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FACT SHEET

OUR CURRENT KNOWLEDGE OF:

Svalbard

Climate change in the Arctic is happening twice as fast as in the rest of the world. In the summer of 2020, new temperature peaks were recorded in several places north of the Arctic Circle, in Verkhoyansk, Siberia[1] in Russia, and Longyearbyen, Svalbard[2]. The Arctic island group Svalbard* is a climate hotspot and an important centre for international and German polar research. In many respects, pan-Arctic challenges can be illustrated using the example of Svalbard[4]. Not least the 100th anniversary of the Svalbard Treaty, which regulates Norwegian sovereignty and the protection and use rights over the archipelago, and the many years of research by the Alfred Wegener Institute together with the French polar research institute IPEV in Ny-Ålesund are the reason for the present fact sheet.

The Svalbard Archipelago

The Svalbard Archipelago is located between 74 and 81° north latitude and 10 and 35° east longitude in the Arctic Ocean[5], 1000 km from the North Pole. The West Svalbard Current, the northernmost branch of the Gulf Stream on the west coast of Svalbard, provides a comparatively mild climate and ice-free fjords[6] in summer. About 60% of the archipelago is covered by glaciers[5]. The administrative centre of Svalbard is Longyearbyen on the main island of Spitsbergen[7], which also serves as the seat of the Governor (Sysselmannen), the highest-ranking representation of the Norwegian government in the archipelago[8]. In total, there are six inhabited places on Svalbard (Ny-Ålesund, Pyramiden, Barentsburg, Longyearbyen, Svea and Hornsund), which, with the exception of the Hornsund research station operated by Poland, have their origins as mining settlements[9]. About 2500 people live permanently on Svalbard, most of them in Longyearbyen (about 2000). About 10% of them are researchers and scientists at various institutions, such as the northernmost university in Longyearbyen, the international research village Ny-Ålesund, or individual research stations, such as in Hornsund.

What are the important economic sectors?

Norway's strategic plans for the development of Svalbard are based on three activities: economy (coal mining), tourism and research[7, 9, 10]. While the coal mining industry is in decline[5], Arctic tourism, in particular, is being promoted politically[4, 10]. For example, in 2018 Svalbard counted 70,000 tourists, a large part of whom are cruise ship tourists[11]. However, the corona pandemic is also leading to sharp declines in tourism[12].

** Spitsbergen is the old English (and Dutch) name of the archipelago which is also used in the correspondent treaty signed 1920. Svalbard, which means „cool coast", is the modern Norwegian name of the region which is nowadays also used internationally[3]. "Spitsbergen" today refers to the largest island of the archipelago.*

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1920 – 2020: 100 years Svalbard Treaty

Although 1596 is considered the year of the official discovery of Svalbard by the Dutchman Willem Barents[13], it took time for the archipelago to start playing a role in international politics[14]. At the same time, the Arctic archipelago, due to its rich resources, was an early target of economic activities of various nations, and whaling, in particular, played an important role[7]. Throughout history, there have been several (small) conflicts between the major maritime powers operating in the area[13]. Until the 20th century, Svalbard was accepted as "Terra Nullius" - "no man's land "[3] whose legal status was not further defined[13]. However, the rapidly growing coal industry in particular, and the resulting conflicts, made the legal uncertainties no longer tenable[7]. The legal status of the archipelago changed only and finally with the Svalbard Treaty, which was signed in Paris on 9 February 1920 in the course of the Versailles peace negotiations and came into force on 14 August 1925[15]. Norway, which had taken the initiative for a binding settlement even before the First World War, gained full sovereignty over the archipelago, including all islands and rocks, through the Treaty.

> „[...] Desirous, while recognising the sovereignty of Norway over the Archipelago of Spitsbergen, including Bear Island, of seeing these territories provided with an equitable regime, in order to assure their development and peaceful utilisation [...]"
>
> (Preamble of the Svalbard Treaty)[15]

What are the special features of the Svalbard Treaty?

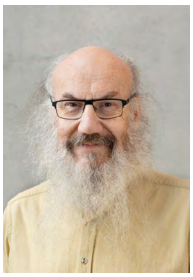
It is possible for any state to become a member of the Svalbard Treaty[14]. The 50 states that have signed the Treaty also inlcude Egypt, Switzerland and New Zealand. Germany has been a signatory state since ratification in 1925. Norway must grant the contracting parties equal access to resources of the archipelago and territorial waters. The citizens of all contracting states thus have visa-free access and enjoy rights in areas such as hunting, fishing, mining and other industrial, maritime and commercial activities. At the same time, however, there are also obligations in the area of nature conservation[7]. A central element of the Treaty is the peaceful use of Svalbard. The Treaty prohibits military fortifications and infrastructure[15]. Furthermore, tax revenues may only be used for investments in the archipelago[15]. Accordingly, the political and economic objectives for the archipelago are influenced by the legislation. Norway is obliged to protect Svalbard's natural environment and is allowed to take appropriate measures to ensure the conservation of flora and fauna[10, 15]. To this end, a comprehensive environmental protection act (Svalbard Environmental Protection Act) was adopted in 2001[16]. The Norwegian Svalbard policy aims to ensure the implementation of the Svalbard Treaty, to sustain peace and stability, to maintain Norwegian sovereignty over the archipelago, to protect its wilderness and cultural heritage sites and to preserve Norwegian settlements[10].

How crisis-proof is the contract?

There is no doubt that the political setting in which the Treaty and the interpretation of its provisions operate has become more complex[4]. In particular, the development of the United Nations Convention on the Law of the Sea (UNCLOS 1982) and the application of the Treaty to the Norwegian Exclusive Economic Zone (EEZ - 200-mile zone) has given rise to conflicts due to different interpretations, including between the EU and Norway[13, 17, 18, 19]. Nevertheless, the Treaty has, in essence, proved to be stable and crisis-proof over the last 100 years. It can be expected that its acceptance will be maintained in the future[4, 20].

Climate hotspot in the Arctic

Various climatic feedback mechanisms contribute to the Arctic warming faster than the rest of the world[21]. This process is also known as Arctic Amplification[22]. Different climate developments can be observed in the circumpolar Arctic. The Atlantic sector and the region around the Svalbard archipelago are the warmest. For example, Longyearbyen made the headlines at the end of July 2020 with a record temperature of 21.7°C[23]. These climate changes can be read from long-term measurements taken on site[24].



"The Arctic is warming twice as fast as the rest of the world. Svalbard is within the area in the Arctic warming the most of all. Everywhere I look, on land, in the sea, in the atmosphere, in the biosphere and think back on my first visits to Svalbard 30+ years ago I see large changes. We are losing the Arctic as we know it."

Prof. Kim Holmén / International Director, Norwegian Polar Institute

In Ny-Ålesund, the oldest time series of temperature measurements date back to 1934, at Svalbard Airport, they can even be traced back to 1898 (see Figure 1). This development is particularly visible during the winter months when temperatures have risen by 2-3°C per decade at Svalbard Airport over the last 30 years[25].

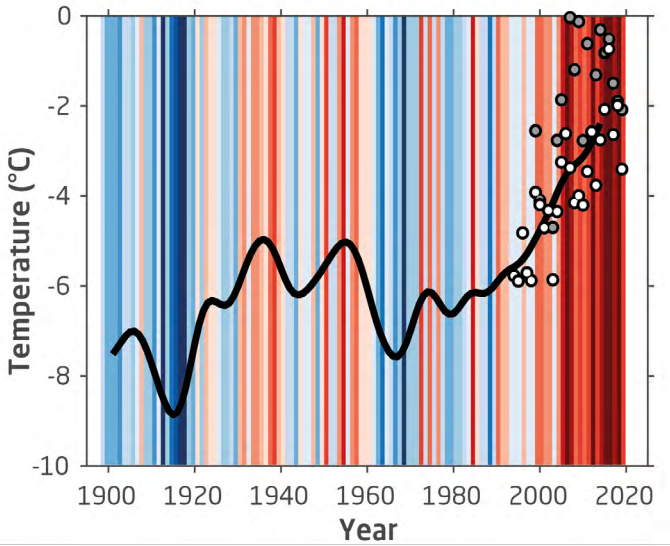


Figure 1: *Temperature record of Svalbard. Black curve: long-term record at Svalbard Airport in Longyearbyen (low pass filtered data of the Norwegian Meteorological Institute[21]). Surface air temperature (white dots) and soil temperature at 59 cm depth (grey dots) recorded at the AWIPEV research base. Warming Stripes for Svalbard (source: Ed Hawkins CC BY 4.0).*

The maritime and mountain climate of Svalbard has also changed in recent decades. Rising sea temperatures, the near disappearance of sea ice in the fjords in winter, the arrival of Atlantic cod and other environmental changes are affecting ecosystem functions[4]. Various fatal avalanche accidents, such as in 2015 in Longyearbyen[25] and most recently in February 2020 near Barentsburg, are a consequence of this rapid change. Infrastructure is also suffering from the thawing permafrost, for example in Ny-Ålesund, the site of the AWIPEV research base.

Polar research in Ny-Ålesund

Svalbard served as a starting point for various expeditions to the North Pole in its early history of polar research. The first successful North Pole overflight by Roald Amundsen, Umberto Nobile and Lincoln Ellsworth with an airship in 1926 also took off from Ny- Ålesund[5]. The great potential for high latitude atmospheric research and commercial satellite projects was also soon recognised. In 1964, the European Space Agency's (ESA) predecessor, ESRO, installed the satellite receiving station at Ny- Ålesund[13]. The former mining settlement of Ny-Ålesund, whose mining activities were suspended following a major mining accident in 1962, has since been established as an international research platform[26]. There are eleven research institutes in Ny-Ålesund, some of which operate a station all year round. The number of scientists varies according to the winter or summer season. To ensure that research is as error-free as possible, the area within a 20 km radius of Ny-Ålesund has been declared a Radio Silent Area. This means that the use of equipment in the area between 2 and 32 GHz is prohibited, except in exceptional cases[27]. The AWI and the French Polar Institute Paul Emile Victor (IPEV), with their research base in Ny-Ålesund, are an integral part of this international research landscape.

How is international polar research organised in Svalbard and Ny-Ålesund?

Since the 1960s, the Norwegian government has actively promoted international polar research. Norway has been conducting year-round research in Ny-Ålesund[28] since 1968. The northernmost university in the world, UNIS (University Centre of Svalbard), which was established in Longyearbyen in 1993, contributes to the growing international research community on Svalbard[29]. 750 students per year are offered a research-oriented education in Arctic biology, geology, geophysics and technology. The Svalbard Treaty does not explicitly regulate research activities[15], so Norwegian authorities and institutions, by virtue of their sovereignty, regulate international research activities[8]. The following bodies are of particular importance:

Norwegian Polar Institute (NPI)
The Norwegian Polar Institute is under the authority of the Ministry of Climate and Environment and acts as "host" in Ny-Ålesund. It also serves as a contact point for research and related activities and is Norway's central institute for environmental monitoring, mapping and scientific research in the Arctic and Antarctic.

Research Council of Norway (RCN)
The Norwegian Research Council is a government agency that funds research projects. It published the latest research strategy for Ny- Ålesund in April 2019[26].

Kings Bay AS
Kings Bay AS is a Norwegian company and has been owned by the Ministry of Environment since 2017. It is responsible for security and land use plans in Ny-Ålesund, while also operating, maintaining and developing the infrastructure necessary for research as a service provider.

Ny-Ålesund Science Managers Committee (NySMAC)
The NySMAC was founded in 1994 and serves the coordination and cooperation of research projects and activities. It consists of the representatives of the Norwegian and international research institutes active in Ny-Ålesund. NySMAC has developed four flagship programmes dealing with the atmosphere, terrestrial ecosystems, the Kongsfjorden (Kings Bay) system, and the cryosphere (glaciology).

Svalbard Science Forum (SSF)
The SSF was established in 1998 to improve cooperation on Svalbard between the research communities in Longyearbyen, Ny-Ålesund, Barentsburg and Hornsund. The associated secretariat also runs the RiS portal ("Research in Svalbard"), where all research projects and activities on Svalbard are registered. SSF manages Norwegian Research Council grants, which also finance scholarships, fieldwork and workshops for international students and scientists.

Svalbard Integrated Arctic Earth Observing System (SIOS)
The AWI is a founding member of SIOS. SIOS is an international research infrastructure programme that coordinates the Earth System Science Observatories installed on Svalbard. Much of the necessary infrastructure and instrumentation is located in Ny-Ålesund. The goal of SIOS is a more efficient use and better integration of the observing system based on a common data management system, an open access programme which also includes logistical support and training and education activities. Working groups, task forces and other SIOS components pursue these goals in direct and structured dialogue with scientists, user groups, political decision-makers and other stakeholders in society and science. SIOS currently has 28 partner institutions from 10 countries. The AWI is particularly involved in the further development of the research infrastructures in SIOS and heads the relevant committee together with the National Center for Polar and Ocean Research, India.

AWIPEV Research Base

AWIPEV Research Base
In 2020, the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research will celebrate its 40th birthday. As early as 1912, Kurt Wegener, Alfred Wegener's older brother, established the first scientific wintering station on the Krossfjord, not far from Ny-Ålesund. In 1991 the Koldewey Station in Ny-Ålesund was inaugurated. There, AWI and the French Polar Institute Paul Emile Victor (IPEV) have jointly operated the research base AWIPEV since 2003. Occupied all year round, it serves German and French research projects as a short- or long-term platform for investigations in the fields of biology, glaciology, geophysics and atmospheric research, with accommodation capacity for up to 24 researchers at the same time. In addition, the station staff supports scientific activities in the field and takes care of the technical operation of the station as well as continuous long-term measurements.

Blue House (Photo: AWI)

The geographical location of Ny-Ålesund on the west coast of Svalbard makes it possible to observe climate-relevant parameters in the ocean, on land and in the atmosphere.

Start of a sounding balloon (Photo: Gregory Tran, AWI)

Atmosphere

The AWIPEV atmospheric observatory in Ny-Ålesund monitors key atmospheric parameters for climate change over the long term[30]. The data are also fed into various international scientific networks. Since 1993, daily meteorological measurements have been carried out on the ground (temperature, humidity, air pressure, wind direction, wind speed) and with weather balloons[21]. These so-called radiosondes ascend into the troposphere every day at noon and provide data which, in cooperation with the Norwegian Meteorological Institute, are fed into the international meteorological data system as Norwegian weather station data. Thus, the AWIPEV weather balloons with their data also form a basis for weather forecast models in Germany. Once a week (twice a week during the polar night) a balloon-borne probe measures the vertical ozone distribution. Radiation measurements close to the ground (long-term observation) also provide important data from which climate changes can be deduced. Stratospheric water vapour is measured every two months using a special research probe (frost point hygrometer). The Koldewey Aerosol Raman Lidar, called KARL, is used to study clouds and aerosols.

Land and Permafrost

The Bayelva long-term measuring field has been measuring temperatures and humidity in the near-surface layer (approx. 1.50 m depth) of the permafrost since 1998. Since 2009, there has also been a temperature chain that observes dew processes in the permafrost at depths of up to ten metres. A special feature of the site is that the permafrost temperature itself is already close to 0°C (about -2.8°C). Measurement results from 1998 - 2017 show that the trend of warming is high. Over a period of 20 years, temperatures in the active layer near the surface have increased by 0.18 (±0.07)°C per year and the thickness of the thaw layer has approximately doubled[31]. Since 2012, these data are even available daily on the AWI website.

OBSERVATORIES AND LONG-TERM MEASUREMENTS

AWI operates several observatories in Ny-Ålesund for the long-term recording of essential climate variables, which contribute to international networks of the Global Climate Observing System (GCOS). The **Atmospheric Observatory** is specially designed for remote sensing instrumentation. In addition, long-term data series of meteorology and radiation are collected on the measuring field and balloon soundings are carried out regularly. Since 1998, the **Permafrost Observatory** outside of Ny-Ålesund records soil temperature and hydrological parameters at different soil depths, as well as parameters relating to the exchange between atmosphere and ground. Furthermore, an **Underwater Observatory** is operated at AWIPEV since 2012, which records oceanographic parameters of the Kongsfjord over the long term.

AWIPEV Atmosphere Observatory (Photo: M. Maturilli, AWI)

Temperature measurement in the permafrost (Photo: Gregory Tran, AWI)

Ocean

Water exchange between the Atlantic and Arctic Oceans has played a significant role in global climate in the past (for about 20 million years). The Fram Strait between north-east Greenland and Svalbard is of particular importance as the only deep-water connection between the Arctic and the world oceans. It is still widening today, accompanied by earthquakes and seabed volcanism[32]. For more than 15 years AWI has been operating long-term observation series with moorings in this region (AWI "Hausgarten"). Since 2014, these have been expanded as modular infrastructure within the framework of FRAM (Frontiers in Arctic Marine Monitoring) and supplemented by mobile components (e.g. deep-sea robots, ice buoys, autonomously navigating underwater robots). These will enable year-round investigation of physical, chemical and biological processes on the ice, under the ice, in the water column and on the seabed. The data thus obtained will provide information on the effects of climate change on the global ocean circulation and the animal and plant world.

Coast

Since 2012, AWI in Ny-Ålesund has been operating the wired AWIPEV underwater observatory in the Kongsfjorden[33, 34]. The platform, which is installed at a depth of 11 m, carries various sensors for long-term hydro-graphic measurements, providing year-round data from the coastal area in almost real-time. This made it possible to prove, for example, that the average temperature in shallow water warmed up by 0.22 °C / year between 2012 and 2018, i.e. almost 10 times faster than in the North Sea. Thanks to the fibre-optic internet connection between Norway and Svalbard, which has been in place since 2015, even complex experiments can be remotely controlled. New installations and repairs are carried out twice a year by AWI's scientific diving centre.

Biology of the Coast

The light-flooded shallow water areas of the Kongsfjorden with rocky subsoil are, as along all temperate and polar rocky coasts, populated by a dense underwater forest. The "trees" of the underwater forest, 1-3 m high brown algae, form a complex, species-rich ecosystem and serve as habitat, feeding ground and nursery for many associated animals and other algae[35, 36]. The underwater forest is home to species that grow predominantly in cold seas as well as species that have a distribution as far as Central Europe[37]. The climatic changes of recent decades have significantly altered the structure of the forest[38]. Especially in the very shallow regions, which used to be regularly eroded by winter ice, the total algae biomass and the number of species have increased considerably[38,39]. Similarly, in the shallow water areas, which play a central role as nursery grounds for young fish, in particular, the fish community has changed considerably. Polar cod, which is typical of the Arctic, is increasingly being replaced by Atlantic cod[40], which is spreading further and further north as the water warms. The climate-change-induced increase or decrease in such "key ecological species" has the potential to significantly change the associated fauna of the algae forest and thus influence the entire food web, including marine mammals[41, 42].

Biological studies in Kongsfjorden (Photo: Paolo Verzone).

Kongsfjorden

An important link between the coastal and marine research mentioned above is the study of the ecosystem in the water column of the Kongsfjorden. Since 2014, AWI researchers have been investigating the so-called spring bloom, i.e. the mass reproduction of microscopic algae, the phytoplankton, almost every year. The phytoplankton is the basis of the marine ecosystem and plays an important role in the carbon dioxide absorption capacity of the ocean. Studies on winter conditions[43, 44] and the characteristics of the spring bloom, help to better predict future changes in this ecosystem, which is strongly influenced by climate change[45, 46]. These studies are supported by experiments at the AWIPEV research base, where

by experiments at the AWIPEV research base, where the effects of complex climate change scenarios are tested under controlled laboratory conditions[47, 48]. For example, it has been shown that Arctic phytoplankton are better able to compensate for the effects of ocean acidification than communities in other ocean regions[49].

Conclusion

Svalbard is a fascinating place in many ways. Often referred to as "the world's northernmost civilisation", Ny-Ålesund is at the forefront of world-class international research into the scientific knowledge of climate change in the Arctic and its global impact. Its geographical location offers the opportunity to conduct research in marine, terrestrial and atmospheric environments. Of particular importance are the continuous and long time series that make climate change visible. The work of the AWI makes an important contribution to this.

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