



Polar View

Earth Observation Services for Climate Change Adaptation

Strengthening Earth Observation services to
meet public and private sector climate change
adaptation needs



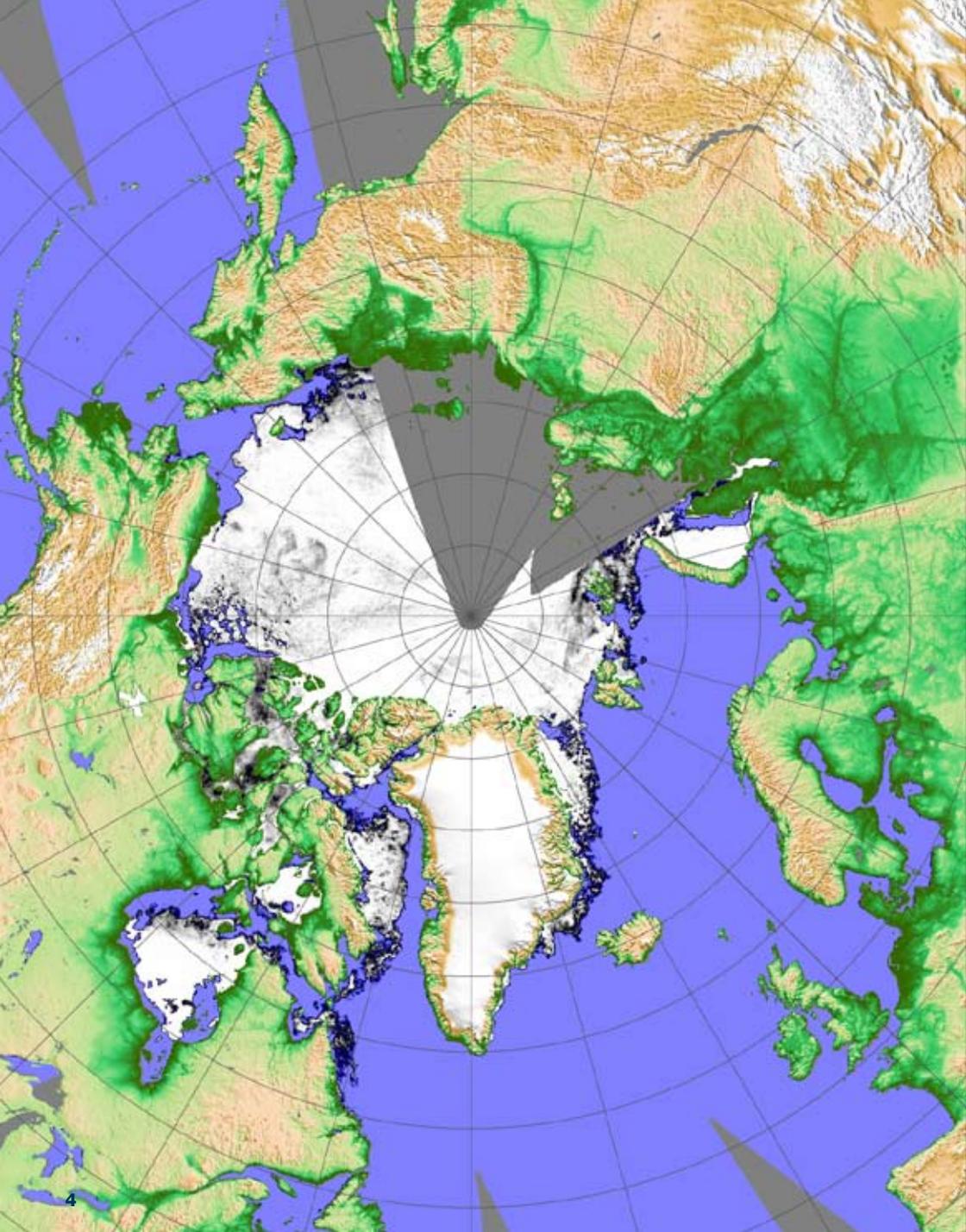
Cover photos:

Ellesmere Island and Greenland (Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC), **RADARSAT** (CSA), **Disko Bay Fishing** (iStockphoto/Neill Staniforth)

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Climate Change Adaptation

Every day people make decisions that are influenced by the climate. Many of these decisions have consequences for the environment, the economy and safety. Decisions on when flood risk is high enough to bring out the sandbags or evacuate a community – or how much water to release from a dam to get the best outcome for hydroelectric production – or what route to navigate an oil tanker to minimize risk. In cold regions, many of these decisions are related to the state of ice and snow.



Forecasts of weather and related environmental conditions, like river flows, are based on a mix of models and observations. Increasingly, as the climate changes and becomes less predictable, people need up-to-date, reliable information on snow and ice conditions, often over large, isolated areas, to help make daily decisions and to update forecasting models. Policy makers need this information to adapt institutions, plans and infrastructure to make communities and economies more resilient to climate change.

Polar View provides satellite-based monitoring and information services related to ice and snow to a range of public and private sector clients. These snapshots from space are used daily to adapt activities such as marine transportation, travel on ice, and flood management. Polar View delivers services targeted to meet the needs of clients, primarily in the Arctic, but also in the Baltic Sea, North Atlantic, Central Europe and the Antarctic.

The environmental conditions that are monitored from space – sea, lake and river ice conditions; snowpack characteristics and snow melt timing; and glacier dynamics – are being affected now by global climate change.

Ice and snow are projected to undergo far-reaching changes in the years and decades to come. This translates into changing and emerging needs for timely and reliable information on ice and snow. The Polar View team is working to implement technological and institutional solutions to meet these needs.

Polar View is an international consortium of government agencies, research institutes and service providers across Europe and Canada, offering integrated monitoring and forecasting services in polar and mid-latitude regions affected by ice and snow. Using satellite earth observation technology, we view the land and sea from far away. We transform satellite data into useful products with automated, fast delivery, providing near real time information and new perspectives for improved planning and decision making. Polar View's clients include public agencies, national ice centres, marine commercial ventures, and Arctic indigenous people. Polar View is supported by the European Space Agency as part of the Global Monitoring for Environment and Security initiative.

Navigating Ice-infested Waters

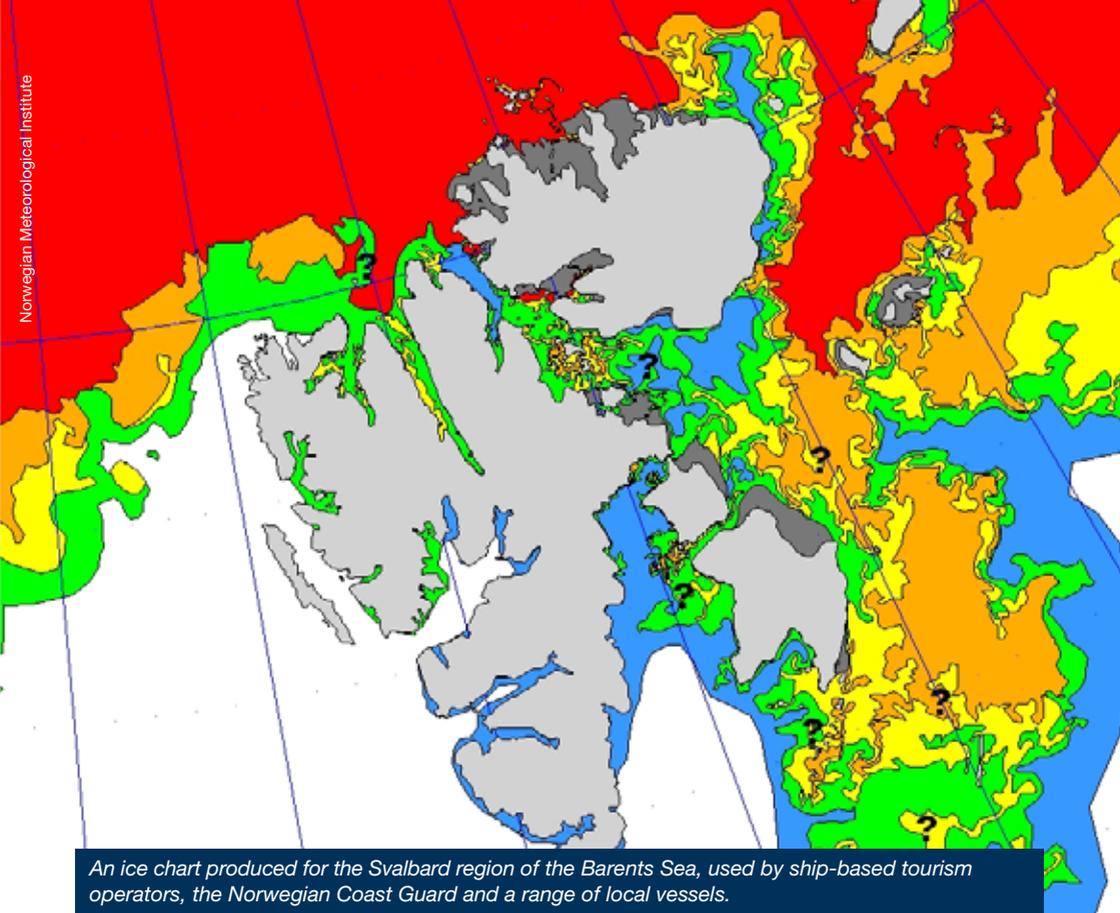
Adaptation goal:	Safe navigation in waters with changing and less predictable sea-ice conditions.
Polar View service:	High resolution products such as ice charts, information on ice conditions (especially ice thickness), ice forecasts, iceberg monitoring.
Provided to:	Shipping industry, coastguards, ice patrols, icebreakers, tourism operators, fishing vessels, research vessels and others accessing the information through the internet or extranets.
Where:	Svalbard region of Barents Sea (high resolution charts), Baltic Sea (ice distribution, thickness and forecasts), North Atlantic (iceberg advisory), Southern Ocean (ice concentration and high resolution images).
Service provider:	Norwegian Meteorological Institute, Finnish Institute of Marine Research, Swedish Meteorological and Hydrological Institute, C-CORE, British Antarctic Survey, Danish Technical University and others.

Polar View provides a range of satellite-based products and services related to sea ice and icebergs – tailored to meet specific needs and to supplement ice charts produced by national ice services. The Polar View service providers function as an international expert network and develop, adapt and deliver navigational products for ice-infested waters around the world. The goal is safe and efficient navigation to protect lives and the environment and to benefit economies.

Climate Change and Sea Ice

One of the most dramatic and alarming signals of climate change is the shrinking of Arctic sea ice. Large areas of ocean that were formerly frozen solid year-round have been melting, or partially melting, in recent summers. But this does not mean that marine navigation in the Arctic is becoming simpler. Ice may be disappearing in the summer in some areas, like off the coasts of Alaska and Siberia – but it is piling up elsewhere, like

around Svalbard and Fram Strait. There is more drift ice appearing in the Barents Sea. Overall there is less thick, multi-year ice and more thin, easily melted first year ice. Rapid changes occur, and it is harder to predict ice conditions. In other marine areas in the world where ice is a hazard – the Baltic Sea, the North Atlantic and the Southern Ocean around Antarctica – ice cover is also changing, and is projected to change more and more as the climate warms up.



An ice chart produced for the Svalbard region of the Barents Sea, used by ship-based tourism operators, the Norwegian Coast Guard and a range of local vessels.

At the same time, maritime transportation is on the rise world wide – including much more ship-based tourism in the Arctic and Antarctic, increased activity around Arctic marine and coastal economic development, and growing interest in new Arctic shipping routes. Marine traffic in the Baltic Sea has increased more than 30% in the past 10 years.

What does this mean for climate change adaptation? Increased demand for dependable information on current sea-ice

conditions translates into growing needs not just for technological development, but also for changes in policies and institutions. Adaptation measures include harmonizing the production of ice charts, sharing technological know-how, and developing flexible institutional arrangements so that frequent, detailed charts can be produced where and when they are most needed. Underlying these measures is the need for stable funding – both for ice monitoring and for the enhancements and changes needed to adapt to new conditions.

Assisting Arctic Indigenous Communities

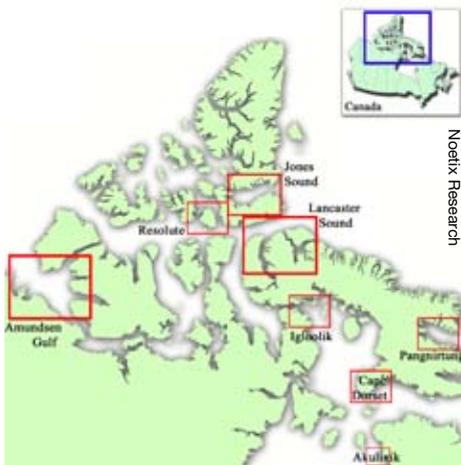
Floe Edge Monitoring Service

Adaptation goal:	Safe and efficient travel and hunting by Inuit under changing sea ice conditions.
Polar View service:	Images showing the ice edge and zones of moving ice and land-fast ice.
Provided to:	Inuit communities; public services such as search and rescue operators.
Where:	Nunavut and Northwest Territories, Canada.
Service provider:	Noetix Research.

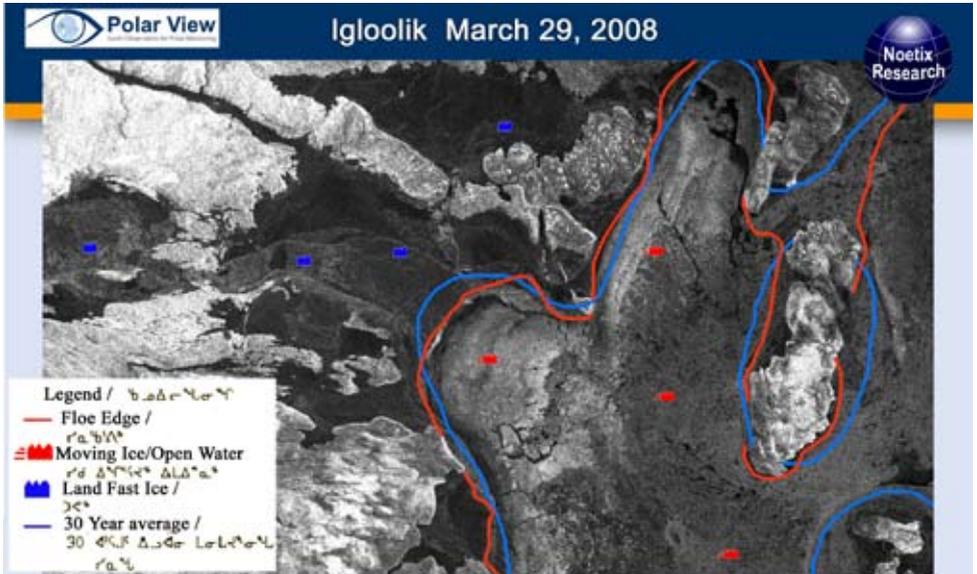
“People travel on the ice a lot, and they use the images to find out where the floe edge and open water is, or where the smooth ice is, since it’s easier to travel across.... It all started after more people were getting stranded on the ice near the floe edge. I was actually one of those people who got stranded on the ice in Lancaster Sound along with a group of students and elders. After that people got interested in using the satellite images.”

Brian Koonoo, Park Warden, Sirmilik National Park, Baffin Island.

In the Canadian northern territories, snow and ice are part of everyday life. Ice covers the territories’ marine bays and sounds for much of the year, and knowing the location of the ice edge is important. With climate change, Arctic sea ice conditions are changing radically and becoming less and less predictable. Local knowledge, based on past experience, is no longer enough. Polar View’s images make it possible to keep an eye on what’s happening with the ice from high above the earth. These satellite images, delivered over the internet to communities in Nunavut and the Northwest Territories, are used by Inuit residents to plan safe and efficient travel by snowmobile or dog sled across the frozen sea.



Areas covered by Polar View’s floe edge service.



Noetix Research (RADARSAT data © Canadian Space Agency/Agence spatiale canadienne 2008. Received by the Canada Centre for Remote Sensing. Processed and distributed by MDA Geospatial Services.) Supported by Canada Space Agency, European Space Agency, Canadian Ice Services/Environment Canada.



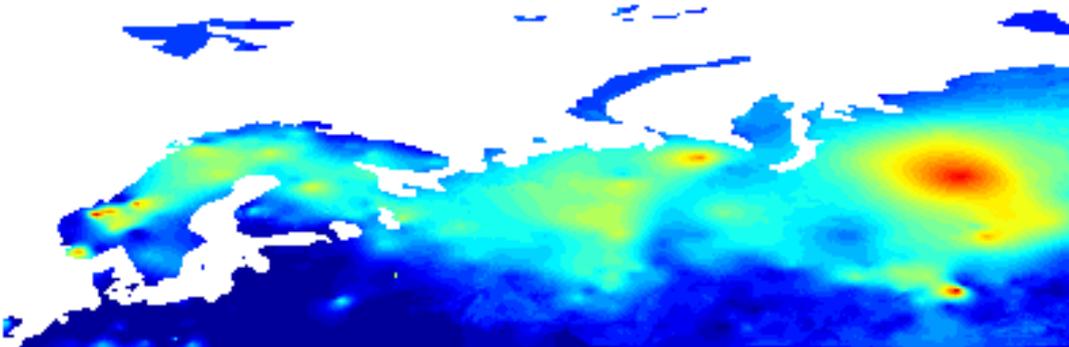
Roger DeAbreu, CIS

Assisting Arctic Indigenous Communities

Reindeer Pastures Monitoring Service

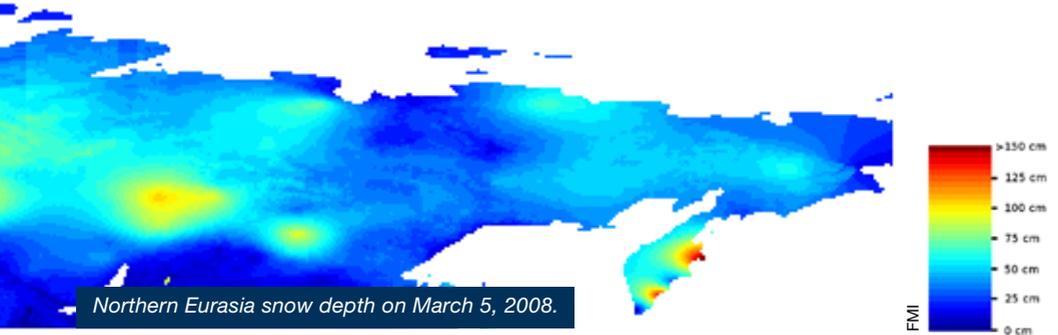
Adaptation goal:	Sustainable reindeer husbandry under changing snow conditions on pasture lands.
Polar View service:	Maps of snow extent and snow water equivalent.
Provided to:	World Reindeer Herders Association, Kautokeino, Norway
Where:	Northern Eurasia (large scale) and finer scale on study areas.
Service provider:	Finnish Environment Institute.

Polar View snow monitoring services are assisting the Association of World Reindeer Herders understand and monitor changing snow conditions. The work is part of an International Polar Year research project called EALÁT, a Sámi word for pasture. The project focuses on the capacity of reindeer pastoralism to adapt to climate variability and change, in particular through integration of science and reindeer herders' traditional knowledge. With snow melt coming earlier and earlier each year, and with snow conditions changing, reindeer herders are adapting their seasonal cycles of activities and their migration patterns. The northern Eurasian snow maps produced by Polar View aid in understanding how reindeer pastures are altered by climate change.





Reindeer Herder, Yamal Peninsula, Russia.



Assisting Arctic Indigenous Communities

Lake Ice Monitoring Service

Adaptation goal:	Sustainable Inuit food fishery for Arctic char under changing lake ice conditions.
Polar View service:	Monitoring of lake ice distribution and thickness.
Provided to:	Inuit communities; Nunavik Research Centre, Makivik Corporation.
Where:	Two study areas in Nunavik (Northern Quebec, Canada).
Service provider:	Hatfield Consultants.

The low-lying lands around Ungava Bay in Nunavik (northern Quebec, Canada) are pitted by lakes and criss-crossed by rivers. Large numbers of Arctic char over-winter in the lakes, migrating to the sea in summer. These fish are a vital winter food resource for the region's Inuit, who travel to lakes on snowmobiles and fish through the ice. Ice conditions have a significant impact on the survival and distribution of char, as well as on people's ability to travel to the good fishing lakes. Polar View team members are working with the Nunavik Research Centre to deliver satellite-based monitoring of lake ice distribution and thickness. The goal is to integrate this large-scale view from space with traditional ecological knowledge to improve understanding of the impacts of climate change on critical char habitat and to assist with sustainable management of these important food fisheries.



Bobby Baron with an Arctic char from Lake Akilasaaluk near Kangiqsualujuaq.

Traditional knowledge interviews identify critical Arctic char habitat and ice conditions.



Flood Forecasting

Snow plays a major role in the flow patterns of many rivers – not just in the North and in the mountains, but also extending far downstream to the large rivers of the densely populated lowlands of Central Europe. Sudden spring thaws can lead to torrents of melted snow pouring through the watershed and overtopping river banks. An additional source of periodic flooding for some cold-region rivers is the formation of ice jams. River ice can pile up to form a temporary dam partially blocking water flow, soon bursting and releasing a flood wave of water and broken ice.



Climate Change and Flooding

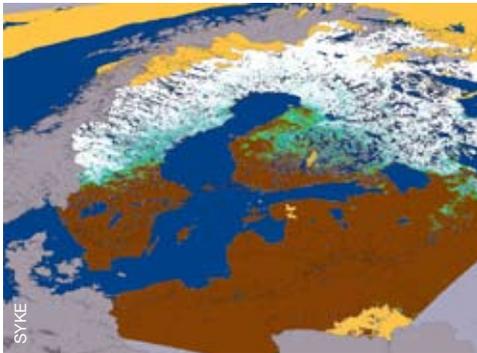
There is a global trend towards increased run-off and earlier peak high waters in rivers fed by glaciers and snow. In addition, warming waters in lakes and rivers in many regions can alter ice formation and melt. As the climate warms further, flooding from ice and snow melt is anticipated to increase, with flash floods predicted to become more frequent in Europe.

Changes in snow and river-ice regimes mean that models based on past records are often no longer adequate for predicting floods. The baseline has shifted, and is shifting all the time. Variability in flow amounts and in timing of melt is increasing. River ice may melt and freeze more frequently, altering ice characteristics. These and other changes lead to increasing needs to update and supplement hydrologic models with reliable and comprehensive pictures of snow and ice conditions.

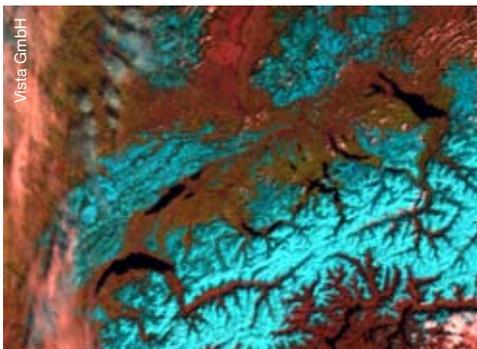
Reference: Fourth Assessment Report (AR4) of the IPCC (2007) on Climate Change: Part II – Climate Change Impacts, Adaptation and Vulnerability, Summary.

Snow Services for Flood Forecasting

Adaptation goal:	Risk to lives and damage to property from snowmelt flooding minimized, despite changing snowmelt conditions.
Polar View service:	Maps showing areas of snow cover, snow water equivalent, snow depth, snow line in the mountains, and areas that are melting.
Provided to:	Water resources authorities and flood forecast centres.
Where:	Baltic Sea region, Norway, European Alps and watersheds downstream in Central Europe.
Service provider:	Finnish Environment Institute (SYKE), KSAT, Vista GmbH.



An example of a snow cover map. The lowlands in Northern Europe and in the Baltic Sea drainage basin are characterized by several snow accumulation and melting periods until the snow stays on the ground. In spring the melting process is often very rapid, leading to flooding. Snow cover maps for the Baltic region are produced daily during the melt season.



Snow cover information for the Alps, provided to flood forecasting authorities every three days during melt season. Most downstream flood events in the populated areas of Central Europe result from a combination of melting snow and heavy rainfall. This type of flooding is expected to increase due to climate change.

Flood Forecasting

River-ice Services for Flood Forecasting

Adaptation goal:	Risk to lives and damage to property from river-ice-jam flooding minimized, despite changing river ice conditions.
Polar View service:	Images delivered in near real time, showing patterns of ice build-up during freezing and break-up periods, providing early warning of dangerous conditions.
Provided to:	Water management services and flood protection authorities.
Where:	Canada and Northern Russia.
Service provider:	C-CORE.

Service for Newfoundland and Labrador

“Badger was a classic case that showed us that something had changed. There has been a dam on the Exploits River since the 1920s, so flow was constant. The flow had not changed. Something about the ice had changed.”

*Dr. Amir Ali Khan, Water Resources Management Division,
Government of Newfoundland and Labrador, Canada*

In February 2003 the town of Badger, Newfoundland and Labrador, was struck by an ice-jam flood. The town, situated at the confluence of three rivers, has a long history of flooding due to ice build up in the Exploits River. The water level rose 2.3 metres in less than one hour. The flood waters froze, encasing parts of the town in ice for weeks.

Since then, flood forecast models have been supplemented with surveillance of the Exploits River by satellite imagery, using techniques developed through Polar View. This methodology has been exported to other regions prone to ice-jam flooding.



Satellite monitoring of the Exploits River is used to identify build-up of ice that may result in ice-jam flooding.

A. A. Khan

*Ice-jam flooding,
Badger, Newfoundland
and Labrador.*



Service for the Lena, Ob and Yenisei Rivers, Northern Russia

“Using satellite data to monitor the surface of the earth allows us to have another perspective when monitoring river ice. It is especially useful for monitoring large, sparsely populated territories like Siberia.”

Dr. Dimitri Burakov, Professor and Director of the Krasnoyarsk Krai Science and Research Center for Weather and Environmental Monitoring

In the extreme climate of Siberia and the Russian Far East, rivers are frozen from around December to May. When they thaw, the hydrological authorities who monitor for floods and river hazards are on the lookout for ice jams. When ice jams break, built-up waters and chunks of ice are released in wild torrents that spill over river banks and threaten lives and property. Polar View river monitoring services provide early warning of dangerous ice conditions. This information is also used to monitor the many hydroelectric dams that supply electricity to these remote regions. With river-ice break-up becoming more erratic, authorities need to use all available monitoring methods to predict ice-jam flooding, including statistical analysis, models, and satellite data.

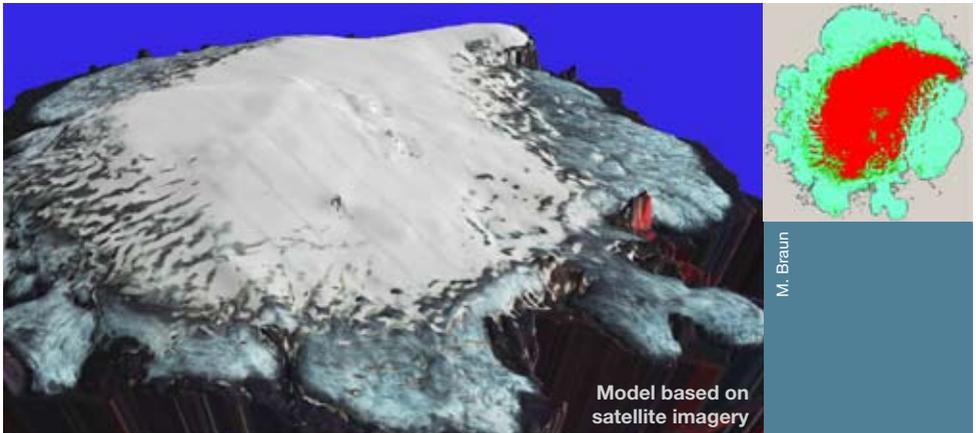


Water Management and Electricity

Adaptation goal:	Efficient and sustainable hydropower production under changing snowmelt and glacier meltwater conditions.
Polar View service:	Maps of snow cover, snow water equivalent and snowmelt; mapping and modelling of glacier characteristics and changes.
Provided to:	Hydroelectric companies; water and energy authorities.
Where:	Scandinavia and Central Europe (snow); Norway and Iceland (glaciers).
Service provider:	Finnish Environment Institute and KSAT (snow); University of Stockholm and B&T Geoconsulting and Mapping GmbH (glaciers).

“Satellite data gives a quick and comprehensive view of snow melting on the whole basin. The knowledge helps us decide which areas will probably produce much inflow in the future and which are drying up. As well, computer models produce more accurate results by using this data.”

Spokesperson for Kemijoki Oy, Finland’s largest producer of Hydroelectric Power



The Hofsjökull ice cap in Iceland is monitored with a combination of ground and satellite observations. The information is used to track and predict changes in characteristics like mass balance, surface energy balance, stability and discharge. This information is critical for management of hydropower stations located on rivers fed by meltwater from the ice cap.



Snowmelt is an important source of water for the many small hydroelectric operations in Scandinavia.

Increased climatic variability has made predictive models based on historical climate data less reliable. Services based on satellite imagery provide the watershed-scale coverage and quick turnaround that is needed to adjust to rapidly changing conditions during times of peak melt.

Polar View snow and glacier services contribute to managing current hydroelectric operations and planning for climate change. The services help determine how much water will be produced by the melting snow and glaciers and when it will become available. This helps managers to adjust seasonal patterns of water storage and release as well as to plan development of new hydro facilities and adapt existing ones to changing conditions.

Climate Change and Meltwater

The overall trend in the Northern Hemisphere is a decrease in snow cover and a shift to earlier snow melting – but this varies around the world, and in parts of northern Eurasia, the amount and duration of snow has been increasing over the past few decades. Mountain regions are particularly sensitive to climate change and to large shifts in snowmelt patterns.

Glaciers are shrinking around the world – which means increased seasonal meltwater now. But continued and accelerating glacier melt will eventually lead to flow reductions and even, in some areas, to the loss of glacier meltwater as a resource.



For further information about Polar View
please visit our website at www.polarview.org
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