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Photo: A. Renner, NPI

THE NORWEGIAN ARCTIC

NORWEGIAN POLAR INSTITUTE

Photo: Jon Aars, NPI

Arctic and Antarctic Knowledge

Polar scientific research, environmental monitoring and advice to Norwegian authorities on polar matters

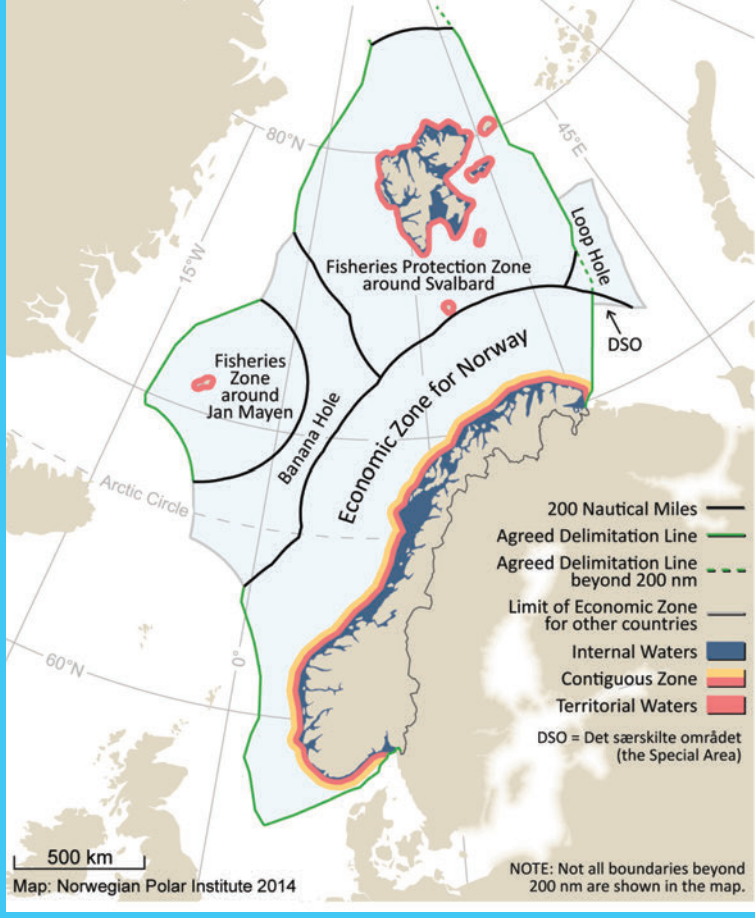
A government agency under the auspices of the Ministry of Climate and Environment, the Norwegian Polar Institute (NPI) is Norway's main institution for research, environmental monitoring and topographic and geological mapping in Norwegian polar regions. The Institute also advises Norwegian authorities on matters concerning polar environmental management and runs research stations in the Arctic and Antarctica. It is the competent authority responsible for implementing and overseeing Norwegian Antarctic environmental legislation. NPI experts take part in work regarding environmental management and represent Norway in international processes, and are involved in the work of the IPCC.

One of the highlights of 2013 was the start of the process of acquiring a new research vessel. The Kronprins Haakon ship will cost 1.4bn NOK, and will be ready for Arctic and Antarctic waters in 2016. Before Lance (the institute's current vessel), is retired, she will be frozen into the sea ice north of the Svalbard archipelago. Here she will serve as a research platform during the polar night – part of the ICE Centre's "Norwegian Sea Ice Cruise 2015" research programme. What better way for Lance to wind up her service than as a platform for a special campaign that will enhance our knowledge of climate, snow, sea ice and the Arctic Ocean? Leading national and international scientists are invited to take part with their own projects.

The ICE Centre is closely coordinated with NPI's established research programmes. The Oceans & Cryosphere and the Geology & Geophysics Programmes contribute to a greater understanding of climate change by considering climate variability and feedbacks in the sea ice-land-ocean-atmosphere system, assessing the system's sensitivity to disturbances and analysing the consequences of a changing climate from a physical perspective. NPI polar climate monitoring programmes collect data in collaboration with international institutions. The Institute's climate research contributes to regional climate models.

NPI's Biodiversity Programme is designed to provide sound scientific advice to Norwegian and international agencies responsible for resource management and conservation practices. The group contributes scientific knowledge to the global knowledge base regarding polar ecosystems and their functioning. The Eco-toxicology Programme gathers knowledge to improve our understanding of the sources and biological effects of contaminants in the European Arctic.

The Norwegian Polar Institute publishes reports and handbooks. Its international peer-reviewed open access journal, Polar Research, presents articles concerning diverse fields of research in the polar regions. The library has a substantial collection of polar literature, including original diaries, and the picture library contains 90,000 contemporary and historical photographs of which 47,000 are publicly accessible via an online database.



The State of the Norwegian Arctic

Nearly two decades ago, the Norwegian Polar Institute was tasked by the authorities to design a monitoring programme for the Norwegian Arctic. As a result, the Environmental Monitoring of Svalbard and Jan Mayen (MOSJ) has evolved as an umbrella programme that collects and interprets relevant data series in the Arctic territories of Svalbard and Jan Mayen. A main objective of the programme is to assess whether the environmental aims set by the Norwegian government have been achieved. Where these have not been met, the programme should identify the causes and propose recommendations for management actions.

The following two MOSJ reports are in the process of being published.

The report on the marine environment focuses on the fishery protection zone around the archipelago of Svalbard (with Spitzbergen as the principal island) and the fishery zone around the island of Jan Mayen. The authors – representing several Norwegian institutions – present interesting findings from various studies. They conclude that impacts caused by non-sustainable harvesting of wildlife and fisheries have been greatly reduced during the last 40 years. Currently the most threatened species are protected, fishing and hunting are regulated according to internationally accepted criteria for sustainability and quotas are set according to scientific advice from relevant international bodies. The exception is overharvesting of the Red-listed golden redfish (*Sebastes marinus*).

The report on the terrestrial environment is more severe. It focuses on the fact that climate change in the Arctic is the main pressure likely to cause major state changes in the terrestrial ecosystems in Svalbard.

Svalbard is on the verge of "a novel climate", characterised by winters without very low temperatures (above -20 degrees C) and summers with extended growth seasons (above 5 degrees C). Due to these changes, invasive species are threatening the native species which are adapted to a colder climate. However, currently the largest risk is caused by species increasing in number, such as the destructive impacts of native geese on vegetation. The impact caused by goose abundance is mainly due to management outside of the Arctic.

The report points out that research findings have contributed substantially to a better understanding of recent climate impacts on high Arctic ecosystems, but that the lack of historical analogues of the vast climate changes projected to take place over the next decades in combination with invasive/increasing species and expanding human traffic and actvities, makes reliable projections of future states of the ecosystem almost impossible to derive.

Photo: P. Dodd, NPI

Into-the-Ice Experience

Climate models predict that the rise in temperatures which is now evident in the Arctic is only the beginning. The rapid warming will continue, and within a short period of time the Arctic Ocean will be ice-free in summer – even at the North Pole.

The ice is diminishing not only in its extent, but it is also thinning. We now have an Arctic Ocean where the ice cover mainly consists of ice which is less than one year old, whereas multi-year ice was the rule a few decades ago.

The young ice has different characteristics than multi-year ice. Firstly, it absorbs more energy from the sun, which in turn leads to it melting even faster. Also, more energy passing through the ice cover warms up the water underneath and lets light through to the primary producers living beneath the ice. These are the basis for the ecosystem in the polar seas.

There is little knowledge about the physical processes in the Arctic Ocean in winter when it is dark and inaccessible. What happens during this time? To answer some of the questions, the Norwegian Polar Institute will have the research vessel (Lance) freeze into the drift ice north of the Svalbard Archipelago, at about 83 degrees northern latitude, in January 2015. The ship will drift along with the ice until it is free, probably by late April, then go back north and re-freeze again. The aim of the "Norwegian Young Sea Ice Cruise 2015" project is to study the energy balance and the effects on the ecosystem and the climate.

During this time, a number of different projects will be carried out on board and at measurement sites on the sea ice. There will be helicopter flights approximately every 21 days to change scientists and crew. The project aims to increase our knowledge of:

- Upper ocean – sea ice interaction
- Atmospheric forcing
- Sea ice and snow mass balance
- Sea ice dynamics
- Biologeochemical sea ice interactions.

The scientists on board will mainly come from European research institutions.

Environmental pollutants

The European Union's REACH list of substances that can cause serious health and environmental damage was updated with 54 new chemicals last year. The Norwegian Polar Institute's research on pollutants and their effects on animals and the environment in the Arctic contributed data for the regulations. REACH requires that all new and existing chemical substances be registered and regulated in a common regulatory framework.

Although there are few sources of pollution in the Norwegian Arctic, substances are carried to the region with air and water currents. A joint research report from the Norwegian Institute for Air Research, the Norwegian Polar Institute and the sustainable engineering firm SWECO found extremely high levels of chlorinated paraffins in birds (and their eggs), fish and mammals in Svalbard. Levels of these pollutants are increasing in the marine food chain in the Arctic. The pollutants were also found in samples of breast milk collected in northern Norway. Chlorinated paraffins constitute a group of substances that are toxic, resistant to breakdown in the environment and can accumulate in humans and animals.

Researchers observe a downward trend in levels of "old" pollutants (e.g. PCBs and pesticides) in several Arctic species. However, in kittiwakes from Kongsfjorden in Svalbard, HCB levels are increasing. New contaminants (fluoride compounds, brominated flame retardants and chlorinated paraffins) in marine food chains have also been screened for. Of the 17 fluorine compounds analysed in 2013, 10 were found in samples from seals, seabirds and polar bears. In glaucous gulls, a strong correlation was found between metabolites (from PCBs and brominated flame retardants) and hormone levels.

The scientific results are of vital importance when it comes to managing the environment. In 2013 it was agreed that the flame retardant HBCDD should be banned under the Stockholm Convention. Norway first proposed a total ban on HBCDD in 2008. Since the 1990s, the Norwegian Polar Institute has documented HBCDD in polar bears, glaucous gulls and Brünnich's guillemots in Svalbard, and noted increasing amounts of the substance in the eggs of several species of Arctic seabirds. Through monitoring, mapping and efficacy studies of environmental contaminants in the Arctic, the Institute has been a driving force in getting HBCDD and other substances onto the agenda in international negotiations.

A changing climate

Minister for Climate and Environment in Norway, Tine Sundoft discusses some of the climate challenges making Norway and its polar regions vulnerable…

Norwegians are used to taking fairly extreme weather conditions into account in everyday life. We have learned to cope with a range of climatic variations over the centuries. Norway has a long coastline, wide mountain ranges and extends right up to the Arctic. This makes the country varied in its climatic conditions and exposed to extreme wind and weather.

Over the past 100 years, the Norwegian climate has become warmer and precipitation has increased by about 20%. These trends are expected to continue. We will have warmer winters with more rain and less snow. In the west of Norway, the amount of rain will increase more than the average for the country as a whole.

Some of the major challenges caused by climate change in Norway are storms and flooding. We already see increased flooding of rivers and urban areas due to increased precipitation and intense rainfall. Sea levels will rise, there will be more drought and forest fires and ecosystems will be affected. This will change the conditions for biodiversity and nature-based industries such as agriculture, forestry and fisheries.

Vulnerability in the Arctic region

Norway stretches all the way to the high Arctic in the Svalbard Archipelago. Here, temperatures are rising 2-3 times faster than the global mean. Rising temperatures and rapid retreat of sea-ice and snow cover threatens ecosystems and wildlife, in particular species dependent on sea-ice such as polar bears. Climate change also makes the Arctic more accessible for shipping and resource exploitation, exposing vulnerable areas and species to new risks and impacts.

Adapting to the new climate

A white paper on climate change adaptation was published in 2013. It states that each sector is responsible for climate change adaptation. All members of society must map their own climate vulnerability, plan to handle climate change and implement measures. The municipal sector has a wide range of responsibilities. This may, for instance, include prohibition to build houses in areas exposed to flooding, or stimulating replacement of hard surfaces with flower beds or lawns.

Tine Sundtoft
Minister of Climate and Environment

An important part of Norwegian climate adaptation policy is ensuring good planning. Infrastructure, urban areas, and new buildings must all be designed to sustain the future climate. This is settled in a legal framework, but needs to be supported by knowledge on climate change and how the changes can be addressed. Projections of future climatic conditions are essential.

Norway has established a centre for climate services. The centre will help to translate climate science data into practical climate adaptation measures and provide information to local authorities. The Centre will also be responsible for interpreting wider climate projections so that they will be relevant at the local level. Networks for sharing experiences and knowledge have been established, including a dedicated website for climate change adaptation that serves as an information base for local authorities.

Norway has several centres for climate research. Ocean and polar research are some of the main concerns. The High North Research Centre for Climate and the Environment in the Fram Centre in Tromsø, was established in 2010. In Fram, about 500 scientists from 20 institutions carry out interdisciplinary research in natural science, technology and social sciences.

At the Bjerknes Centre for Climate Research in Bergen, there is a large research programme exploring the extension of the Gulf Stream through to the Nordic Seas, and its important and influential role in the climate system. The Polar Regions are under mounting pressure from the impacts of climate change, pollution, greater accessibility, and economic activity. To meet some of these challenges, Norway is establishing an Arctic Earth Observation System in and around Svalbard, which integrates and complements existing research and monitoring platforms for geophysical, biological and chemical studies.

Both scientific research on climate change and adaption to a changing climate are prioritized in Norway. But although adaptation is important to ensure a robust and sustainable future society, reducing greenhouse gas emissions is at the core of Norwegian climate policy. To avoid the potential devastating consequences of climate change, it is vital that we achieve an ambitious new global climate agreement in 2015.

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