short of those required to "stabilize" the climate over the short-to-medium term; instead, the focus is shifting inexorably towards adaptation. However, processes of adaptation remain poorly understood, and the empirical basis on which adaptation theory and practice rests is weak. There is therefore an urgent need for studies that can shed light on how and why societies and communities do or do not adapt successfully to climate change, and on the mechanisms and potential consequences of adaptation. Such information is required in order to support the design and implementation of policies, strategies, and measures to promote and achieve adaptation by governments and bodies such as the United Nations Development Programme.

Case studies of contemporary adaptation are beginning to emerge from regions such as the Arctic and the African Sahel, but remain few in number. Further examples must wait until processes of climate change and human response have played out more fully. However, we need not remain completely in the dark about how humans respond to environmental change, including abrupt climate change: the more distant past is replete with examples of such changes. While there are no perfect analogies for our current predicament, we might look to the warmer times of the early Holocene to see how biophysical systems respond to regional warming patterns, with the caveat that future warming is likely to be much greater than that of the early Holocene without serious and immediate mitigation efforts. We might use archaeology to see how human populations responded to the onset and termination of warmer conditions in the Arctic or wetter conditions across the now arid desert belt of Africa and Asia. While such studies are unlikely to yield any universal, absolute "laws" of adaptation, some broad general principles might be inferred.

> *Across the globe, diverse societies and communities are facing the challenge of human-induced climate change.*

Archaeological studies of abrupt climate change indicate that past adaptation has been overwhelmingly reactive and *ad hoc* in nature, and has generally occurred after populations have suffered significant damages: it is the survivors who adapt. Furthermore, adaptation is not cost free. While emerging adaptation "strategies" may enable a population to survive, those mechanisms may make life harder for individuals and lead to radical social transformation. These observations hold lessons for the present day, when managed adaptation is seen by many policy makers as an alternative to mitigation that represents a low- or no-cost means of neutralizing the impacts of climate change, while at the same time supporting the socio-economic *status quo* or supporting predefined developmental goals. Perhaps adaptation can be managed in order to achieve pre-defined goals in some instances, but we must recognize that such an anticipatory approach to longer-term climate variability and change represents a fundamental shift in the way we interact with the physical world. Adaptation will not be cost free and will not always be successful or predictable. In addition, we must recognize that there will be limits to the ability of societies to adapt, particularly to abrupt and severe changes in climate. While adaptation is necessary and desirable, so is mitigation; a focus entirely on adaptation at the expense of mitigation will simply mean that attempts to adapt are less likely to succeed.

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Volume 3 Number 4

A quarterly newsletter published by the Northern Climate ExChange, Whitehorse, Yukon, Canada

ISSN 1703-4256 (Print)
ISSN 1703-4264 (Online)

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Design by Outcrop Yukon Ltd.

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The Northern Climate ExChange is funded by Government of Canada, Government of Yukon, and Yukon College.

Holocene environmental change and human adaptation on the Central Alaska Peninsula, Alaska

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The Alaskan Arctic provides dramatic evidence of late-Pleistocene and Holocene climate and environmental change. The central Alaska Peninsula is located at the southernmost extent of the Arctic zone in North America. The National Science Foundation sponsored multidisciplinary field research that was conducted in 2000 - 2001 on the Peninsula, which is the northernmost arc of the volcanically active Pacific Ring of Fire. These studies yielded several lines of evidence for a variety of often abrupt Holocene environmental changes that affected the subsistence-settlement decisions hunter-gatherers who were living there made.

Paul, Jewell, and Nattie Boskoffsky at Marratuq. Paul is the grandson of chief Nicolai Ruff and the son of the Kanataq Postmaster, Pete Boskoffsky. Paul and his father were the last residents of Kanataq. Paul maintains a cabin near Marraatuq (NSF Project OPP-0102687).

View west, Portage Bay, Alaska Peninsula Pacific coast. The prehistoric and historic winter village of Kanataq is situated on the beach ridges south of Kanataq Lake (NSF Project OPP-0102687).

The Alaska Peninsula was locked up in glaciers until after 12,000 years ago. Different areas of the Peninsula became available for colonization at different times during the Holocene. Sites at Amalik Bay on the Peninsula's Pacific coast yielded information that people with material culture similar to the inhabitants of the Kodiak Islands lived along this coast over 7,000 years ago. Archaeological sites at the Ugashik Lakes and the north side of the Peninsula provided evidence that people sharing a material culture with much of Alaska and northeast Asia were present by around 9,000 years ago.

At Portage Bay, a series of interesting geomorphological features, identified during the 2000 - 2001 field project, was formed on the glacial outwash plain at the head of the bay. Around 6,000 years ago during a warm period resembling conditions today, the Pacific Ocean was at its highest level. As the climate cooled and new glacial ice formed, the climate became stormier, and a series of substantial gravel, cobble, and boulder beach ridges was formed as the sea level dropped. Humans settled sequentially on these four beach ridges beginning at least 1,900 years ago based on radiocarbon dating of burned wood associated with human activities. The winter village of Kanataq was inhabited from that time until recent historic times. According to historic accounts of former residents, the villagers experienced earthquakes and tsunamis, but appear to have been little affected by the volcanic activity on the Peninsula. Only small traces of volcanic ash, possibly from the Aniakchak volcanic explosions around 4,000 and 3,000 years ago, were identified at Kanataq.

To the north, at the end of a trail crossing the Aleutian Range, the prehistoric and historic summer village of Marraatuq is located on the toe of a large landslide that occurred suddenly before 4,000 years ago, based on a diagnostic stone tool found buried at the site. The landslide, a possible consequence of glacial retreat and runoff at the end of a Holocene glacial advance, apparently dammed the drainage at the base of the mountain and formed Ruth Lake and Ruth River that flow into Lake Becharof, creating ideal habitat for anadromous and freshwater fish. The prehistoric village is situated on a narrow neck of land between the shores of Lake Becharof and Ruth River, while the historic structures are located just to the east, around the base of a glacially-formed teardrop-shaped lobe of land extending into Lake Becharof. No volcanic ashes were identified in the soil profiles at Marraatuq. The villagers at Marraatuq also appear to have been undisturbed by the regional volcanic activity through time. In fact, this region may have been an area of relative safety and refuge for humans and animals during a series of volcanic eruptions elsewhere on the Peninsula over a 4,000-year period.

For Further Reading:

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Living with climate change in Ulukhaktok (Holman, NT)

TRISTAN PEARCE, DEPARTMENT OF GEOGRAPHY, UNIVERSITY OF GUELPH

"We hunt ducks in the spring. You need good ice to hunt ducks; go by (snow) machine. If it's an early breakup and the ice is bad we go by boats but it's harder to hunt ducks from the boat. The boat moves around and it's harder to shoot. You need good icebergs and ice to hide behind and get close to them to shoot" (Holman community member, July 2005).

Hunting *kingalik* (King Eider ducks) is an important cultural and subsistence activity in Ulukhaktok (Holman), one in which any reduction in the community's ability to hunt *kingalik* would be devastating. A greater understanding of current conditions that are relevant to people in Ulukhaktok and the adaptive strategies they employ is important for understanding how climate change may affect Ulukhaktok in the future.

Research on climate change has most often taken the form of large-scale and long-term impact studies on physical and biological systems. Yet climate change is already being experienced in the Arctic with implications for people's livelihoods and lives and there are questions about the degree to which adaptations can be stretched to deal with changing conditions.

Climate change is global in scale but research has shown that the impacts of climate change have and will be felt strongly at the local level. A proven method for understanding the implications of climate change on people is to assess community vulnerability. When the purpose of the research is to assess the vulnerability of a community we need to look at both the physical conditions that create risks for the community and also at the community's ability to cope with, recover from, or adapt to external risks. Vulnerability is not exclusive to physical stresses and effects, but must be considered within the scope of a synergy of local factors including local geography, community history, economy, culture, and social conditions.

An important implication from this conceptualization of vulnerability is that assessments need to focus on and engage with community members in order to identify those conditions that are relevant to the community and those adaptations that are realistic.

TRISTAN 'NAKIMAYAK' PEARCE

Manuk & Eukiat at the open water retrieving a kingalik (King Eider). (This photo was taken in front of Keketakyuak (Holman Island) by the auilagutt (where ice opens and closes), June 2003. Spring melt is becoming more rapid making travelling and hunting on the ice increasingly difficult

ADAM KUDLAK

Ulukhaktok (Holman, NT) is located on Queen's Bay on the southwest of Victoria Island in the Inuvialuit Settlement Region, July 2005v

Using this approach for assessing community vulnerability, a series of 60 interviews were conducted with community members in Ulukhaktok to document how people are experiencing, responding to, and coping with conditions related to climate change.

Preliminary findings indicate that the community is currently exposed to changing physical conditions that may be climate related, including: greater unpredictability of weather and ice conditions; rapidly changing seasons (e.g. timing of breakup); a change in the Peary caribou migration; skinnier and lower quality seals; changes in wind directions; and higher ocean levels.

Community members indicate that the timing of the break-up of ice in Queen's Bay (where the community is located) is happening earlier and more rapidly. This creates a risk for people who travel on the ice in the spring and sometimes prevents people from using snow machines to travel to spring camps for hunting *kingalik*. Some people have adapted to this change by travelling by boat; however, people who do not have access to a boat are limited in their ability to travel when ice conditions deteriorate and thus cannot access the same traditional hunting grounds. In this case, household economy, local geography, and social conditions influence how people are affected by and respond to changing physical conditions.

Collaboration with the community of Ulukhaktok is ongoing and in depth findings from this research will be forthcoming. Similar research on community vulnerability has been and is actively being conducted by members of the Global Environmental Change Group at the University of Guelph.

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Acknowledgements:

Special thank you to the residents of Ulukhaktok; specifically to Annie Goose, Fred Kataoyak, Robbie Inuktalik, and Adam and Melanie Kudlak. Thank you also to the continued support of Dr. Barry Smit, Frank Duerden, and the Global Environmental Change Group at the University of Guelph. This research is supported ArcticNet, Latornell Travel Scholarship, Northern Scientific Training Program, and Aurora Research Institute.

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ExChanging **VIEWS**

Accounting for human-induced rapid land-scape change

MICHAEL WESTLAKE, C-CIARN YUKON COORDINATOR

The role that land cover plays in climate forcing has largely been neglected by global climate change research, while more favour has been lavished on the obvious culprits —greenhouses gases, solar variability, and aerosols.

Consider the fact that an estimated one third to one half of our planet's land surface has been transformed by human development and wonder how that couldn't play a significant role in climate change. In fact, scientists have proven that land-surface change acts as an additional significant forcing of climate. It happens through changes made to the physical properties of the land surface: like urban sprawl, deforestation and reforestation, and agricultural and irrigation practices. These activities strongly affect regional surface temperatures, precipitation, and larger-scale atmospheric circulation.

Scientists are calling this global radiative forcing by surface albedo change, and its effects on climate may be comparable with anthropogenic aerosols, solar variation, and several of the greenhouse gases. Moreover, in regions of intensive human-caused land-use change such as North America, Europe and southeast Asia, the local radiative-forcing change caused by surface albedo may actually be greater than that of all the well-mixed anthropogenic greenhouse gases together (IPCC 2001).

This important aspect of human influence on climate is not currently accounted for under the Kyoto Protocol. One reason for this may be the difficulty in objectively comparing the effects of different local land-surface changes region-to-region coupled with the effects of changing atmospheric composition. However, neglecting the effects of land use will lead to inaccurate quantification of contributions to climate change with the danger that some actions may give unintended and counterproductive results. It is therefore important that possible metrics for land-use effects are explored under future rounds of negotiations for the post-2012 Kyoto world.

Dynamic nature and a conservation ethic

HOLMES ROLSTON, III, UNIVERSITY DISTINGUISHED PROFESSOR AND PROFESSOR OF PHILOSOPHY AT COLORADO STATE UNIVERSITY

An environment in motion motivates life; dynamic change is the context of creativity. Like most philosophical truths, this is a half truth which becomes false if taken for the whole. Stability in an environment is equally requisite for evolutionary development; the currents of life flow in the interplay of constancy and disturbance. An ecological philosophy of nature has to be double-edged and ambivalent because ecosystems - and the sciences describing these processes - are, complex, subtle, confusing. Ecologists once made too much of balance, stability, and equilibrium; but disorder and chaos can be overemphasized too. There are degrees of regularity and of contingency within both evolutionary history and landscape ecology, as there are also within genetics and molecular biology.

Over the decades, ecosystems have dynamic stability. Over the millennia, this passes into evolutionary development. The half-life, on average, of many species is something like five million years. North America has undergone repeated ice ages, speciation and extinctions of fauna and flora, and re-speciation. A landscape is like a palimpsest manuscript, new texts written over and over previous ones, layer after layer. The result is to elaborate and diversify the biota.

Over the centuries? Some landscapes, some of the time, change more rapidly than others - and here the Yukon landscape seems to be one of the most dynamic on Earth. The challenge is to find the right levels of scale and analysis. There may be order at one level and change at another. "The dynamic nature of ecosystems," concludes Claudia Pahl-Wostl, is "chaos and order entwined" (1995). Many general characteristics are repeated; many local details vary. Patterns of growth and development are orderly and predictable enough to make ecological science possible, even with openness and novelty, and also to make possible an environmental ethics respecting these creative, vital processes. Characteristically (though not invariantly) climate does not change so rapidly that components of the fauna and flora cannot track those changes, sustaining the ecosystem through modifications. The proof of that is three and a half billion years of life on Earth, generated and regenerated.

But today we must be warned of the difference and danger of anthropogenic changes on these previously resilient landscapes. The human upset may be so rapid and at such multiple scales that landscapes and regional biomes - even the integrity of the planet - may be in jeopardy. The Yukon with its rapid landscape change may prove, in this sense, a laboratory in which we come to study, appreciate, and respect life at the margins, when tolerable change becomes intolerable. That would be conservation biology at its best: understanding life to conserve ongoing natural history past and present - and our own human future as well.

Reference:

Pahl-Wostl, C., 1995. *The Dynamic Nature of Ecosystems: Chaos and Order Entwined*. New York: John Wiley.

Holmes Rolston, III, University Distinguished Professor and Professor of Philosophy at Colorado State University.