Facts on Arctic Climate Change

A Summary of the Arctic Climate Impact Assessment

GreenFacts
Facts on Health and the Environment

THE INTERNATIONAL POLAR FOUNDATION

ARCTIC CLIMATE CHANGE will not only affect local people and ecosystems but also the rest of the world, because the Arctic plays a special role in global climate. Permafrost is melting, glaciers are receding, and sea ice is disappearing. How has the climate changed in the Arctic so far, and what future changes are expected?

Introduction: Global climate change and the Arctic region

The world's climate is changing. On average, the temperature on the Earth's surface has increased by 0.6°C (1°F) over the last two centuries.*[1] There is strong evidence that the recent warming goes beyond natural climate variability, with most of it due to human activities, particularly the burning of fossil fuels.

In the Arctic, climate changes are particularly intense. These changes will affect the rest of the world by increasing global warming further and raising sea levels.

The Arctic region is the area around the North Pole, essentially an ocean surrounded by land. Its territory includes the northern parts of the North American and Eurasian continents, as well as Greenland and Iceland. The Arctic is home to a range of plants, animals, and almost four million people, which are adapted to survive in some of the planet's most extreme conditions. Climate change puts increasing pressure on fragile Arctic populations and ecosystems.

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How is the climate changing in the Arctic?

Arctic climate is now warming rapidly and much larger changes are projected.

Evidence of the recent warming of the Arctic is provided by: records of increasing temperatures; melting glaciers, sea ice, and permafrost; and rising sea levels.

Global temperatures are expected to increase further during the 21st century. In the Arctic, this warming is expected to be substantially greater than the global average, and the following changes are expected over the current century*:

- The average annual temperatures are projected to rise by 3 to 7 °C (5 to 13°F), with the greatest warming occurring in the winter months
- Precipitation is projected to increase by roughly 20%.
- Sea ice is expected to continue to decline significantly, reflecting less solar radiation and thereby increasing regional and global warming.
- The area of Arctic land covered by snow is expected to decrease by 10 to 20%.

These projections assume a gradual warming. However, abrupt and unexpected changes cannot be ruled out.

The Arctic is home to a range of plants, animals, and almost four million people.

How will Arctic warming affect the rest of the planet?

Arctic warming and its consequences have worldwide implications.

Changes in the Arctic can influence the global climate through three major mechanisms:

- The amount of the **sun's energy reflected back to space** decreases as snow and ice melt, leading to a more intense surface warming.
- The melting of Arctic ice and increased regional precipitation can add freshwater to the oceans, and potentially affect **ocean currents** in the North Atlantic.
- As warming progresses, more **greenhouse gases could be released** into the atmosphere by the thawing of the permafrost. However, warming can increase biological growth, and thus absorption of CO_2.

By 2100, melting of Arctic glaciers alone will have contributed to a sea level rise of roughly 5 cm out of the projected 10-90cm total rise for this century.*[2] Melting of the Greenland ice sheet may increase this number significantly.

Access to **Arctic resources** is likely to be affected by climate change, including: wildlife, such as whales, seals, birds, and fish sold on world markets; and oil, gas and mineral reserves.

Arctic ecosystem changes will have an impact on a global scale, notably by affecting migratory species' summer breeding and feeding grounds.

* Note: The ACIA report sourced some of its measurements and projections from the Third Assessment Report (TAR) published in 2001 by the Intergovernmental Panel on Climate Change (IPCC). In its Fourth Assessment Report (AR4) published in 2007, the IPCC has refined some of the figures. For example,

1 The IPCC AR4 estimate of the Earth's average global temperature increase is 0.76°C.

2 The IPCC AR4 projection of sea level rise is 18-59 cm.

GreenFacts' summary of the IPCC AR4 is available at www.greenfacts.org/en/climate-change-ar4/.

How will vegetation be affected by Arctic warming?

Arctic vegetation zones are likely to shift, causing wide-ranging impacts.

The Arctic region has three main types of vegetation: polar deserts in the north, boreal forests in the south, and tundra in between. Rising temperatures are expected to favor a northward expansion of boreal forest into the tundra, and of tundra into the polar desert.

The **expansion of forest is likely to amplify global warming**, because the newly forested areas are darker than the tundra they replace, and absorb more of the sun's energy. However, this can be somewhat counterbalanced by the fact that they also take up more carbon from the atmosphere.

Due to the warming, **insect outbreaks** will increasingly disturb large areas of forest. Most scenarios project more **forest fires** in all ecosystems.

Climate change is expected to increase the range of **crops** that can be grown in the Arctic and to extend the growing season. However, problems caused by insects, diseases, and weeds are likely to worsen.

How will animals be affected by Arctic warming?

Animal species' diversity, ranges, and distribution will change.

Many Arctic animals, such as polar bears, seals, walruses, and seabirds, rely on the sea's biological productivity and on the presence of sea ice, both of which are highly dependent on climatic conditions.

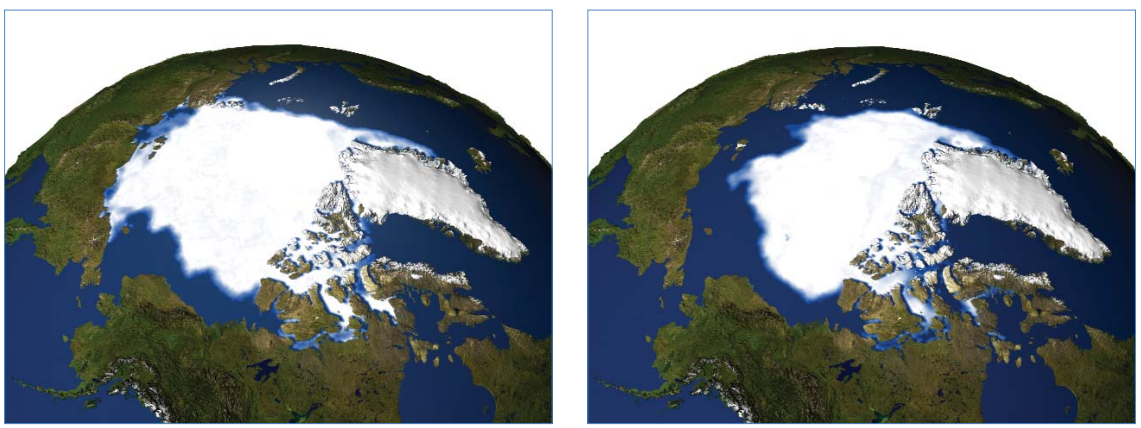
Changes in sea surface temperatures or currents could have a strong effect on Arctic **marine fish stocks**, which are an important food source for the world and play a vital role in the region's economy. Rising temperatures could have both positive and negative impacts on the **aquaculture** of salmon and trout, which is a major industry in the Arctic.

A decline in certain types of vegetation would affect the animals that feed on them (such as lemmings or reindeers). In turn, predators (such as foxes or birds of prey) and human communities that depend on these animals would be affected.

Freshwater ecosystems, such as rivers, lakes, and wetlands are home to a variety of animals. They would be affected by increases in water temperature, thawing of permanently frozen ground, and ice cover breaking up earlier in spring.

One of the main types of arctic vegetation, the polar desert, is found in the north of the Arctic region

Observed sea ice



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How will settlements and infrastructures be affected by Arctic warming?

Access to Arctic resources is likely to be affected by climate change including wildlife, fish, and oil

Many coastal communities and facilities face increasing exposure to storms.

Rising temperatures are modifying the Arctic coastline and are expected to change it even more in the future. Sea level rise is likely to cause flooding of marshes and coastal plains and accelerate beach erosion. Some towns and industrial facilities are already suffering severe damage as a result of erosion, and are now facing the prospect of relocation.

Reduced sea ice is very likely to increase marine transport and access to resources.

A further decline in the area of Arctic sea-ice will extend the navigation period and allow better accessibility by ship around the Arctic Basin and probably open new shipping routes.

Thawing ground will disrupt transportation, buildings, and other infrastructure

The melting of the permafrost layer poses significant engineering challenges for roads, buildings, pipelines, and industrial facilities. New constructions will require deeper foundations, thicker insulation, and other preventive measures that will increase construction costs.

How will people and their environment be affected by Arctic warming?

Indigenous communities are facing major economic and cultural impacts.

The many indigenous communities whose cultures and activities are shaped by the Arctic environment are facing new challenges because of climate change, in addition to those posed by current social, economic, and political conditions. They find weather less stable and predictable, and are affected by changes in snow and sea ice.

Elevated ultraviolet radiation levels will affect people, plants, and animals.

The increase of ultraviolet (UV) radiation reaching the Earth's surface as a result of the thinning of the ozone layer has negative effects on humans, animals and plants in the Arctic, particularly in the spring when living organisms are most vulnerable.

Multiple influences interact to cause impacts to people and ecosystems.

The ability of the Arctic populations to cope with the impacts of climate change will be greatly affected by political, legal, and socioeconomic factors such as growing populations, urbanization, or self-determination movements.

Many coastal communities are facing the prospect of relocation

How can future climate change assessments be improved?

Indigenous communities are facing major economic and cultural impacts

The Arctic Climate Impact Assessment (ACIA) represents the first effort to comprehensively examine climate change and its impacts in the Arctic region, bringing together the findings of hundreds of scientists and the insights of indigenous people.

There remain important gaps in knowledge that will require improved long-term monitoring, studies of ecosystem processes, climate modeling, as well as analysis of impacts on society. The International Polar Year (in 2007-2009) will be an opportunity to improve our understanding of the impacts of climate change.

Conclusion

Climate change presents a major and growing challenge to the Arctic and the world as a whole. Implications are particularly great for future generations that will face the consequences of current action or inaction.

Resulting environmental changes will present **risks** as well as **opportunities** across the Arctic. For example, the large reduction in summer sea ice threatens the future of several ice-dependent species but will also increase marine access to resources and population centers.

The scenarios used in this assessment assume that changes will be gradual. However, because of the complexity of the Earth's climatic system, major **surprises** are possible if climate evolves differently. Ocean currents in the North Atlantic might undergo major changes with wide-ranging consequences for climate.

Impacts of changing climate in the Arctic are already being widely observed and felt. They provide an early indication for the rest of the world of the significance of climate change. The changes will also reach far beyond the Arctic, affecting global climate, sea level, biodiversity, and many aspects of social and economic systems. Climate change in the Arctic thus deserves and requires urgent attention by decision makers and the public worldwide.

The 10 key findings:

1. Arctic climate is now warming rapidly and much larger changes are projected.
2. Arctic warming and its consequences have worldwide implications.
3. Arctic vegetation zones are likely to shift, causing wide-ranging impacts.
4. Animal species' diversity, ranges, and distribution will change.
5. Many coastal communities and facilities face increasing exposure to storms.
6. Reduced sea ice is very likely to increase marine transport and access to resources.
7. Thawing ground will disrupt transportation, buildings and other infrastructure.
8. Indigenous communities are facing major economic and cultural impacts.
9. Elevated ultraviolet radiation levels will affect people, plants, and animals.
10. Multiple influences interact to cause impacts to people and ecosystems.

GLOSSARY

Boreal forest – A forest that grows in regions of the northern hemisphere with cold temperatures. Made up mostly of cold tolerant coniferous species such as spruce and fir.

Break-up – The breaking, melting, and loosening of ice in the spring.

Glacier – A moving body of ice that forms on land from the accumulation and compaction of snow, and that flows downslope or outward due to gravity and the pressure of its own weight.

Ice cores (carrots) – Cylinders of ice obtained by drilling into a glacier. Since the different layers of ice are formed over time through build-up of snow, ice cores provide information on climate from different periods (up to almost one million years) that can be used for research.

Permafrost – A layer of soil or bedrock at a variable depth beneath the surface of the earth in which the temperature has been below freezing continuously from a few to several thousands of years.

Polar desert – Polar deserts are areas with annual precipitation less than 250 mm and a mean temperature during the warmest month of less than 10° C. Polar deserts on the Earth cover nearly 5 million square kilometres and are mostly bedrock or gravel plains.

Sea ice – Sea ice is frozen ocean water. It occurs in both the Arctic and Antarctic and can cover large extents of water. It grows during the winter months and melts during the summer months, but some sea ice remains all year in certain regions. About 15 percent of the world's oceans are covered by sea ice during part of the year.

Tundra – A type of ecosystem dominated by lichens, mosses, grasses, and woody plants. Tundra is found at high latitudes (arctic tundra) and high altitudes (alpine tundra). Arctic tundra is underlain by permafrost and is usually [water] saturated.

Facts on this publication

This publication presents a faithful summary of ***Impacts of a Warming Arctic***, a leading scientific consensus report produced in 2004 by the Arctic Climate Impact Assessment (ACIA). The summary was written by GreenFacts in collaboration with the International Polar Foundation.

The ***Arctic Climate Impact Assessment*** was an international project of the Arctic Council and the International Arctic Science Committee (IASC). It was initiated in 2000 "to evaluate and synthesise knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences." This project was an unprecedented four-year scientific study of the Arctic region conducted by an international panel of 300 scientists. The full report is available on: www.acia.uaf.edu.

A more detailed summary can be found on ***www.greenfacts.org/en/arctic-climate-change/***

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