Scientific Facts on

Global Impacts of climate change in the Arctic

Source document:
AMAP (2017)

Summary & Details:
GreenFacts

Level 2 - Details on Global Impacts of climate change in the Arctic

This is a faithful summary of the leading report
produced in 2017 by the Arctic Monitoring and Assessment Programme (AMAP):
"Snow, Water, Ice and Permafrost in the Arctic, AMAP "

The full Digest is available at: https://www.greenfacts.org/en/global-impact-arctic-climate/

This PDF Document is the Level 2 of a GreenFacts Digest. GreenFacts Digests are published in several languages as questions and answers, in a copyrighted user-friendly Three-Level Structure of increasing detail:

- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

All GreenFacts Digests are available at: http://www.greenfacts.org/

1. How is the Arctic climate changing?

The Arctic is undergoing what is known as a 'state shift', which means that it is going through a phase of rapid changes towards a new stable state. Many of the changes underway are due to a simple fact: ice, snow, and frozen ground— the components of the Arctic cryosphere—are sensitive to heat. Over the past 50 years, the Arctic's temperature has risen by more than twice the global average.

Rises of greenhouse gases are driving changes in the Arctic's sensitive climate, hydrological and ecological systems. 2012 saw the ice cover of the Arctic Ocean reach a record minimum, and changes in ice thickness, snow cover and permafrost have continued since. With each additional year of data, it becomes increasingly clear that the Arctic as we know it, is being replaced by a warmer, wetter, and more variable environment. This transformation has profound implications for people, resources, and ecosystems worldwide.

Arctic temperatures are rising faster than the global average. The Arctic was warmer from 2011 to 2015 than at any time since instrumental records began in around 1900, and has been warming more than twice as rapidly as the world as a whole for the past 50 years. January 2016 in the Arctic was 5°C warmer than the 1981–2010 average for the region, a full 2°C higher than the previous record set in 2008, and monthly mean temperatures in October through December 2016 were 6°C higher than average for these months. Sea temperatures are also increasing, both near the surface and in deeper water.

2. What changes in the Arctic are expected in the future?

Three points in particular deserve special emphasis:

- The Arctic Ocean could be largely free of sea ice in summer as early as the late 2030s, only two decades from now;
- The recent recognition of additional melt processes affecting Arctic and Antarctic glaciers, ice caps, and ice sheets suggests that low-end projections of global sea-level rise made by the Intergovernmental Panel on Climate Change (IPCC) were underestimated;
- Changes in the Arctic may be affecting weather in mid-latitudes, and influencing even the Southeast Asian monsoon.

More specifically:

The frequency of some extreme events is changing. Recent observations include a widespread decline in periods of extreme cold during both winter and summer, and increases in extreme warm periods in some areas, such as northern Alaska and northeastern Russia in autumn and spring.

The decline in sea ice continues, with variation from year to year. Sea ice thickness in the central Arctic Ocean declined by 65% over the period 1975–2012. Sea ice extent has varied widely in recent years, but continues a long-term downward trend. A record low minimum sea ice extent occurred in 2012 and a record low maximum sea ice extent occurred in 2016.

The area and duration of snow cover are decreasing. Snow cover has continued to decline in the Arctic, with its annual duration decreasing by 2–4 days per decade. In recent years, June snow area in the North American and Eurasian Arctic has typically been about 50% below values observed before 2000.

Permafrost warming continues. Near-surface permafrost in the High Arctic and other very cold areas has warmed by more than 0.5°C since 2007–2009, and the layer of the ground that thaws in summer has deepened in most areas where permafrost is monitored.

The loss of land-based ice has accelerated in recent decades. Since at least 1972 the Arctic has been the dominant source of global sea-level rise. Seventy percent of the Arctic's contribution to sea-level rise comes from Greenland, which on average lost 375 gigatons of ice per year—equivalent to a block of ice measuring 7.5 kilometers or 4.6 miles on all sides—from 2011 to 2014. This is close to twice the rate over the period 2003–2008. These measurements suggest that the IPCC might have underestimated the projections of global sea level rise.

Freshwater storage in the Arctic Ocean has increased. Compared with the 1980–2000 average, the volume of freshwater in the upper layer of the Arctic Ocean has increased by 8,000 cubic kilometers, or more than 11%. This volume equals the combined annual discharge of the Amazon and Ganges rivers, and could— if it escapes the confines of the Arctic Ocean—affect circulation in the Nordic Seas and the North Atlantic.

Ecosystems are changing. The decline in sea ice thickness and extent, along with changes in the timing of ice melt, are affecting marine ecosystems and biodiversity. Terrestrial ecosystems are feeling the effects of changes in precipitation, snow cover, and the frequency or severity of wildfires. While many tundra regions have become greener over the past 30 years, reflecting an increase in plant growth and productivity, recent satellite data show shifts toward browning (indicating a decrease in plant cover and productivity) over large areas of the Arctic, particularly in Eurasia.

3. Can those future changes in the Arctic climate be prevented?

Arctic climate trends affect carbon storage and emissions. New estimates indicate that Arctic soils hold about 50% of the world's soil carbon. While thawing permafrost is expected to contribute significantly to future greenhouse gas emissions, the amount released over the past 60 years has been relatively small.

The impacts of these changes reach beyond the Arctic itself. In addition to the Arctic's role in global sea- level rise and greenhouse gas emissions, the changes underway appear to be affecting weather patterns in lower latitudes.

Together, these findings portray a system whose component parts are changing at different speeds, affecting the Arctic's role as a regulator of global temperature and its influence on Northern Hemisphere weather, its contribution to sea-level rise, the livelihoods of those who live and work in the Arctic, and the habitats of Arctic species. Today's Arctic is a new environment, evolving rapidly and in unexpected ways.

By analyzing climate models, scientists have identified the relative contribution of the different feedbacks to warming in the Arctic. Some of them, unique to the Arctic, are responsible for the more rapid warming observed over the Arctic compared with the rest of the world. These feedbacks amplify warming well beyond the effects caused by increasing greenhouse gas concentrations alone. The largest feedbacks, according to climate models, are related to the Arctic's inefficiency at radiating heat. Cold regions radiate heat slowly, so the warmth trapped by greenhouse gases tends to build up. Furthermore, warming in the Arctic is concentrated close to the Earth's surface, slowing the rate at which heat is lost to space from the top of the atmosphere.

4. What are the impacts of Arctic climate changes on human communities and ecosystems?

Changes will continue through at least mid-century, due to warming already locked into the climate system:

- Warming trends will continue. Models project that autumn and winter temperatures in the Arctic will increase to 4–5°C above late 20th century values before mid-century, under either a medium or high greenhouse gas concentration scenario. This is twice the increase projected for the Northern Hemisphere. These increases are locked into the climate system by past emissions and ocean heat storage, and would still occur even if the world were to make drastic near-term cuts in emissions.
- The Arctic Ocean may be ice-free sooner than expected. Extrapolations of recent observed data suggest a largely ice-free summer ocean by the late 2030s, which is earlier than projected by most climate models. Natural variability and model limitations make precise predictions impossible.
- Declines in snow and permafrost will continue. The duration of snow cover is projected to decrease by an additional 10–20% from current levels over most of the Arctic by mid-century under a high emissions scenario, and the area of near-surface permafrost is projected to decrease by around 35% under the same scenario.
- The melting of land-based ice will contribute significantly to sea-level rise. If increases in greenhouse gas concentrations continue at current rates, the melting of Arctic land-based ice would contribute an estimated 25 centimeters to sea-level rise between 2006 and 2100. Many of the smallest glaciers across the Arctic would disappear entirely by mid-century.
- The Arctic water cycle will intensify. Climate models project increases in cold-season precipitation of 30–50% over the Arctic Ocean toward the end of this century, with an increasing portion of that precipitation falling as rain instead of snow.
- Arctic ecosystems will face significant stresses and disruptions. Changes in sea ice are expected to affect populations of polar bears, ice-dependent species of seals and, in some areas, walrus, which rely on sea ice for survival and reproduction. There will also be losses of ice-associated algae. Physical disturbance arising from an increasing frequency of wild re and abrupt thawing of permafrost could accelerate ecological shifts, such as the expansion of tall shrubs and trees into tundra. Boreal forests will be affected by thawing permafrost, increases in wildfires, insect pest outbreaks, and climate zone shifts.
- Arctic changes will affect sources and sinks of important greenhouse gases. The amount of atmospheric carbon dioxide absorbed by the Arctic Ocean may be significantly affected by changes in sea-ice cover, the structure and functioning of marine ecosystems, and the hydrological cycle. Thawing permafrost is expected to increase emissions of methane.

5. How does the Arctic climate affect the global climate system?

In the most part, no, since the warming over the next few decades is already locked into the climate system. If emissions continue to increase, future changes in the Arctic would be even more substantial and long-lasting. However, substantial cuts in GHG emissions can stabilize the impacts after mid-century.

Reducing not only emissions of GHGs, but their concentrations in the atmosphere would make a difference. While the changes underway in the Arctic are expected to continue through at least mid-century, substantial global reductions in net greenhouse gas emissions can begin to stabilize some trends (albeit at higher levels than today) after that. Reversing trends would require reductions in atmospheric greenhouse gas concentrations.

Compliance with the Paris Agreement will stabilize snow and permafrost losses, but there will still be much less snow and permafrost than today. Climate models show that reducing greenhouse gas emissions and stabilizing concentrations, under a scenario roughly consistent with the Paris.

Agreement, could stabilize the further loss of snow cover and permafrost after mid-century. In contrast, higher emissions would result in continued losses.

However, the Arctic will not return to previous conditions this century under the scenarios that are under consideration. The near-future Arctic will be a substantially different environment from that of today, and by the end of this century Arctic warming may exceed thresholds for the stability of sea ice, the Greenland ice sheet, and possibly boreal forests.

6. How can people adapt to those changes?

Arctic communities, such as Tromsø in Norway, are facing important changes

The rapid changes underway in the Arctic affect lives, livelihoods, and ecosystems throughout the region, with both positive and negative consequences.

Climate change is only one of many factors contributing to changes. Oil and gas activities, mining, tourism, shipping, fisheries, economic development, and pollutants are just some of the other stressors faced by the Arctic today. Many of these factors interact with each other.

Changes underway have wide-ranging consequences for its ecosystems and for people living and working there. The Arctic also plays an important role in global climate and weather, sea-level rise, and world commerce meaning that impacts in this area resonate far south of the Arctic Circle. A recent economic analysis of the global costs of Arctic change estimated the cumulative cost at USD $7–90 trillion over the period 2010–2100.

The Arctic Ocean’s open water season has already increased by 1–3 months over much of the ocean since the late 1970s, creating more opportunities for marine shipping, commercial fisheries, tourism, and access to resources. In contrast, losses and decreases in the thickness of lake and river ice and changes in permafrost conditions affect or threaten ice roads, restricting access to remote communities.

Some northern communities have found it harder to obtain wild sources of food due to the shorter snow cover season (which affects travel to hunting grounds as well as animal habitat). Thinner sea ice and lengthier melt season also affect access to resources.

Communities and infrastructure built on frozen soils are significantly affected by thawing permafrost, one of the most economically costly impacts of climate change in the Arctic. The bearing capacity of building foundations has declined by 40–50% in some Siberian settlements since the 1960s, and the vast Bovanenkovo gas field in western Siberia has seen a recent increase in landslides related to thawing permafrost. Thawing permafrost may also contaminate freshwater resources when previously frozen industrial and municipal waste is released.

7.

For wildlife and ecosystems, the impacts are also severe:

- Reductions in snow cover change the availability of habitat for microorganisms, plants, and animals.
- Winter thaws and rain-on-snow events can damage vegetation, while refreezing creates a layer of ice over the vegetation that may be difficult for animals to penetrate with their hooves, adversely affecting conditions for grazing animals such as caribou, reindeer, and musk ox.
- The thinning and loss of sea ice has many impacts on Arctic life, from promoting the growth of marine phytoplankton and creating more habitat for open- water species to loss of ice-associated algal species and disrupting the feeding platforms and life cycles of seals, polar bears and, in some areas, walrus.
- Food webs are affected by changes in the structure of ecological communities and shifts in the geographic ranges of species.

8.

Changes in the Arctic affect the rest of the world, not only in obvious ways (such as the contribution to sea-level rise), but also through the its role in the global climate system, its influence on ocean circulation, and its impacts on mid-latitude weather.

Compared with mid-latitudes and the tropics, the Arctic receives relatively little energy from the sun. Because most of the its surface is covered by snow and ice, much of the energy that it receives is reflected back to space, these factors account for the its cold climate. The Arctic acts as a global refrigerator by drawing warm ocean water from the south, cooling it, and ultimately sinking it toward the ocean bottom. Surface water moves in to replace the sinking water, thus creating ocean currents. This movement of warmer ocean waters to the north has a major influence on climate; it accounts for northern Europe's relatively mild climate compared with that of Canadian provinces at the same latitude, for example, and it keeps the tropics cooler than they would be otherwise.

Melt water from Arctic glaciers, ice caps, and the Greenland ice sheet also influences climate by flooding the ocean with freshwater, affecting ocean circulation and weather patterns. Coastal communities, low-lying islands, and ecosystems throughout the world will be affected by the melting of land ice (glaciers and ice sheets) in the Arctic, which is projected to increase the rate of global sea-level rise. Impacts include coastal flooding, erosion, damage to buildings and infrastructure, changes in ecosystems, and contamination of drinking water sources.

The Arctic is both a source and sink for greenhouse gases; as an example, thawing permafrost is expected to increase emissions of methane. Changes in the quantities of greenhouse gases such as carbon dioxide and methane stored or released in the Arctic can have a long-term impact on global climate.

One of the major new areas of research since 2011 is on connections between Arctic changes and mid-latitude weather. Some studies have linked the loss of land and sea ice, along with changes in snow cover, to changes in Northern Hemisphere storm tracks, floods, and winter weather patterns, and have even found evidence that Arctic changes influence the onset and rainfall of Southeast Asian monsoons.

While it is clear that Arctic changes can influence weather outside of the region, scientists are still working to characterize the nature, magnitude, and extent of the effects.

9.

Adaptation at the community and regional levels, both in the Arctic and globally, is essential. The near inevitability of accelerating impacts in the Arctic and globally between now and mid- century reinforces the urgent need for local and regional adaptation strategies that can reduce vulnerabilities and take advantage of opportunities to build resilience.

Effective mitigation and adaptation policies require a solid understanding of Arctic climate change. Reducing knowledge gaps will improve our ability to respond to current and future changes in the Arctic. Efforts are needed to increase the geographic coverage of observations, improve local-level projections, and reduce uncertainties.

Coordination across monitoring efforts, modeling studies, and international assessments can facilitate information- sharing and avoid duplication of effort. As international attention becomes increasingly focused on Arctic climate change and its impacts, the need to coordinate among assessment processes and studies becomes greater.

Stabilizing Arctic warming and its associated impacts will require substantial near-term cuts in net global greenhouse gas emissions. Full implementation of the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) will cause Arctic temperatures to stabilize—at a higher level than today—in the latter half of this century. This will require much larger cuts in global greenhouse gas emissions than those planned under current nationally determined contributions to the fulfillment of the UNFCCC.

The Arctic Council and other international organizations should prioritize research and knowledge-building efforts to reduce uncertainty in predictions of changes and their consequences at local to global scales, facilitating the development of effective adaptation responses to changes in the Arctic cryosphere.