



European
Commission

ARCTIC

RESEARCH and
INNOVATION



*Understanding the
changes, responding
to the challenges*

Research and
Innovation

ARCTIC RESEARCH and INNOVATION – Understanding the changes, responding to the challenges

European Commission
Directorate-General for Research and Innovation
Directorate — Climate Action and Resource Efficiency
Unit I.4 - Climate action and Earth Observation

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FOREWORD



Federica Mogherini

*High Representative of the Union for
Foreign Affairs and Security Policy/
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Carlos Moedas

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Science and Innovation*

The Arctic is of unmatched pristine natural beauty – and home to some 4 million people living across vast regions which many indigenous peoples have inhabited for thousands of years. In recent years, we have seen much greater attention from all over the world in this region, which speaks to everyone’s imagination.

Dramatic changes in climate patterns have severe consequences for the Arctic regions. The very rapid changes are disrupting Arctic ecosystems and impacting and transforming the livelihoods of indigenous and local communities.

As the result of a phenomenon known as Arctic amplification, the Arctic warms at a much faster rate than other parts of the world. This makes the Arctic a global bell-wether for climate change, and indicates what lies ahead for the rest of the world in the near future. But more than this, Arctic warming is affecting the entire planet. Melting ice sheets contribute to rising sea levels elsewhere and cause major changes in global weather patterns.

However, these changes also produce new opportunities, such as new shipping routes or easier access to resources. This creates

an additional responsibility to ensure that in their pursuit, precaution and preservation are not overtaken by the interests in, and exploitation of Arctic opportunities.

These developments deserve our full attention and devotion to strike the right balance between sustainability, socio-economic effects and reaping the benefits of new opportunities.

Primarily, understanding and responding to Arctic changes requires joint efforts by the global community. This means we must focus on international cooperation and dialogue. A safe, stable, sustainable and prosperous Arctic is important not just for the region itself, but for the European Union and for the world. The Arctic can be a gateway to cooperation across many issues and partners. The EU actively supports endeavours undertaken in that spirit, which is the basis of the EU's Arctic policy¹.

Secondly, we need to increase our knowledge of Arctic changes. Investigations into the causes, mechanisms, consequences and evolution over time are the main subjects of Arctic research. Consequently, over the last decade, the EU has increased its investments in Arctic research and innovation, resulting in a EUR 70-million budget for the period 2018-2020.

The EU will continue to show leadership in the Arctic regions through international dialogue and international scientific cooperation. This publication provides an insight into the key areas of EU Arctic research and innovation activities and gives examples of funded projects, to form the basis of what we consider underpins a sustainable future for the Arctic.

¹ 'An integrated European Union policy for the Arctic' - JOIN(2016) 21 final, 27 April 2016

INTRODUCTION

The Arctic: a global responsibility

The Arctic is undergoing profound transformation. The warming generated by global greenhouse gas emissions is amplified more than twice in this part of the world due to various causes, and in particular to the change in albedo mainly caused by the shrinking of the sea-ice area, and the corresponding exposure of a wider, dark ocean surface to sunlight during the Arctic summer. Higher average temperatures significantly affect the extent and thickness of sea ice and snow cover, as well as the melting of ice sheets and the thawing of permafrost. All this results in disruptive changes for ecosystems, the Arctic's indigenous peoples and other human communities.

Environmental, ecological and subsequent social changes are happening faster than ever before, affecting the way Arctic residents live.

While it may seem remote, changes in the Arctic have global consequences. For instance, the melting of the Greenland ice sheet contributes to global sea-level rise and has the potential to change ocean circulation patterns that can impact the whole planet. Moreover, Arctic warming is affecting weather patterns and the occurrence of extreme weather events, with worldwide repercussions on infrastructures and physical and socio-economic consequences.

These changes – among others – are a clear indication of the impending shifts that will increasingly impact Europe's environment, society and industry. Understanding and responding to these changes is a global responsibility which requires the international community to come together.

While changes in the Arctic pose challenges, they may also provide economic opportunities for the region, Europe, and the rest of the world. New transport routes, access to previously inaccessible resources, and a shift to the north of fish stocks all increase this area's strategic importance.

Science is a vital tool for understanding what is driving the rapid changes being observed at high latitudes and identifying sustainable and innovative approaches to tackle the resulting challenges. However, a full understanding of Arctic changes should also be based on the wide body of knowledge developed by indigenous peoples, who have lived in this region for millennia, as reflected in their culture and languages.

International scientific and technological cooperation is essential for the Arctic, and the EU is committed to being a part of it.

The scale and complexity of many of the Arctic's challenges often go beyond the capabilities of individual countries to address them. Therefore, pan-Arctic observations, satellite measurements and expensive infrastructure call for a high degree of collaboration.

Horizon 2020 offers a unique framework for this, with five of the eight Arctic countries either members (Denmark, Finland and Sweden) or associate members (Iceland and Norway). The EU has a very strong cooperation with Canada and the United States of America on Arctic science under the Atlantic Ocean Research Alliance. In addition, Horizon 2020 has cooperation agreements with the remaining three Arctic countries (Canada, Russia and the USA), and is open to participation by partners from all other countries worldwide.

The EU is a major investor and player in Arctic research.

Over the first four years of Horizon 2020, the EU funded more than 45 Arctic-related projects, investing more than EUR 120 million. It also supports development and international access to Arctic research infrastructure throughout Europe and via cooperation activities with non-EU Arctic countries. In addition, the EU is proposing to make the Arctic a test location for sustainable innovation by, for instance, developing cold-climate technologies and services, and contributing to the identification of 'Arctic standards' to ensure the sustainability of processes and technologies.

Furthermore, the EU Arctic Cluster is a network of several current EU-funded Arctic research projects. Jointly, this group delivers the most up-to-date findings on Arctic change and provides guidance and policy-relevant information.

Arctic science and observations are part of the EUR 3.3-billion 'Building a low-carbon, climate-resilient future' Horizon 2020 Work Programme Focus Area for 2018-2020. For this period, in line with the EU's integrated Arctic policy, the Commission is continuing – and even stepping up – investments in Arctic research and innovation, with an expected average investment of more than EUR 20 million per year. Overall, the EU is investing around EUR 200 million in Arctic-related research under the Horizon 2020 Programme (2014-2020).

The actions featured in this publication illustrate the different elements of EU Arctic research and innovation policy being implemented through Horizon 2020.



Research matters

The Arctic is warming twice as fast as the global average with impacts worldwide and locally to the **environment, communities and economies**.

These impacts include changes to:



weather patterns, including the frequency and intensity of extreme events



sea levels, and threats to coastal communities



ecosystems, biodiversity and fish stocks



As the Arctic becomes more accessible due to climate change, **economic activities** will put more pressure on an already fragile environment.

Investment in Arctic research will **reduce knowledge gaps** and improve our **ability to respond** to these changes.

The EU is a major investor in Arctic research



- ▶ **€200 m** 2014-2020 through Horizon 2020
- ▶ **€120 m** has already been provided to **45** Arctic-related projects
- ▶ **€3.3 bn** for a Horizon 2020 focus area to build a '**low-carbon, climate-resilient future**' – includes funding for Arctic science and observations.



The EU also supports development and international access to **Arctic research infrastructure** throughout Europe, and through cooperation activities with non-EU Arctic countries.



The EU also proposes to make the Arctic a test location for **sustainable innovation** by developing – for example – cold-climate technologies and services, and by contributing to the identification of 'Arctic standards' to ensure the sustainability of processes and technologies.

EU science-diplomacy leadership

The EU supports **international scientific cooperation** to:



develop an international **Arctic Observing System**



improve local-level climate **predictions and projections**



make Arctic research and monitoring **datasets** accessible and relevant for communities



facilitate international access to Arctic research infrastructure and understand the **regional and global dynamics** of Arctic changes



enhance multilateral **scientific cooperation** between Arctic and non-Arctic countries, indigenous peoples, local communities, and societal and economic stakeholders



Five of the eight Arctic countries are either EU countries (**Denmark, Finland and Sweden**) or associate members (**Iceland and Norway**).

Horizon 2020 has cooperation agreements with the other three Arctic countries: Canada, the Russian Federation and the USA.

Sharing research and observation infrastructures helps to keep the Arctic a region of **peaceful cooperation**.

Connecting science to society

Rapid changes occurring in the Arctic are making a significant impact on the global climate – with far-reaching consequences felt worlds away.

Environmental, economic and social changes are now occurring at greater speed and scale than ever before and in increasingly interconnected ways. The Arctic is undergoing significant developments with unprecedented levels of human activities. Therefore, residents and stakeholders in the Arctic regions urgently need applied and detailed knowledge on a range of key issues.

In Europe, as the effects of climate change become more pronounced through extreme weather and higher temperatures, Arctic issues have risen up the political agenda in recent years.

Higher government investment in Arctic-related research is a clear demonstration of the extent to which scientific findings are critical for shaping policy objectives, including those linked to climate change, energy and food security, as well as innovation and economic growth.

European research has provided essential insight for identifying the processes behind these rapid changes, but the full impacts of a warming Arctic have yet to be fully assessed and quantified which means it is

not yet possible to effectively predict the effects of Arctic changes on our climate and society.

This situation can only be improved by taking a more holistic and integrated approach, as well as implementing a higher degree of coordination

of research activities and closer scientific cooperation with all the relevant actors at an international level, including societal stakeholders.



The rapid changes occurring in the Arctic are making a significant impact on the global climate – with far-reaching consequences felt worlds away.



EU-POLARNET

This project comprises an alliance of research institutes aimed at boosting Europe's ability to generate new knowledge about the world's polar regions, which are seen as indicators of our planet's health.

 **Coordinator:**
Alfred-Wegener-Institut
Helmholtz-Zentrum für Polar- und
Meeresforschung, Germany

 **Total cost:**
EUR 2 174 504

 **EC contribution:**
EUR 2 174 504

 **Start/end:**
March 2015 to February 2020

 **Other countries:**
France, United Kingdom, Italy,
Sweden, Portugal, Netherlands,
Norway, Spain, Austria, Bulgaria,
Denmark, Belgium, Finland, Poland,
Estonia, Greenland

 **Web:**
<http://www.eu-polarnet.eu>

EU Arctic Research Cluster

The EU Arctic Cluster is a network of EU Arctic research projects funded under Horizon 2020 and the Seventh Research Framework Programme (FP7), which merges the most up-to-date findings on Arctic change and its global implications. The European Polar Board is an affiliated partner.

The Cluster's objective is to provide policy-relevant information and support the EU in advancing international cooperation; respond to the impact of climate change on the Arctic's fragile environment; and promote and contribute to the region's sustainable development.

It cooperates closely with policymakers, local Arctic communities and indigenous peoples, business representatives and European civil society.

Strengthening, integrating and sustaining Arctic observations

An improved and sustained observation system is essential for properly studying, forecasting and assessing environmental changes in the Arctic – and supporting the region’s sustainable development.

To fit the bill, current national and international observation and research efforts should enhance their coordination and collaboration, as well as their focus, to ensure that the data they collect is both comprehensive and useful. To that end, more temporal and geographic coverage is needed.

In addition, accurately assessing and predicting environmental change in the Arctic requires multifaceted data on the region’s meteorology, climate and oceanography, alongside the state of its ecosystems and pollution levels.

Arctic science challenges demand a pan-Arctic approach and long-term commitment that go beyond the average research project duration. An ideal Arctic observation system is one that is integrated, multi-disciplinary and has a high level of complexity. It provides key data on global issues such as climate change and takes regional, national and local interests into consideration.

In an effort to contribute to the long-term improvement of Arctic observation, such a system should combine input from several sources having very different spatial coverage and scope, ranging from community-based observations led by indigenous

peoples, to satellites, ground-based stations, and high-tech autonomous platforms.

Demonstrating the benefits and value of such observation systems is essential to justifying the required long-term investments.

Within this context, Copernicus, the EU’s Earth

Observation Programme – with its space-based products derived from Sentinel satellite missions and its environmentally focused thematic operational services – plays a fundamental role.

For example, Copernicus Marine Service Arctic ocean models are able to simulate a 3D view of phytoplankton, the first level of the marine food chain. This provides key clues for studying the marine ecosystem as a whole, as well as the global carbon cycle and climate change.



An ideal Arctic observation system is one that is integrated, multi-disciplinary and has a high level of complexity. It provides key data on global issues such as climate change and also takes regional, national and local interests into consideration.



INTAROS

The overall objective of INTAROS is to develop an integrated Arctic Observation System (iAOS) by extending, improving and unifying existing systems. It seeks to help address Arctic challenges and enable better-informed decision-making.

 Coordinator:

Nansen Environmental and Remote Sensing Center, Norway

 Total cost:
EUR 15 490 067

 EC contribution:
EUR 15 490 067

 Start/end:
December 2016 to November 2021

 Other countries:
Sweden, Germany, Poland, Denmark, Finland, United Kingdom, Ireland, France, Germany, Belgium, Portugal, Spain, Italy, Greenland, Russia, United States, Canada, China

 Web:
<http://www.intaros.eu>

iCUPE

iCUPE aims to help establish and maintain long-term, coherent and coordinated polar observations and research activities. Its focus is on improving the integration of existing *in-situ* observational networks collecting data on pollutants, including aerosols and trace gases, as well as contaminants. It also seeks to harmonise quality control.

 Coordinator:
University of Helsinki, Finland

 Total cost:
EUR 9 340 000

 EC contribution:
EUR 2 750 000

 Start/end:
September 2017 to August 2020

 Other countries:
Italy, Denmark, Germany, France, Estonia, Greece, Sweden, Switzerland

 Web:
<https://www.atm.helsinki.fi/icupe>

Transnational access to Arctic research infrastructure

Arctic research is crucial – but it comes at a cost. Pooling resources could help lower the price tag and promote better results.

It takes expensive infrastructure that can survive harsh climatic conditions to observe, monitor and understand the rapid changes taking place in the Arctic.

Europe has a long tradition and very strong reputation for world-class scientific research in the Arctic region. This is enabled and supported by significant and substantial scientific infrastructure, as well as facilities and platforms operated by many European nations.

While there is already a degree of coordination and cooperation between Europeans operating in the Arctic, great potential exists for the considerable resources available to be used more coherently and effectively in order to achieve the highest-quality research possible.

There is also a significant opportunity to link up much more productively with other nations in the wider international polar science community, including with those lacking infrastructure or facilities. The same applies to connecting with businesses, such as those involved with shipping, which operate Arctic infrastructure.



While there is already a degree of coordination and cooperation between Europeans operating in the Arctic, great potential exists for the considerable resources available to be used more coherently and effectively to achieve the highest-quality research possible.

It is important to develop and bolster networks that make it easier for projects to carry out potentially groundbreaking studies and analyses in the Arctic. Supporting transnational access to research facilities or installations is one concrete way of fostering this.

Moreover, costs can be cut not only by sharing infrastructure and observation systems but also by making data freely and openly available in a timely manner.



INTERACT

This project aims to build capacity for identifying, understanding, predicting and responding to diverse environmental changes in the Arctic. It offers scientists access to numerous research stations, giving them the chance to work in the field in often remote locations.

 **Coordinator:**
Lund University, Sweden

 **Total cost:**
EUR 10 000 000

 **EC contribution:**
EUR 10 000 000

 **Start/end:**
October 2016 to September 2020

 **Other countries:**
United Kingdom, Denmark, Finland, Italy, Germany, Norway, Russia, Czech Republic, Greenland, Poland, Austria, Faroe Islands, Iceland, Canada, United States, Netherlands, Belgium

 **Web:**
<http://www.eu-interact.org>

ARICE

ARICE seeks to give polar scientists better access to ice-breakers and boost Europe's capacity for marine-based research in the ice-covered Arctic Ocean. It also aims to work with the maritime industry on a programme that involves commercial ships collecting oceanic and atmospheric data.

 **Coordinator:**
Alfred-Wegener-Institut
Helmholtz-Zentrum für Polar- und
Meeresforschung, Germany

 **Total cost:**
EUR 5 996 567

 **EC contribution:**
EUR 5 996 567

 **Start/end:**
January 2018 to December 2021

 **Other countries:**
Sweden, Norway, Canada, United States, Iceland, Spain, Italy, United Kingdom, Poland, Finland, France, Denmark

 **Web:**
<https://www.arice.eu>

Impact on the weather and climate of the Northern Hemisphere

There is proof that changes to the Arctic climate are having an impact far beyond the region's borders – including in Europe and North America.

Climate change is warming up the Arctic twice as fast as the rest of the world, causing Greenland glaciers to release hundreds of gigatonnes of melted ice into the oceans each year. This results not only in rising sea levels but also changing weather patterns and a higher incidence of extreme weather events.

New findings show that, indeed, severe snowfall, as well as extreme rain and scorching heatwaves that have hit Europe in recent years, may be influenced by the Arctic warming trend.

With so much at stake, more needs to be done to better incorporate processes specific to the Arctic into weather and climate modelling. This could help provide greater clarity on the region's role in the global climate system, as well as explore a link to extreme and potentially catastrophic weather.

Timely and trustworthy weather and climate predictions, both within the Arctic and elsewhere, are key for a number of reasons.



With so much at stake, more needs to be done to better incorporate processes specific to the Arctic into weather and climate modelling. This could help provide more clarity on the region's role in the global climate system, as well as explore a link to extreme and potentially catastrophic weather.

For example, such predictions are necessary for boosting Europe's capacity to respond to the impact of climate change – on both the environment and on human activities in the Arctic. These could become more widespread if rising temperatures cause a thaw in the region, creating new fishing grounds and providing easier access to natural resources that are of economic interest.

More comprehensive modelling focused on extreme weather events could also save lives by, for example, giving people in harm's way more time to seek shelter.



APPLICATE

This project addresses the need for trustworthy weather and climate predictions in the Arctic and beyond. APPLICATE's international team of experts are aiming to make significant improvements to current climate and weather models and help determine the influence of Arctic climate change on the Northern Hemisphere.

 **Coordinator:**
Alfred-Wegener-Institut
Helmholtz-Zentrum für Polar- und
Meeresforschung, Germany

 **Total cost:**
EUR 8 715 066

 **EC contribution:**
EUR 7 999 591

 **Start/end:**
November 2016 to October 2020

 **Other countries:**
Spain, United Kingdom, Norway,
Belgium, Sweden, France, Iceland,
Russia

 **Web:**
<https://www.applycate.eu>

BLUE-ACTION

The aim of BLUE-ACTION is to boost the ability to describe, model and predict Arctic climate change and its impact on the Northern Hemisphere. It seeks to do this by, for example, improving the uptake of relevant Earth observation satellite data and contributing to a forecasting framework.

 **Coordinator:**
Danish Meteorological Institute,
Denmark

 **Total cost:**
EUR 8 103 125

 **EC contribution:**
EUR 7 500 000

 **Start/end:**
December 2016 to February 2021

 **Other countries:**
Finland, Portugal, Italy, France,
South Korea, Norway, Germany,
Faroe Islands, China, Russia, Spain,
Canada, Iceland, United States,
Netherlands

 **Web:**
<http://www.blue-action.eu>

Environmental, social and economic impact

Arctic change is here to stay so strategies are needed to soften its blow and adapt to the new normal.

Due to the warming process already locked into the climate system, the Arctic is expected to keep thawing at least until 2050.

Going forward, mitigation and adaption strategies could stabilise the impact of rising temperatures in this very fragile environmental and social ecosystem while reducing vulnerabilities and building up the region's resilience.

But effectively responding to the serious challenges posed by Arctic change requires a solid understanding of the phenomenon – as well as a clear grasp of its environmental, social and economic consequences.

This understanding can be enhanced by taking a closer look at current and anticipated future changes – and projecting their impact.

This could help determine the economic effect of Arctic warming, both locally and globally. It could also shed light on what Arctic changes mean from a social point of view – such as their repercussions for indigenous peoples and local communities living in the area.



Arctic research and innovation is key to developing the capacity to manage risks and take advantage of opportunities emerging from climatic changes in this region. It can also be instrumental in promoting the engagement of, and interaction with, indigenous peoples and others who call the Arctic home ...

In this respect, Arctic research and sustainable innovation is key to developing the capacity to both manage risks and take advantage of opportunities emerging from climatic changes in this region.

It can also be instrumental in promoting the engagement of, and interaction with, indigenous peoples and others who call the Arctic home, ensuring that their interests and knowledge are taken into consideration.



ICE-ARC

This project assessed the global cost of Arctic change. It found that the acceleration of climate change, driven by thawing Arctic permafrost and melting sea ice, could cause up to USD 130 trillion-worth of extra economic losses globally under the current business-as-usual trajectory over the next three centuries.

 **Coordinator:**
British Antarctic Survey,
United Kingdom

 **Total cost:**
EUR 11 531 469

 **EC contribution:**
EUR 8 874 626

 **Start/end:**
January 2014 to December 2017

 **Other countries:**
Croatia, Norway, Netherlands,
Greenland, Denmark, Germany,
France, Belgium, Spain, Italy,
Russia

 **Web:**
<https://www.ice-arc.eu>

NUNATARYUK

The main goal of NUNATARYUK is to determine the impact of thawing land, coast and subsea permafrost on both the global climate and humans in the Arctic, and to develop targeted and co-designed adaptation and mitigation strategies.

 **Coordinator:**
Alfred-Wegener-Institut
Helmholz-Zentrum für Polar- und
Meeresforschung, Germany

 **Total cost:**
EUR 11 467 318

 **EC contribution:**
EUR 11 467 318

 **Start/end:**
November 2017 to October 2022

 **Other countries:**
Sweden, Netherlands, France,
Canada, Finland, Denmark, Iceland,
Austria, Italy, Norway, Portugal,
Belgium

 **Web:**
<https://www.nunataryuk.org>

Safety of maritime transport activities

Arctic sea ice is declining at a dramatic rate, creating both environmental concerns and the potential for new economic opportunities.

As captured by satellites, the Arctic Ocean has seen a rapid reduction in both the extent and volume of sea ice.

With this decline expected to continue, the Arctic will gradually become more accessible – opening up major opportunities for the maritime sector such as short cuts for cargo vessels and, by default, lower greenhouse gas emissions.

The Northern Sea Route and the Northwest Passage are already open seasonally most years, although specialised vessels are currently required. However, as the ice has receded, traffic has increased.

The downside is that more shipping poses potential problems for the Arctic's fragile ecosystems. For instance, the migration corridor used by marine mammals and birds corresponds broadly with the main shipping routes into and out of the Arctic, and accidents such as oil spills may put the pristine environment at serious risk.



It is of paramount importance to ensure safe Arctic navigation and enable European maritime transport to fully embrace the region's significant and growing shipping opportunities all while protecting its natural environment.

Even during summer, the harsh Arctic conditions make navigation difficult amid unpredictable weather and ice floes. Ships often require an expensive ice-breaker escort and additional insurance which offset some of the route's potential fuel savings.

It is of paramount importance to ensure safe Arctic navigation and enable European maritime transport to fully embrace the region's significant and growing shipping opportunities while protecting its natural environment.



GRACE

The GRACE project is focusing on developing, comparing and evaluating the effectiveness and environmental impact of different oil-spill response methods in a cold climate. It is also developing a system for the real-time observation of underwater oil spills and a strategic tool for choosing oil-spill response methods.

 **Coordinator:**
Suomen Ymparistokeskus, Finland

 **Total cost:**
EUR 3 031 648

 **EC contribution:**
EUR 2 852 760

 **Start/end:**
March 2016 to August 2019

 **Other countries:**
Denmark, Estonia, Germany, Spain,
Norway, Greenland, Sweden,
Canada

 **Web:**
<http://www.grace-oil-project.eu>

SEDNA

This project is developing an innovative and integrated risk-based approach to safe Arctic navigation, ship design and operation to enable European maritime interests to fully embrace the Arctic's significant and growing shipping opportunities while safeguarding its natural environment.

 **Coordinator:**
BMT Group Ltd, United Kingdom

 **Total cost:**
EUR 6 726 565

 **EC contribution:**
EUR 6 498 752

 **Start/end:**
June 2017 to May 2020

 **Other countries:**
Sweden, Norway, Ireland, Finland,
China

 **Web:**
<http://www.sedna-project.eu>

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OPEN DATA FROM THE EU

The EU Open Data Portal (<http://data.europa.eu/euodp/en>) provides access to datasets from the EU. Data can be downloaded and reused for free, both for commercial and non-commercial purposes.

This booklet outlines key aspects of ongoing EU-funded Arctic research and innovation. Climate change is the main cause of Arctic changes, and therefore the investigation on its mechanisms, its consequences and its evolution is the main subject of Arctic research. The Arctic, despite being home to only about 4 million people – a fraction of the world population of 7.6 billion – is the canary in the mine of climate change. The Arctic is warming because of greenhouse gas emissions generated by human activities mainly elsewhere and at a much faster rate than in other parts of the planet because of a phenomenon known as ‘Arctic amplification’.

Research and Innovation policy

