weathering change

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Rapid landscape change and its human effects

TONY BERGER, CO-DIRECTOR, IUGS GEOINDICATORS INITIATIVE, WOODY POINT, NL

Rapid changes in mean temperature of 10^0C 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^oC 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.uninsubria.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