Vulnerable populations: health of humans and animals in a changed landscape

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The climate is changing. There have always been natural variations in temperature and CO_2 concentrations, as demonstrated in samples from the Antarctic ice sheet dating back some 800,000 years. But something has affected the stable era, the Holocene that the globe has been in for the past 10,000 years. Repeated measures from recent years show that for the past 200 years, the rise in global temperature and in CO_2 levels occurred at a speed not previously observed. In 1769, the patent for the steam engine was registered marking the start of the Industrial Revolution and since then activities of man have accelerated the increase in CO_2. This new era has been called the Anthropocene, to reflect man's impact on the earth's ecosystems. The changes are noticed mostly in the north of the globe and current predictive models all agree that changes will affect the northern hemisphere first. Up to now, real-time measures underestimate the changes predicted by modelling. Changes have occurred at a higher rate than first predicted. Because of the complexity of the drivers of ecosystem change and because we yet do not have all the tools needed to analyse the complex changes taking place, it is important to realize that we do not know much of what the outcome of climate change will be.

Reports from the International Panel on Climate Change (IPCC) point to an increase in extreme weather events. The Greenland ice sheet has decreased by 70 metres in 5 years, and if it continues at this rate, it will have an impact on the level of the oceans. Consequently, we have come to understand that the globe is more fragile than robust. And those changes in eco-systems will affect us as humans, a species among others on the globe.

The Arctic and its people are facing drastic change. Given the close dependence on natural resources, global climate change (and globalization) is expected to have immediate and significant consequences for Arctic populations and local communities.

Arctic societies and cultures are faced with multiple stressors and challenges related to the on-going and combined effects of environmental processes (impacts of climate change); cultural developments (erosion of indigenous languages); economic changes (the emergence of narrowly based mixed economies); industrial developments (the growing role of multinational corporations engaged in the extraction of natural resources); and political changes (the devolution of political authority). The distant and once economically unviable resources of the far north will be linked to global markets more closely than ever before, playing an increasingly important role in the world economy. They constitute a new frontier of investment and industrialization.

Indigenous peoples live in closer contact with nature than others and have valuable knowledge of on-going biophysical and ecological processes. The rest of the world can learn a lot of adaptive strategies from them and from studies on what is happening due to climate change to the eco-systems in the north.

The changes include a higher level of mental ill-health and the health consequences of a change of diet to a more western way of eating (including a much higher intake of processed foods), causing overweight, type 2 diabetes and an increase in cardiovascular diseases. For example, mortality rates for Alaska Natives exceed that of other citizens in the United States.

a. Life expectancy 64.9 years vs. 76.7 years for the United States
b. Infant mortality 8.7/1,000 vs. 7.2/1,000 for the United States
c. Unintentional injury mortality 3.3 times US rate
d. Suicide 4.2 times rate for all races in the United States
e. Cancer mortality is 1.5 times all races in the United States
f. Higher rates of some infectious diseases

Life expectancy of the indigenous populations also of northern Canada, Greenland and the northern Russian Federation is lower than that of the respective national

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populations. Infant mortality remains higher than respective populations of the US, northern Canada, Greenland and northern Russian Federation. In fact, for some conditions, the mortality has increased among indigenous peoples as living conditions have changed, from a lower baseline compared to the other population to levels exceeding the population. The exception is the Saami population. In the Nordic countries, the Saami have the same health standard as the general population but a slightly higher suicide rate among male reindeer herders.

Mortality rates for heart disease and cancer were once lower among the indigenous populations of the US, Canada and northern European countries, but are now similar to their national rates.

Today, climate change is considered to be a human-rights issue, not least through some work by activists like Sheila Watt-Cloutier.

Food security is a central concern and an important example. Food security requires that all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active healthy life. However, with the advent of climate change, climatic conditions and seasonal timetables will change in ways that affect food yields. Other more specific problems will result. Today, 70% of Inuit pre-schoolers in households in northern Canada are rated as food insecure.

For example, underground ice cellars traditionally used to store whale meat frozen all year round no longer function safely due to thawing of the permafrost. Such climate-related changes in long-standing customs and ways of living ultimately lead to stress, mental disorders and suicides. Animals that were previously hunted have disappeared or are contaminated so recommendations include not eating them as frequently as before.

Water security means having access to water of good quality. Without access to food and water of good quality, health is threatened and living conditions are impaired. Data reported in this issue show that, in Alaska in areas with declining access to water, there is an increase in respiratory and skin infections resulting in more cases of hospitalisation. A surveillance of the quality of food and water, and of access to them, is of particular importance in the Arctic, especially now that in addition to longer standing and more localised environmental problems, the climate is changing so rapidly.

In many communities in the north, the buildings stand on permafrost. Loss of this support will result in damage to water intake systems and pipes and may result in contamination of community water supplies, and damage to water and sanitation infrastructures and distribution systems forcing communities to rely more on untreated (or traditional) water sources. This is already resulting in increase in clinic visits and hospitalizations for various "Water washed" infectious diseases, those commonly prevented by hand washing such as gastroenteritis, respiratory infections caused by RSV, influenza, skin infections, impetigo, and boils caused by MRSA.

With an increase in CO_2 in the atmosphere, some trees will produce much more pollen than they do today. This will lead to more allergies among humans and later chronic pulmonary diseases. The increase in precipitation and flooding events will create favourable conditions for mould growth in homes. This indoor exposure may result in an increase in mould-related respiratory disorders and allergies.

Environmental risks to health from chemical contaminants in the environment have been of particular concern in the Arctic, due to long-range transportation (atmospheric and ocean transport) from lower latitudes as well as from local sources. Examples of such contaminants are persistent toxic substances, including mercury and lead, and persistent organic pollutants such as polychlorinated biphenyls and pesticides. These hazardous chemicals are of particular concern for the unborn.

When flora changes, animals, including mammals, insects and parasites, start adapting very quickly and change boundaries of their habitats in response. With a change in the boundaries of fauna, microorganisms will change boundaries as well. Zoonoses, infections passed to humans from animals, are already the main emerging infections, and this is likely to increase further as habitats for animals change.

Warmer temperatures may allow infected host animal species to survive winters in larger numbers, increase in population, and expand their range of habitation, thus increasing the opportunity to pass infections to humans. For example, milder weather and less snow cover may have contributed to a large outbreak of Puumala virus infection in northern Sweden in 2007. The climate-related northern expansion of the boreal forest in Alaska and northern Canada has favoured the steady northward advance of the beaver, potentially extending the range of Giardia, a parasitic infection of beaver that can infect other mammals, including humans who use untreated surface water. Elevated run-off from snow melt and increased precipitation could exacerbate contamination of water supplies with Giardia and Cryptospridium cysts and oocysts. The association between infection and increased precipitation is well recognized. In a recent outbreak in 2 towns in northern Sweden, more than 50,000 residents developed Cryptosporidium-related gastroenteritis after drinking contaminated municipal water following heavy rainfall that overwhelmed water purification systems. Hunters in northern Sweden, for example, have noticed that more ticks are infesting their dogs each year.

In Sweden, the number of human cases of tularaemia has increased in the north recently, and Tickborne encephalitis (TBE) is now also occurring over a wider

region in southern Sweden. Effective surveillance of these changes in the range and seasonality of various infectious diseases, and their health consequences, is needed to minimise future risks for humans and animals.

Climate change could exacerbate the potential for the food and/or waterborne transmission of *Toxoplasma gondii* in the Arctic. The recent discovery of Toxoplasma in polar bears and Arctic foxes in Svalbard underscores the widespread nature of this infection.

Another important meat borne parasite in the Arctic is Trichinella, commonly responsible for outbreaks related to the consumption of undercooked bear or walrus meat. The most common species survives freezing. The geographical distribution of cold tolerant verse freeze tolerant *Trichinella sp.* follows the January isothermal lines (−5C for *T. native*). Thus, shifts in host diversity and environmental temperature could lead to altered distribution.

Similarly, warmer temperatures in the Arctic and sub-Arctic regions could support the expansion of the geographical range and populations of foxes and voles, common carriers of *Echinococcus multilocularis*, the cause of alveolar echinococcus in humans. The Northern strain cystic hydatid disease is caused by *Echinococcus granulosus*, which maintains a cycle that includes wolves, coyotes, foxes or dogs and caribous. However, several species are also competent hosts for *E. granulosus* such as moose and deer who may move further north in response to climate change.

In Sweden, the incidence of TBE has substantially increased since the mid-1980s. This increase corresponds to a trend of milder winters and an earlier onset of spring, resulting in an increase in the tick population (*Ixodes ricinus*) that carries the virus responsible for TBE and other potential pathogens. Similar movement of TBE has been documented in northern north-western Russia where *Ixodes persulcatus* is the predominant vector. This movement corresponds to the estimated climate-induced changes in the *I. persulcatus* habitat. Whether or not disease in humans is a result of these climate change-induced alterations in vector range depends on many other factors, such as land-use practices, human behavior (suburban development in wooded areas, outdoor recreational activities, use of insect repellents, etc.) and human population density as well as adequacy of the public health infrastructure.

Past outbreaks of Anthrax among cattle and reindeer have resulted in more than 13,000 burial grounds in Russia containing the carcasses of infected animals. More than half of these are located on permafrost in Siberia. There is concern that with a warming of the Arctic, melting permafrost in these regions will expose many of these burial sites together with Anthrax and therefore increase the risk of infection in humans.

These are also risks for tourists; for example, snow mobile safaris have been moved from lakes to soil in some tourist centres in the Northern Finland.

There are also opportunities that will emerge in Arctic regions when resources become more accessible when sea and land ice cover is lost. The image of the Arctic is rapidly changing. It is growing into a dynamic region; a region of interest for many countries, businesses and other stakeholders.

But to realize that actions will have an impact on climate and environment is of uttermost importance to mankind, and to realize that the eco-systems are actually part of our society, our place on earth, is fundamental for our survival. Maybe governments are in need of a "road to Damascus" experience to realize how fragile this globe of ours actually is. Let us give them this experience as researchers and as human beings.

Suggested readings

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