The Research Council of Norway

Research Strategy for the Arctic and Northern Areas

Revision 1 (forskning.nord.to)
2011-2016

About the Research Council of Norway

The Research Council of Norway is a national strategic and funding agency for research activities. The Council serves as a chief source of advice on and input into research policy for the Norwegian Government, the central government administration and the overall research community. Moreover, the Research Council works together with research institutions as well as the private and public sectors to enhance financial and quality targets in Norwegian research and innovation activities. It is the task of the Research Council to identify Norway's research needs and recommend national priorities. The Council utilises specifically-targeted funding schemes to help translate national research policy goals into action. The Research Council provides a central meeting place for those who fund, carry out and utilise research and works actively to promote the internationalisation of Norwegian research.

Foreword


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This publication presents the Research Council of Norway's revised Research Strategy for the Arctic and Northern Areas, Revision 1 *(forskning.nord.to),* which builds on the first strategy, *forskning.nord*. The new strategy will apply from 2011 to 2016.

The revised strategy takes account of changes in the national and international framework for the Arctic and northern areas. The establishment of a permanent secretariat for the Arctic Council in Tromsø is a clear indication of the high level of national and international interest in the northern areas.

The strategy describes the challenges and opportunities that the Research Council views as being most critical and deserving of particular emphasis. The strategy deliberately refrains from setting clear priorities. Instead, it addresses a wide range of current issues, while at the same time remaining open to the fact that new issues may arise.

The revised strategy will provide the basis for the Research Council's efforts with regard to research in and for the Arctic and northern areas in the years to come. The strategy will be incorporated into all relevant Research Council programmes and activities.

It is our hope that the revised research strategy will serve as an important component in promoting the development of the Arctic and northern areas. The strategy is the result of a broad-based consultation process and we would like to thank all those who have provided input for their positive contributions to the development of the revised Research Strategy for the Arctic and Northern Areas.

Oslo, 15 June 2011

Arvid Hallén, Director General

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1 Background

The Arctic and northern areas are of great strategic importance both globally and to Norway. There is an increasing need for research and new knowledge to ensure the sustainable management of the area's abundant natural resources and to respond to the challenges and opportunities arising from climate change and a new political framework.


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1.1 The northern areas are important for the world and for Norway

The global and strategic significance of the Arctic and northern areas in terms of resources, energy and maritime potential has increased considerably in recent years. Climate change is having a significant impact on all these areas. There is a rising demand for vital resources found in the north, in particular seafood, oil and gas, alternative energy sources and geological resources. Norway has both a great need and a great responsibility to gain a deeper understanding of the Arctic and northern areas and to manage resources in a sustainable manner based on knowledge. From a national perspective it is also essential to enhance the development of North Norway as a region.

The Arctic and northern areas (see chapter 3 for definition) are subject to a number of international agreements and national regulations. Several of the circumpolar countries are engaged in efforts to permanently establish the outer boundaries of their continental shelves.

Today the Arctic and northern areas are characterised by predictability and stability. It is crucial that relevant international agreements and legal frameworks are applied to ensure that the region remains free of major geopolitical disputes in the future. Any realisation of the growing interest in expanding industrial activity in the area shown by the circumpolar countries as well as other nations, such as the EU countries, China, Japan, India and South Korea, must be predicated on adherence to existing international agreements and common acceptance of the principles of international law.

1.2 The Research Council's Arctic and northern areas initiative

Efforts to develop the Research Council of Norway's Arctic and northern areas initiative began in 2005 and were based on the report of the government-appointed committee on the High North (Official Norwegian Report 2003:32 *Mot Nord! Utfordringer og muligheter i nordområdene* ("Look North! Challenges and opportunities in the northern areas", Norwegian only), the white paper presented by the Bondevik II Government (Report No. 30 (2004-2005) to the Storting:

Opportunities and Challenges in the North), and from autumn 2005 the significant focus on the High North in the Stoltenberg II Government's policy platform. Early in 2006 the Government appointed an expert committee for the High North which presented its report in June 2008.

The Research Council's initial strategic initiative on the Arctic and northern areas was shaped by several factors of both national and international significance: climate change was accelerating and the Arctic and northern areas provided an important reference area for climate change. Moreover, there was a growing demand for the natural resources found onshore as well as offshore in and under the ocean. Estimates that a quarter of the world's undiscovered petroleum reserves are to be found in the Arctic areas gave rise to optimism regarding the development of a significant petroleum industry. At the same time attention was being focused on the rights of indigenous peoples to exploit natural resources and on the preservation of indigenous culture. At the national level it was important to exercise Norwegian sovereignty in Svalbard and in the surrounding sea areas and to facilitate future-oriented, sustainable industrial development in the north.

To ensure that research activities would contribute to solving social challenges in the north the Research Council chose to adopt a broad-based societal perspective towards research on the Arctic and northern areas. It was also important to facilitate research that was not inspired by social challenges, but by the knowledge potential provided by the region by virtue of its location, geography, culture, resources etc.

The first strategy was implemented primarily by establishing research relevant to the Arctic and northern areas as a cross-disciplinary activity, incorporating research relevant to the northern areas into all the Research Council's funding instruments. In addition to adding a new dimension to ongoing programmes and activities, new research initiatives were also launched.

At the beginning of 2006 an overview compiled of all research related to the northern areas in the Research Council's project portfolio showed that a total of NOK 440 million had been allocated to this research. The response to this was a stated aim to expand the volume of research on the northern areas through allocations in the annual budget proposals. Although the ensuing growth did not meet expectations, the Research Council achieved a significant increase in research relevant to the northern areas within existing frameworks.

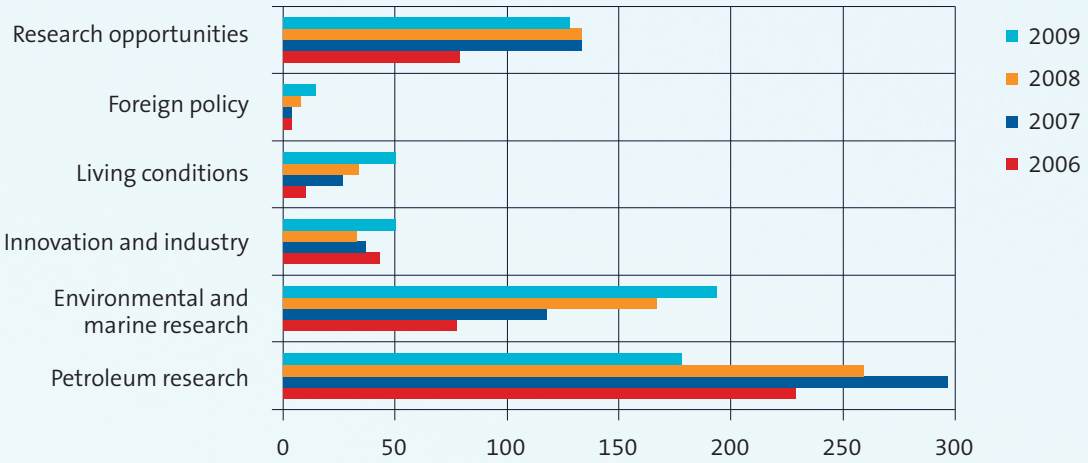
By 2007 the portfolio of relevant projects had reached NOK 617 million. A little under half of this increase was new funding allocated in connection with International Polar Year (IPY 2007-2008). The remaining growth came from the incorporation of northern areas-related research topics in a number of the Research Council's funding announcements. The field of petroleum research, in particular, saw a substantial increase in research relevant to the northern areas, and cooperation agreements were signed with the Russian Academy of Sciences and the Oil and Gas Research Institute in Russia. In subsequent years the portfolio has varied between NOK 616 million and NOK 636 million per year and growth has primarily been in the fields of climate, environmental and marine research. A number of new programmes and initiatives have been introduced during this period.

The Research Council's analyses show that the level of petroleum research has declined somewhat in recent years. The level of research activity is lower than desired within the focus areas of innovation and industry, foreign policy and living conditions in the Research Council's northern areas-related portfolio, particularly given that these are areas of crucial importance for the future. Moreover, the fact that foreign policy and living conditions are relatively under-researched indicates that social science research activities are limited, also in North Norway.

In light of the results of the first strategy period and the altered framework conditions, it is productive for the Research Council to continue and further strengthen its focus on the Arctic and northern areas. The strategic foundation for the next period is set out below, based in part on a number of measures implemented during the first strategy period:

In May 2006 the government-appointed expert committee took the initiative to develop a national strategy for marine bioprospecting (2008), in cooperation

The development of the portfolio for research related to the northern areas 2006 – 2009



with the Research Council, Innovation Norway and the Industrial Development Corporation of Norway (SIVA), taking as a starting point the national marine biobank Marbank and the Centre for Marine Bioactives and Drug Discovery (MabCent-SFI). The expert committee and the Research Council also took a decision to launch the Research Initiative for Northern Norway (NORDSATSING). IPY (2007-2008) and funding under the research programme Functional Genomics in Norway (FUGE) under the Large-scale Programme initiative have produced results and new knowledge. In addition, the ARKTEK initiative (a strategic industry-oriented Arctic technology initiative designed to strengthen cooperation between academia and trade and industry in North Norway) and the research programme Russia and International Relations in the Northern Areas (NORRUSS) have been established. The scope of a number of existing Research Council programmes was also expanded as a result of the Arctic and northern areas initiative.

1.3 New framework conditions for the Arctic and northern areas initiative

Since 2005 the framework conditions for development in the Arctic and northern areas have changed considerably. The need to adopt a global approach to resources and energy has become more evident, while at the same time we are seeing an increasing need for multinational research cooperation to ensure the best possible management of natural resources and the environment. The treaty on maritime delimitation and cooperation in the Barents Sea and the Arctic Ocean signed by Norway and Russia, together with economic development in Russia, has paved the way for more equitable Norwegian-Russian cooperation. Changes in the climate have opened up both the Northern Sea Route and the Northwest Passage to commercial maritime transport. Activities under the International Polar Year (IPY 2007-2009) provided a significant boost to both Norwegian and international polar research cooperation, which has given new momentum to a key component of research relating to the Arctic and northern areas. The Arctic Council has become an increasingly important political organisation, which is expected to give a higher profile to key research questions related to the

Arctic. The Nordic Council of Ministers has issued a report, *Megatrends in the Arctic,* which describes key development trends in the region. In addition to the EU, countries such as Russia, Denmark, Finland and the US have developed their own national strategies for the Arctic and northern areas.

In December 2006 the Government launched a national strategy for the High North, which was followed up in 2009 by the report *New Building Blocks in the North – the next step in the Government's High North strategy*. The new High North Research Centre for Climate and the Environment (Fram Centre) was launched as part of this strategy. New funding schemes promoting research on the Arctic and northern areas have been introduced both within and outside the Research Council. Interest in Norway's geological resources has increased as a result of the escalation of prices of metals and industrial minerals. The management plan for the Norwegian Sea and the updated management plan for the Barents Sea–Lofoten area are based on extensive mapping and research and are designed to facilitate value creation, coexistence between industries and the sustainable harvesting of marine resources. The Research Council policy for Norwegian polar research sets out the framework for polar research activities. Annual analyses of the Research Council's own northern areas-relevant portfolio and the overview of Norwegian polar research compiled by the Norwegian Institute for Studies in Innovation, Research and Education (NIFU STEP) in 2009 (Report no. 31/2010 *Nordområdeforskningen 2009,* "Research on the Arctic and northern areas", Norwegian only), which encompassed all national research activities, not just those funded by the Research Council, provided a good picture of the various input factors and results of the Arctic and northern areas initiative, and its value added for research.

The Government is currently preparing a new white paper on the High North, which is expected to be presented during the course of 2011. The white paper will set out knowledge needs and other aspects of the Government's High North strategy and will be used as a reference for establishing the Research Council's priorities.

1.4 Key challenges in the future

Increasing the participation of trade and industry in research both at the national level and at the regional level in North Norway has always been a key challenge. A review of the Research Council's existing instruments is needed and new and better strategic measures must be identified. Closer cooperation between the public and private sectors could provide part of the solution. The regional research fund for North Norway and the Research Initiative for Northern Norway (NORDSATSING) along with the SkatteFUNN tax deduction scheme under the Research Council are all essential for securing knowledge-based industrial development in North Norway. It is important to ensure that the NORDSATSING initiative is implemented as an eight-year initiative as planned and that the benefits for trade and industry and society at large are fully realised.

In the coming period it will be crucial to focus on the international and global dimension of the Arctic and northern areas, and to strengthen international research cooperation in this area. In 2009 EU-funded research relating to the northern areas accounted for 2 per cent of research in the field, which is on a par with the national average. The EU's growing interest in issues related to the Arctic and northern areas implies that there is a potential for increased funding under the EU framework programmes, particularly in the fields of science and technology. It is also important to take full advantage of the opportunities presented by the framework programmes to increase the volume and breadth of research relevant to the northern areas. Norway has much to offer in terms of expertise and advanced infrastructure, as well as the unique research opportunities available on Svalbard.

2 Vision

Norway must seek to be a leading nation for research on the Arctic and northern areas and to develop knowledge that can help to enhance natural resource management, protect the environment and spur the development of North Norway.


Photo: Colourbox


Photo: Jon Solberg, Research Council of Norway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Norway needs to develop knowledge about the Arctic and northern areas for a variety of reasons and is extremely well placed to become a leading nation for research in the field. In certain areas Norway is already among the leading research nations in the north, but there is significant potential for Norway to become a leading research nation in a wider range of fields. The prospects for industrial development in the north are substantial. The Research Council's vision can be stated thus:

By 2020 Norway will be a leading nation for research on the Arctic and northern areas, the country will be recognised for its sound management of resources in the north, and North Norway will be known for its dynamic, diversified industrial sector and active R&D efforts.


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3 Scope and organisation

The *Research Strategy for the Arctic and Northern Areas* complements other established strategies and will make use of the entire range of the Research Council's funding instruments.

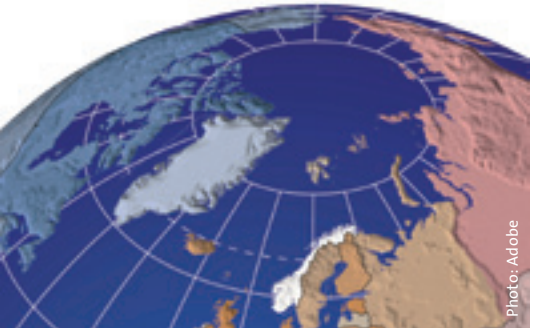
Photo: Adobe

The scope of the *Research Strategy for the Arctic and Northern Areas* is defined by established strategies:

The Government's High North Strategy (2006)
The High North is a broad concept both geographically and politically. In geographical terms, it covers the sea and land, including islands and archipelagos, stretching northwards from the southern boundary of Nordland county in Norway and eastwards from the Greenland Sea to the Barents Sea and the Pechora Sea. In political terms, it includes the administrative entities in Norway, Sweden, Finland and Russia that are part of the Barents Co-operation. Furthermore, Norway's High North policy overlaps with the Nordic cooperation, our relations with the US and Canada through the Arctic Council, and our relations with the EU through the Northern Dimension.

Research Council's Policy for Norwegian Polar Research 2010–13
In this document the geographical term "Arctic" refers primarily to the polar part of the Arctic. It includes Svalbard, Jan Mayen, the northern part of the Norwegian Sea, the Barents Sea, the Greenland Sea and the Arctic Basin, together with adjacent land areas. Research stakeholders are not restricted to one geographical area and may just as easily be located outside the Arctic and northern areas, in other parts of Norway or in other countries.

Opportunities and challenges in the High North have held a prominent place on the political agenda for several parliamentary periods and it is essential that the northern areas initiative is based on a national effort to promote knowledge that encompasses the entire Norwegian research community and all relevant sectors. It is therefore an overall aim to ensure that funding for research relevant to the northern areas under the Research Council's programmes and activities is awarded primarily through open competition and on the basis of relevance and scientific merit.

The Research Council's initiative will continue to be incorporated into all relevant Research Council programmes and activities. The Council will coordinate the initiative internally to ensure the most effective interplay possible between the various instruments.

To facilitate the implementation of the strategy, the Research Council will apply its funding instruments in close co-operation with the other public funding agencies, including Innovation Norway and SIVA (partly in the cluster initiatives) and the regional research funds (supplementary initiatives etc.).

The Research Council will encourage national and international research cooperation in activities relating to the northern areas, in part through active use of its internationally-oriented network. Importance will also be attached to developing trade and industry, existing as well as new enterprises, by facilitating close cooperation between the research community and the industrial sector. A key objective is to secure the involvement of research-based industry in both traditional and new industrial areas in order to exploit the commercial potential of the northern areas.

4 Main action points

The revised strategy is based around three main action points: ensuring the quality of the research, promoting international research cooperation and strengthening research-based industrial development.

4.1 Providing the best possible knowledge for the public administration, for trade and industry and for society at large

It is important to ensure that Norway's High North policy is based on research of the highest calibre and that this research is also made available to trade and industry. If Norway's management of natural resources in the north is to be the best in the world, its efforts must be based on the best research available in the field and knowledge must also be developed in new fields. In the same way R&D-intensive industry must be developed on the basis of the best knowledge available. It is therefore essential to promote cooperation with leading research groups in Norway in the various individual fields and via these groups with the leading research communities in the world.

4.2 Strengthening international cooperation

International research cooperation is important in all areas of research, and promoting such cooperation in the northern areas is essential. A coordinated international effort is required if we are to be able to meet the knowledge challenges we are facing in the north, as these are too wide-ranging for one nation alone to solve. International research cooperation will also help to maintain the relevance and quality of the research.

The Arctic is an area that presents significant opportunities for the international community, and an increasing number of nations, over and above the Arctic states, are beginning to take an interest in the region. Norway should continue to be a driving force behind the development of the Arctic as a global research area. Cooperation between international researchers can provide important input for the identification and analysis of potential conflicts of interest between states, and as a basis for international negotiations.

4.3 Strengthening research-based industrial development in North Norway

If R&D efforts are to play a key role in innovation and industrial development and if trade and industry itself is to engage in systematic development efforts, there must be closer collaboration between the companies and the research system, both in Norway and abroad. Both Norwegian and foreign-owned companies must be encouraged to establish themselves in North Norway, provided the market and framework conditions make it attractive. Long-term and binding cooperation between companies, capital interests, the research community and the public funding agencies is essential if commercialisation is to be successful, particularly as regards the utilisation of research results in products and services targeted for new markets.

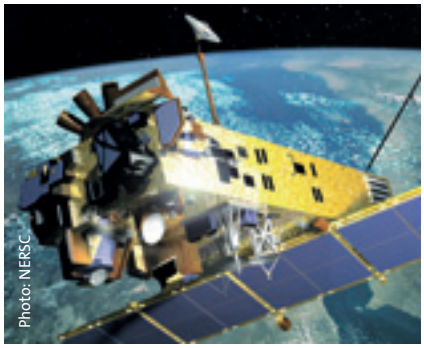
Photo: NERSC

5 Thematic priority areas

The six defined thematic priority areas encompass research topics related to the natural surroundings, technology, people and society and include issues of a cross-disciplinary nature.

Photo: Tor Ivar Karlsen, Norwegian Polar Institute (detail)

The Research Council's Arctic and northern areas initiative identifies a number of broad priority areas. Whereas the first strategy defined five thematic priority areas, the revised strategy sets out six. These are to some extent a continuation of the previous priority areas but they also take into account lessons learnt and changes that have taken place since the first strategy was launched. There are no clear boundaries between the priority areas – some research questions may be cross-disciplinary in nature and common to more than one of the priority areas and there may be issues that arise in the interface between thematic areas that can refresh and enhance our understanding of the research topics. The strategy encompasses research on the natural surroundings, technology and people. It is therefore crucial that the research covers most subject fields, from social and cultural research, to law and medicine to research on the natural sciences and technology.

The six priority areas consist of five broad social challenges and a sixth thematic area which focuses on the unique potential for knowledge development inherent in the location, geography and natural resources of the Arctic and northern areas. The order in which the priority areas are presented reflects their geographical scope, from an international to a regional perspective.

5.1 The international and Arctic dimension

The northern areas as a geopolitical arena

Global interest in the Arctic and northern areas is growing – not least because of the potential of these areas to satisfy expanding energy and resource needs. As a result of climate change more and more sea and land areas are becoming accessible and their natural resources available for exploitation. Technological advancements are making it easier to recover natural resources and utilise air space.

It is important for Norway to be familiar with the views and perspectives on the northern areas that prevail among other key actors, such as the EU, the US, Russia and Canada. Russia plays a key role in international policy on the northern areas and is an important regional and global actor in an energy market that is increasingly turning its gaze towards the northern reaches. Research on foreign policy and international relations can provide important input for our understanding of regional and global dynamics in the Arctic and northern areas. This will provide a sound scientific basis for national policy design. It is important to understand how Arctic institutions, the designation of national policy and bilateral ties in the northern areas form part of, and are shaped by, the states' national interests and an international system in transition. Equally important is an understanding of other actors that represent economic interests, non-governmental organisations,

Photo: Christian Nørstebø / Norwegian National Defence Magazine

indigenous peoples and others, and their role in influencing developments.

Traditionally, a distinction has been drawn between research on security policy, which primarily addresses defence and foreign policy and inter-state relations, and research on societal security, which focuses on security and risk assessments within a single state. Today, security is viewed as a more transnational phenomenon, exemplified by insecurity arising from natural disasters, pollution, sabotage, acts of terrorism and international crime.

This has created a need for new forms of security, emergency response systems and international cooperation.

The concept of security is not only a matter of military or defence security but also extends to the ability of actors in the north to develop effective mechanisms for security and preparedness in order to meet new challenges, such as increased use of long transport routes along potentially vulnerable coastal areas and the issue of nuclear waste storage. Increased economic, commercial and cultural contacts across national borders in the north may pose further challenges, and the need to develop new agreements, rules, measures and systems that ensure security may arise, for example in connection with installations and activities in international waters.

It is important to examine whether military force is still a relevant tool in international policy in the northern areas. A key question is what the likely restrictions are on the use of military force – or the risk of military force being used – between states in this region, and what individual states can do to prevent the use of force. It is also important to shed light on whether, and if relevant how, the military situation in the north is affected by developments in other parts of the world.

Questions of international law in the north

The focus on the northern areas calls attention to a number of transnational

issues related to the management of natural resources and the environment and the rights of indigenous peoples. Dealing with these issues will require analyses that provide a basis for political dialogue, and a common understanding and interpretation of existing international law agreements as well as the development of new international agreements where necessary. In order to understand the political and legal implications of these issues we need knowledge of the interests and power structure in the relevant countries in terms of their economy, industry and history as well as knowledge of institutional development and the political situation in these countries. It will be important to clarify how much legal and political room to manoeuvre the various actors have in dealing with these issues and how this has changed over time.

The easing of international geopolitical tension in recent years coupled with greater interest in the vast energy and resource potential to be found in the north may have significant ramifications for the indigenous populations. This is a field under development both nationally and internationally, in the context of international as well as environmental law. This is particularly evident in efforts to achieve a Nordic Sámi Convention and a UN declaration on the rights of indigenous peoples. Comparative studies of the territorial rights of indigenous peoples and comparative analyses of models for co- and self-determination will generate vital knowledge that can provide a basis for incorporating the rights of indigenous peoples into national legislation. Creating opportunities for indigenous people to participate in international cooperation in the northern areas is another important topic.

Knowledge about Russia

On 1 April 2011 the agreement on maritime delimitation and cooperation in the Barents Sea and the Arctic Ocean signed by Norway and Russia on 15 September 2010 was approved by Royal Decree. On 8 April 2011 the agreement was also approved in Russia when it was signed by President Medvedev, with effect from 7 July 2011. The agreement brought to an end over 40 years of uncertainty regarding the status of large sea areas in the north.

The agreement will pave the way for growth and development in the north in areas such as resource management, industrial cooperation, transport and commercial activity. Norway has extensive contacts with Russia, and in order to engage with relevant Russian actors successfully it is important to have a good understanding of social developments in Russia as well as in-depth knowledge of the Russian language. Knowledge of the international and Arctic dimension is vital for meeting future challenges in the northern areas.

Measures and knowledge needs:

- Acquire knowledge about the policies of key actors with regard to the northern areas, including strategies and interests, and their attitudes towards international agreements, conventions and treaties.
- Acquire knowledge about the impacts of climate change and utilisation of resources in the sea and on the seabed.
- Develop the basis for national and international security rules for the shipping and petroleum industries, encompassing accidents as well as sabotage. This would have to include studies of the legal authority of the various states and bodies to regulate and monitor shipping and fisheries activities in the northern areas. Key topics here are conservation and the preservation of biological diversity, conservation areas, shipping routes and shipping security.
- Acquire knowledge about how rights and livelihoods are affected by new developments and facilities established in connection with offshore and land-based activities. Legal issues related to rights to land and grazing areas, the development of local communities in the Arctic and the living conditions of the region's indigenous peoples are relevant in this context.
- Enhance understanding of key actors and institutions in Russia, including regional policy and the relationship between the national and local authorities, the supervisory authorities and the courts. Enhance understanding of social developments in Russia and knowledge of Russian culture and language.


Photo: Linda Bakken


Photo: Thomas Viborg


Photo: Bendik Eithun Halgunset

5.2 Environmental issues and biological resources

Environmental issues
Large parts of the Arctic contain almost no sources of pollution, but pollutants are being transported into the region via sea and air currents. This, combined with changes in the climate, may affect the organisms that live there in ways of which we are currently unaware. As long-range pollutants account for a greater proportion of the overall pollution level in the north than they do further south, pollution in the northern areas may provide a clear indication of the global dispersal of pollutants. Large parts of the northern areas could therefore serve as a global reference point for studies of the impacts of pollution.

Strengthening the knowledge base for coherent, ecosystem-based management of marine, terrestrial and limnic ecosystems in the northern areas is a stated policy objective, incorporated in the management plan for the Barents Sea-Lofoten area among other things. There is a great need for research on the unique ecosystems of the northern areas and their capacity to sustain services, as well as research on the impacts of change to the environment.

Arctic organisms could be lost as a result of climate change as their ecological niches cease to exist. In addition, it is likely that the Arctic and northern areas will experience a greater influx of species both through natural dispersal as a result of climate change and through unintentional introduction. The introduction of non-indigenous species via ballast water is a significant and growing problem in marine ecosystems. This is expected to increase with a rise in shipping transport. Higher temperatures will probably raise the chances of survival of the introduced species, which in turn will enable them to spread rapidly, thereby increasing the risk of adverse effects.

More specific knowledge of ecosystems is required if we are to be able to predict responses to environmental changes in the north more accurately. This means that we need to know more about the impacts of climate change and pollution as well as about species and stock development in order to shed light on the ecosystem interactions at all levels. In addition, more knowledge is needed about irreversible changes to ecosystems, their causes and ramifications.

Climate change is likely to be the single greatest environmental pressure affecting terrestrial ecosystems. The thawing of the permafrost and altered growing conditions will lead to changes in the vegetation, which in turn will affect animal stocks and grazing conditions. It may also entail changes that affect the distribution between grazing animals and game. Knowledge is needed about how the harvesting of biological resources affects their development and that of associated ecosystems as well as about what constitutes sustainable use of natural and land resources from a wider social perspective.

There is a risk of radioactive pollution of the marine environment. For development, growth and survival conditions in the north it is crucial that nuclear safety is maintained. Research is needed on sources of radioactivity, transport, dispersal, uptake, biological effects, impact and risk assessments and about interactions between radioactivity and other pollutants.

Photo: Kristen Ulstein, Research Council of Norway

Biological resources

The northern areas are rich in biological resources that must be preserved. Research activities should be aimed at enhancing knowledge that supports general ecosystem management in a cold-weather climate. With regard to marine resource management there is also a need for more knowledge of how international frameworks at different levels are "translated" to suit Norwegian conditions. This is important for achieving ecosystem-based management in an international perspective. Reduced ice cover in the summer season could lead to marked changes in the ecosystem as light reaches new areas, for longer periods. Less ice will also cause an increased rise in sea temperature as energy radiation is reduced.

The increased concentration of CO_2 in the atmosphere is leading to greater uptake of CO_2 by the ocean, causing ocean acidification. This affects the conditions for survival of marine organisms and thus the distribution of marine species, and will have major implications for the marine ecosystem as a whole, both in the north and globally. In addition to challenges related to climate change and ocean acidification, marine organisms are confronted with natural changes in access to food, for example, as well as emission of pollutants. CO_2 released from geological formations in connection with petroleum recovery and combustion will also cause gradual changes.

A rise in sea temperature may push the aquaculture industry northwards. Knowledge is needed of the effects this will have on ecosystems, in particular on wild fish stocks.

The harvesting of various resources changes the ecosystem. More knowledge is needed to ensure the balanced exploitation of resources. Poorly managed harvesting can have long-term consequences both for the genetic variation of stocks and for society. In the oceans it could lead to the collapse of stocks or changes in the migration patterns of commercially exploitable marine species, and on land to over-grazing and the loss of biodiversity.

Natural resource management is currently based on biological models. In the future management goals may take greater account of the economic and social impacts of resource management. A number of fish stocks are subject to an international management regime. The premises for successful international cooperation on fisheries resources are changing, in part because economically important stocks could change their migration patterns in response to climate change. It is important to further develop cooperation with other countries to ensure a future-oriented approach to natural resource management.

There are large challenges facing reindeer husbandry, particularly on the Finnmarksvidda plateau. Overgrazing has a significant impact on biodiversity and the large numbers of reindeer mean that pastures are not able to recover between grazing seasons. The shortage of fodder also reduces the slaughter weight of the animals. The large numbers of reindeer in the area also comprise a source of conflict with the agriculture industry regarding land use and land rights.

Changes in climate, the environment and the resource base also pose a challenge with regard to establishing effective monitoring infrastructure and for integrating observations from various observation platforms in order to gain as complete a picture of developments as possible.

Measures and knowledge needs:

- Enhance understanding of the make-up of and changes in ecosystems, species communities, and ecosystem services, of what the total environmental impact on the marine and terrestrial ecosystems will be and of the implications of this for the environment and health.
- Acquire knowledge about the effects of increased aquaculture activity in the north on the use of land area and on ecosystems, including wild fish stocks.
- Seek the development of sustainable reindeer husbandry within an ecosystem-based and a commercial perspective.
- Develop management models and planning processes that enhance coordination and conflict resolution between sectors, businesses and the public administration.

5.3 Energy, petroleum and mineral resources

Global challenges

The Arctic has become more attractive as a region for natural resource recovery, in part because other resource-rich areas are characterised by political instability or uncertain framework conditions. Thus, global factors exert a significant impact on the economy, the environment and social development in the northern areas. More knowledge is needed about the role of global economic development as a driver of the demand for resources in the region.

Energy

Global climate challenges combined with expanding energy needs worldwide have led to an increased focus on renewable energy in recent years. The northern areas represent a wealth of opportunities with regard to the development of renewable energy in the form of hydropower and wind energy, wave and tidal power and power from ocean currents. The utilisation of marine biomass for bioenergy and geothermal heat also has potential here, and is an activity that will require substantial R&D efforts.

As regards CO_2 management, the experience gained from the storage of CO_2 at the Snøhvit gas field and the establishment of the Longyearbyen CO_2 Lab for the demonstration and testing of methods and technologies for CO_2 storage will have global significance.

The increased research focus on renewable energy, energy efficiency and carbon capture and storage (CCS) should encompass topics that will generate new insights into the potential for the recovery and production of environment-friendly energy in the north. Specific environmental or climate-related challenges related to the recovery, production and use of energy in the northern areas will also be important.

Petroleum

Petroleum is important both as a resource for the industry and as a source of energy. A considerable portion of the world's undiscovered petroleum resources are to be found in the Arctic. Russia, Canada and the US have substantial petroleum production activities in their northern areas, and Norway has operations in the Barents Sea and the Norwegian Sea.

The petroleum industry represents a significant opportunity for value creation, innovation, and the creation of new, permanent jobs in North Norway, both during the development and the operational phase of activities. The treaty signed by Russia and Norway on maritime delimitation on cooperation in the Barents Sea and the Arctic Ocean entails a greater likelihood that prospective petroleum activity will take place in the region and provides a basis for intensified activity and cooperation in the petroleum sector. Research that improves management expertise and adds to the foundation for further development of petroleum resource management in Norway may have implications for the development of the petroleum industry in Russia and other areas in the Arctic.

Several factors remain uncertain as regards petroleum activity in the Arctic and northern areas, including the extent of oil and gas resources in the north, whether the discoveries are commercially exploitable, whether oil and gas prices will be able to justify the increased development costs for operations in the Arctic, and what the potential implications of new climate policy obligations will be for the development. So far, exploration activity has not met expectations, but the discovery of the Skrugard field gives grounds for optimism.

While the prospects for new discoveries in the Barents Sea are good, considerable geological uncertainty related to this still remains. Better geological models and understanding will be important for achieving more targeted exploration. R&D activities can provide a better understanding of the resource potential in the area and supply expertise to the industry. Installations and operations in dark, cold surroundings in a unique natural environment pose special limitations on technological and operational solutions, as do development and production activities carried out at potentially long distances from the mainland and in areas that are exposed to drift ice during parts of the year.

The oil industry is highly aware of the possible scenarios that could result from acute spills arising from petroleum activity in the northern areas. There is a need to develop solutions that minimise the risk of pollution from the petroleum industry. However, in the nearest future it is shipping traffic, and in particular the increase in Russian tanker traffic along the Norwegian coast, which represents the greatest threat in terms of emissions.

Oil pollution emergency preparedness under extremely difficult climatic conditions, of darkness, freezing temperatures, wind and ice, is an area that represents a significant research challenge as regards the development of both systems and equipment. In addition to accurate ice and weather forecasts, better climate models are required that can predict developments with increasing precision. There is also a need to make more effective use of the satellite observations recorded over Norwegian territory.

Geological resources

As part of the Government's High North Strategy, the Geological Survey of Norway (NGU), the SINTEF Group, the Norwegian University of Science and Technology (NTNU) and the Northern Research Institute (Norut) have mapped deposits and the possibilities for excavation of ores, metals and industrial minerals in the three northernmost counties of Norway. Because of the scarcity of these resources and the ensuing high prices, geological resources in the north have

Measures and knowledge needs:

- Develop environment-friendly, functional and effective technology for petroleum recovery, renewable energy and utilisation of geological resources in the Arctic climate.
- Implement mapping of resources.
- Develop products and processes for oil pollution control that perform in extreme weather and ice conditions.
- Conduct risk assessment and determine risk management routines for working in harsh environments, characterised by cold, darkness, icing, differing ice conditions, long distances to shore, difficult access to equipment etc. to avoid unfortunate situations.
- Seek cooperation with Russia, Sweden, Finland and other nations that are facing similar issues onshore and on, in and under the ocean.
- Acquire knowledge about the social and environmental impacts of industrial activity in the north.
- Consider HSE challenges.

Melkøya/Snøhvit
Photo: Statoil

significant commercial potential. If exploited, these could result in extensive new land-based activity, involving prospecting, mining and processing. With new technology the re-opening of old mines is also a possibility. The establishment of process industries based on geological resources is an additional possibility. The use of (locally sourced) natural gas may also be a relevant option, both as a source of energy and as a reducing agent in production processes.

If the potential in this area is to be developed, considerably more knowledge of and expertise in resource geology are needed, as well as more extensive mapping. In light of this the University of Tromsø has established a professorship in resource geology. It is crucial that the environmental aspects of this industrial activity are given careful attention. In Sweden and Finland similar opportunities are being examined. Efforts should be made to facilitate research co-operation as well as collaboration on other activities.

Management and the environment
Norway's management of the northern areas and the development of the framework for resource-based economic activity in the north may be widely applicable to other parts of the circumpolar region. One approach is to expand cooperation on the management of the Arctic region. It is important to view the development potential of the various industries in the context of knowledge about ecosystems and environmental change in the northern areas, not least the impact increased economic activity will have on the Sámi population and other indigenous populations in the region. More knowledge is needed for any such collaborative approach to succeed. Knowledge about the distinctive characteristics of land areas and the basis for solving land disputes will also be key topics.

Technology
The often extreme climatic conditions in the Arctic and northern areas present significant challenges, particularly as regards assessing and managing risk at all stages of the development and production process. Better knowledge of the physical environment in the Arctic, including ice conditions, wind, waves, icing and permafrost, is essential for establishing operations in new areas. The need to work in extreme climatic situations will require a special research focus on health, safety and environmental (HSE) issues and the development of relevant knowledge and equipment. In addition new, innovative solutions must be sought based on knowledge of climatic conditions and environmental impacts in order to ensure sustainable industrial development.


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Photo: Sámi University College

5.4 Social development in the Arctic and northern areas

Social change in the north
The Arctic has a widely dispersed population made up of many small communities. North Norway is one of the most densely populated areas in the Arctic region, but large towns are also found in Iceland and northwestern Russia. Most of the indigenous peoples in the Arctic live in small, vulnerable communities. The report *Megatrends in the Arctic* draws attention to development trends such as greater urbanisation, demographic imbalance (partly caused by young people moving away from small communities), dependence on the primary sector, the need for renewable energy and a "green" economy, pollution and climate change, the need for investment in human capital and the potential and risks associated with the fact that these areas are more accessible than previously.

Future developments may bring major changes to social and industrial development in the Arctic and northern areas, influenced by both the specific interests of the countries involved and by collaboration between them. New research-based knowledge that will amplify our understanding of such social developments and can provide a basis for decision-making will be crucial in the years to come. For Norway this applies to the Sámi people, who have better functioning institutions, and whose rights are probably to a greater extent enshrined in law and recognised by conventions than those of many other indigenous groups in the Arctic. This brings an East-West dimension to the research activities and necessitates research cooperation across national borders.

The development of North Norway is also characterised by centralisation and urbanisation. While the area as a whole has experienced negative population growth, vibrant urban centres with diversified business and industry, higher education institutions and research communities have emerged. The structural changes have particularly affected the coastal areas where most of the municipalities are having difficulty maintaining settlement patterns and trade and industry, despite widely accepted political goals of maintaining the main features of population settlement. More knowledge is needed about society's ability to realise such goals. Patterns of education, professional activity, settlement and mobility among women and men, and young and elderly people comprise important dimensions to consider in the context of research as well as policy.

Infrastructure
Infrastructure here refers to the physical and institutional framework for living and working in the north. The importance of access to communications and good transport solutions is obvious, both for commercial activity and private individuals. The extent and quality of the road network, public transport, broadband, TV and mobile telephone coverage are all crucial. There is also a need for adequate and reliable access to electrical power, and this need is expanding at a pace with energy-intensive activity.

A well-functioning society must have good access to educational institutions and to health and welfare services. The skills required in these areas of activity also mean potential job opportunities for highly qualified personnel and will help to raise the educational level of the workforce in North Norway. Experience clearly indicates that higher education and research institutions play an important role when it comes to both


Photo: Colourbox

recruitment and people's choice of place of residence and employment. One challenge for the educational institutions is to be able to meet the need for expertise in this part of the country well enough.

The appeal of the north

Educational opportunities and the labour market play a significant role in people's choice of where to live and start their families. The experience of Hammerfest following the development of the Snøhvit oil field indicates that highly educated young people from the north choose to return home when attractive job opportunities are to be found. Conditions for children, access to health services and public and private welfare schemes, neighbourly relations and cultural and leisure activities also affect settlement patterns. Increased knowledge of what makes people choose to remain living in or move from or to North Norway will help to provide a better basis for further policy development.

The natural surroundings offer more than merely resources for industrial development. It provides a source of recreation and enhances the quality of life and the attractiveness of the area for both residents and tourists. For the tourist and hospitality industry much of the appeal of the north lies in the fact that the destinations are dynamic local communities and not tourist resorts that are deserted out of the season. The ability of the area to attract people to it is an interesting topic for research in the north.

Expertise and labour force

In today's society competence building plays a key role in the development of the country. There is a growing need for expertise in all parts of working life. Outside the university and university college cities the level of formal education in North Norway is well below the national average, especially in trade and industry. Finnmark in particular exhibits a high drop-out rate from upper secondary school and poor recruitment to higher education. It is therefore necessary to enhance our understanding of the mechanisms that will help young people to complete the full course of education.

Unemployment is low in the counties of North Norway, as in the country as a whole. Newly established companies acquire their staffs either through redistribution of the existing workforce in the region or through relocation/ commuting of individuals from the rest of the country and abroad. Key research questions in this respect are how this will affect the rest of the labour market and social life in the local communities


Photo: Shutterstock


Photo: Jon Solberg, Research Council of Norway


Photo: Kjell Merok/Nofima

and which strategies are being developed to meet the need for specialised and highly skilled personnel, in trade and industry, educational institutions and the political arena.

The need to create more jobs in the north must also be viewed in connection with the fact that the market and labour market do not always correspond in size – the labour market is local and regional whereas the markets may just as easily be found elsewhere, outside the region. Particular attention should be devoted to developments in the Sámi communities, both in relation to commercial activity and living conditions, as well as in relation to culture, language and traditions.

Power, interests and actors

It is important to develop an understanding of the power constellations and interests that affect social development in the north. Aspects of these power structures and interests may be brought to light as a result of the implementation of the northern areas initiative, and it is of interest to study which actors and institutions are being strengthened or weakened both in the northern areas and in the interaction between regions.

The interests of indigenous people in and outside Norway are of particular interest. Many of the power structures have been in place for a long time and activities under the northern areas initiative could strengthen them or lead to the creation of different alliances in matters of conflict. The relevant actors in this context are to be found in political organisations, at the local, national and international levels.

Trade and industry is another area where there are varying interests at stake, for example related to the primary industries. The public administration, through both its management of infrastructure and its welfare schemes, looks after the interests of the community. Research plays a role both as an important component of the focus on the northern areas as such, and in terms of providing knowledge to the various actors involved. The role of research in development and knowledge management in the northern areas is therefore an interesting research field in its own right.

Measures and knowledge needs:

- Promote research on culture and society, which plays an increasing role in the development of an integrated knowledge base on social conditions in the north.
- Ensure the incorporation of a social science-oriented approach in other areas by developing research questions specifically targeted towards individual areas of activity and relating them to topics described above.
- Introduce instruments with long-term goals for recruitment of researchers and the provision of teaching as the lack of research activity on social conditions in the north may also be the result of low capacity and limitations in expertise.
- Encourage research cooperation across national borders.

5.5 Knowledge-based industrial development

National and regional challenges
The level of R&D activities carried out by Norwegian trade and industry is considerably lower than in Finland and Sweden, for example. This is partly due to the structure of Norwegian trade and industry, which to a large extent is based on raw materials with many large companies whose performance is measured in terms of turnover.

Companies that do not innovate, i.e., do not bring new products to the market, will stagnate and lose in the face of competition. The public sector is facing the same challenges as the private sector as regards the need to work systematically on its own development, participate in R&D projects and develop or apply new knowledge, new products and innovations.

Most of the R&D activities carried out in the private sector take place without the involvement of the public sector. The education and research system therefore has a crucial role to play in maintaining the level of knowledge and expertise in industry. The knowledge and expertise the employees bring to the company is based on their education, which is a product of the research activities the teaching staff are involved in, directly or indirectly.

R&D invariably generates knowledge and expertise and often also leads to innovations in products, processes and services.

North Norway as a whole is characterised by the existence of many small companies operating in branches that are not research-intensive. This part of the country is therefore under-represented in the Research Council's industry-oriented project portfolio. Another reason for this is that many corporations with subsidiaries in the north carry out their R&D activities in other parts of the country and there are few companies in research-intensive branches and relatively few researcher man-years/individuals with higher education working in trade and industry in North Norway.

According to *Konjunkturbarometeret for Nord-Norge* ("Business Trends Barometer for North Norway", Norwegian only) for 2011 the North-Norwegian economy is now experiencing considerable growth. The finds at the Skrugard field have led to optimism in the petroleum sector. Exports from the marine sector are increasing and the rest of the industrial sector has reported growth. Tourism is still growing, especially during the winter season.

In its January 2011 issue the British journal *Monocle* identified the Barents region as one of the most promising areas in the world for industrial activity (shipping, petroleum, minerals).
Most of the larger companies in the north are export-oriented and natural resource-based: oil and gas, geological resources (rock/slate, ores, minerals), fisheries, aquaculture and other sea-food industries, as well as hydropower as a source of energy for the process industries (including fertiliser, silicon for solar cells, aluminium, ferrous alloys).

Many small companies in natural resource-based industries produce goods both for the national and the international markets, especially in fisheries, aquaculture and the fishing industry, and nature and experience-based tourism.

Some companies, particularly around the University of Tromsø, are at the forefront in terms of technology and offer advanced products and services in the fields of telemedicine and health, natural resource monitoring by satellite and biotechnology products.

There is therefore an excellent platform for further growth in North Norway. Profitable companies bring in other companies as subcontractors. These companies may then become motivated to conduct research in order to make better or new products, processes and services, which in turn contributes to growth and profitability.

Creating more profitable jobs in the private sector in the north is an important political goal. The necessary framework conditions must be in place to make it economically attractive for actors in trade and industry to invest in the north.

Research for innovation
The objective of the Research Council's efforts to promote innovation is to develop knowledge-based and sustainable trade and industry in Norway which, in cooperation with the R&D system, is equipped to meet the challenges of the future. This goal is to be realised by mobilising and funding research activities across the country as a whole. The application of knowledge is the basis for innovation and development activities and interaction between the independent research institutes, universities and university colleges is crucial. The Research Council promotes

collaborative projects between different R&D groups. The participation of regional R&D groups in various consortia needs to be particularly encouraged.

New, more targeted instruments aimed at creating new jobs in all branches and industries are also needed. The Research Council will provide support for R&D activities, competence-building measures and entrepreneurial activities, by supporting new R&D-based start-ups from the higher education sector, by encouraging national and international companies to establish new enterprises and through other forms of cooperation between companies.

The Research Council will also use its funding instruments to increase the degree of innovation in established industries such as fisheries, aquaculture, the processing of natural resources from agriculture, marine industries, Arctic agriculture, reindeer husbandry, Sámi entrepreneurial activities and tourism and hospitality.

The utilisation of the rich biological resources to be found both offshore and onshore presents a wide array of opportunities for value creation, such as in the form of new (sea) food and health food products, as sources of biofuels and as raw materials for pharmaceutical and other products.

Another area of potential growth in the north is bioprospecting in marine and terrestrial environments in search of new bioactive components and compounds that can be exploited commercially. Bioprospecting as a field of research, including the infrastructure needed, is an area under development in the north.

The identification of suitable biological properties requires basic research, and commercialisation is proving to be a major challenge. A long-term strategy must be drawn up in cooperation with researchers, the research funding bodies and companies if the potential for value creation in this area is to be realised.

Industrial activity based on geological resources is another area of great potential. This encompasses the mapping of natural resources, exploration, recovery and production processes in the Arctic, oil pollution control in the Arctic, waste processing and waste management issues, the use of gas in processes, and the use of locally extracted gas as an energy source and reducing agent in production processes. Environmental considerations must be a key perspective in all these processes.

Measures and knowledge needs:

- Capitalise on R&D investments by giving priority to innovation projects in industry that target use of the research results towards the markets.
- Increase commercialisation of basic research in universities and university colleges and the institute sector.
- Encourage knowledge communities and companies all over Norway to come together to form consortia that can result in the establishment of more research-based companies in the north.
- Ensure the continuation of the NORDSATSING initiative.
- Increase the relevance of the education system by promoting projects at universities, university colleges and independent research institutes in the branches of industry in the north where there is a good basis for growth, so that local candidates become attractive to industry.
- Strengthen the ability of industry in North Norway to commission R&D activities, in cooperation with the Research Council, SIVA and Innovation Norway.
- Strengthen instruments designed to raise the level of education in North-Norwegian industry, such as researcher and student mobility, work placement and trainee schemes and the Industrial Ph.D. scheme, ideally through collaborative efforts involving several companies.
- Conduct research on conditions that promote innovation and industrial development with a particular focus on infrastructure, the role of relevant stakeholders, organisation, alliance-building and entrepreneurial activities.
- Make use of the Research Council's portfolio of industry-oriented funding instruments and networks in close cooperation with other public funding agencies, trade and industry, R&D institutions and the county administrations in North Norway, in order to ensure continuity and an integrated approach.
- Make use of the Research Council's regional offices to strengthen practical cooperation between the Research Council's instruments and the regional research fund.
- Intensify efforts to promote the SkatteFUNN tax deduction scheme.


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Photo: Bendik Eithun Halgunset


Foto: Aqualine

There is also potential for development and innovation in activities related to several sources of renewable energy, in addition to hydropower.

Earth observation and space technology are established activities that have further potential for service and product development in an international context.

The Research Council, Innovation Norway, SIVA, the regional research funds and private capital must work together to make the most of these opportunities. The SkatteFUNN tax deduction scheme is an instrument that is effective in traditional industries and amongst smaller companies. This scheme must be marketed more intensively. The Research Council will work to ensure the continuation of the Research Initiative for Northern Norway (NORDSATSING).

Research activity in many areas is crucial for the development of expertise in North Norway, for instance through the introduction of masters' level programmes and doctoral and postdoctoral fellowships. This expertise will be essential for recruitment both to industry and to the research sector. Recruitment at lower levels is also important and is dependent on the ability of the education system to identify the needs of local industry. In addition, new R&D intensive companies may emerge as a result of research activities carried out at local universities and independent research institutes.

The Research Council will use both targeted and general instruments to cultivate increased R&D-based activities in North Norway. The Research Council's contact networks vis-à-vis trade and industry, research, the public administration and political authorities will also be used to influence developments in this area.

The Research Council's innovation strategy identifies three main priorities that will promote knowledge-based industrial development: giving priority to research in and for key industry and knowledge areas, encouraging more research for innovation across the entire range of trade and industry and the public sector, and ensuring the wider application of research results to promote innovation.

5.6 Unique research potential

Understanding the climate system and climate change

The Arctic and northern areas comprise an important reference area and natural laboratory for detecting climate change quickly and for understanding the key drivers behind the global climate system. The temperature in the Arctic is rising more rapidly, and is expected to be far higher than, the global average. The combination of pronounced natural variability and the greater temperature rises expected means that the impacts of climate change in the north will be significant.

In today's climate models there is a need to know more about the various processes in the climate system. In particular the role of sea ice, clouds and methane emissions are poorly understood. Results from projects conducted under the IPY initiative indicate that more reliable climate forecasts for the Arctic and northern areas are possible. Improving the climate models is important for making predictions at the global level on both a one-year and a ten-year time scale. There is also a great need to design better regional models.

Photo: Beautiful Norway

CO_2 uptake is greatest in cold water, and cold sea areas in the north provide favourable conditions for a greater occurrence and abundance of calcium-binding plankton as primary producers in marine ecosystems. This is of great significance for the global carbon balance. A rise in temperature could lead to changes in this but little is known about the impact it would have. A rise in sea temperature in the north will have a feedback effect on the climate system because the carbon uptake will change.

Changes in the extent of the sea ice will also have feedback effects on the climate system as a result of changes in albedo (proportion of solar energy reflected) and changes in the energy balance between the atmosphere and the oceans. Today's climate models are not sufficiently advanced to be able to predict changes in the extent of the sea ice and its seasonal variation and are therefore not well suited for studying the ecological impacts of climate change. Downscaling using regional climate models may be useful in this respect. As with sea ice, changes in the vegetation could have a major impact on the climate as a result of changes in albedo, and predictions indicate that such changes may play a key role in climate development.

One effect of the thawing of the permafrost is the emission of greenhouse gases from terrestrial and marine environments. At present there are few estimates regarding the degree of increased emissions as a result of the thawing, and the stores of greenhouse gases trapped in the tundra and hydrates on the seabed, and these estimates are poor at best.

Location, geography and infrastructure

Svalbard provides a unique research platform for studying a variety of phenomena, not only by virtue of its location far north, but also because of the extensive research infrastructures

available for investigating the marine environment, vegetation and permafrost, glaciers, the atmosphere and the aurora borealis, as well as a satellite data receiving station. The European Strategy Forum on Research Infrastructures (ESFRI) project "Svalbard Integrated Arctic Earth Observation System" (SIOS), which is currently in its preparatory phase, is a means of upholding this and is crucial for establishing an effective framework for international cooperation and sustainable utilisation of the research potential on Svalbard.

Certain areas in mainland Norway also have unique qualities as research platforms. On the Finnmarksvidda plateau, for example, there are areas that are particularly well suited to studying the processes that characterise the southern part of the circumpolar tundra. These studies have become highly relevant in light of the ongoing impacts of climate change. There is no other area in the world where these environmental conditions are so easily accessible and where research at the southern edge of the tundra has the benefit of such good infrastructure.

The development of environmental monitoring in extreme environments that are difficult to access will lead to the creation of innovative solutions that can be used all over the Arctic. Svalbard and the Barents Sea are ideal as platforms, not just for the development of environmental monitoring technology, but also for research on design (temporal and spatial) of monitoring systems. The development of cost-effective environmental monitoring in the polar regions that meets the needs of society is one field of innovation where Norway is particularly well placed to succeed.

The deep seas in the north, including the Arctic Ocean, the Greenland Sea and the northern part of the Norwegian Sea, have not been studied or surveyed to any great extent. Strengthening efforts in this area will provide a better understanding of the geological history of the deep ocean of the Arctic and adjacent areas. It is also important to enhance our understanding of the periphery of the Arctic Ocean and the significance of transport routes for physical and biochemical processes and natural variability in the Arctic.

The shallow seas and the continental shelf areas, including the Barents Sea, pose a number of challenges that are pivotal to understanding the geological history of the continental shelf and for describing ocean circulation on the continental shelf and the role of seabed topography, among other things. Studies that focus on providing a description of the natural variation in primary production, the importance of the drift ice and the marginal ice zone for this variation, and the energy transfer through the food chain will enhance our understanding of changes in biological diversity, habitat and species composition arising from changes in the location of the marginal ice zone.

The terrestrial geo-environment presents opportunities for studies of changes in slope stability and for measuring changes in the water level of rivers (water volume measurements, flood forecast, sedimentation etc.). Ground temperatures and ground temperature variations have implications for permafrost, changes in ice and snow cover and changes in ice dynamics. Instruments used to obtain observations of the natural environment provide crucial

Measures and knowledge needs:

- Implement climate research based in the northern areas. Build on research activities carried out in connection with International Polar Year (IPY) and further develop knowledge through international initiatives.
- Develop climate and environmental monitoring methods in extreme environments.
- Ensure optimal utilisation of research infrastructure in the northern areas.
- Carry out studies of ocean circulation and ice drift in the Arctic Ocean on a geological time scale, the importance of seabed topography, for example, and the link between the Arctic Ocean and thermohaline circulation.
- Carry out studies of the Arctic ice cover, air/ice/sea energy exchange, the fresh water balance and ecosystem dynamics.
- Carry out studies of the ways of life, history, the culture and languages of the indigenous peoples, from both a national and circumarctic perspective.
- Supplement existing infrastructure with new infrastructure facilities to provide a better data base for research and management purposes.


Photo: Jonas Aars, Norwegian Polar Institute (detail)

data for understanding connections in ecosystem, environmental and climate research.

The Arctic and northern areas provide a unique opportunity for studies of the near space environment. A wide range of activities is already underway in the fields of space and aurora research in North Norway and on Svalbard, made possible as a result of significant investments in research infrastructure. This research is important for understanding the interactions between the solar wind and the Earth's atmosphere, involving magnetosphere-ionosphere interaction and energy transfer processes in the middle and upper layers of the polar atmosphere. This offers potential for the mapping and forecasting of ionospheric disturbances with possible implications for secure satellite navigation. It is important that a combination of ground-based observation platforms and rockets is used to study microscale processes in the middle and upper atmosphere.

Effective allocation of resources is also about ensuring access to infrastructure for teaching and research. The University Centre in Svalbard (UNIS) in Longyearbyen, the University of the Arctic and other research infrastructure in the north have much to gain from encouraging, social development and cultural exchange but will also need to solve some major challenges in this regard.

In addition to fixed onshore and offshore installations satellites are an important part of the international research infrastructure to which Norway has access. Long time series obtained from monitoring the climate, natural resources and the environment, such as satellite data from the data receiving stations on Svalbard, are essential for research activities.

Unique cultural conditions and social structures

The northern areas are home to several distinctive communities, comprising some 100 different groups of indigenous peoples spread across seven countries. The communication network is reasonably well developed and in some areas there is a very high concentration of research infrastructure. The region is characterised by its dispersed settlement patterns and small-scale urban structures. A number of important political borders run through the north: Norway is NATO's eastern border with Russia, and the northern border of the EU runs between Norway in the north-west and Russia in the north-east. The Svalbard Treaty recognised Norwegian sovereignty over the archipelago, but at the same time guaranteed the signatory powers certain rights. Moreover, the Schengen border separates Svalbard from mainland Norway.

Cultural research enhances understanding of how the various cultures "get along" and how they affect each other. Archeology and studies of folklore help to uncover information about past communities in the Arctic, which presents new opportunities for comparative studies across larger geographical areas. In language research topics of interest include studies of Arctic terminology that has been developed for survival in extreme natural conditions, and studies of how the Arctic languages influence each other.

Photo: Scanpix
Tromsø

6 International research cooperation

Increased international research cooperation is essential for implementing the measures and achieving the objectives outlined in the Research Strategy for the Arctic and Northern Areas.


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The white paper *Climate for Research* (Report No. 30 (2008–09) to the Storting) states that Norwegian research policy will contribute to the increased internationalisation of research. International cooperation is crucial for meeting research policy goals. Through international research cooperation we can deal with global challenges, increase the quality and capacity of Norwegian research, secure access for Norway to international knowledge production, enhance the competitiveness of trade and industry and promote Norway as a leading nation for research and innovation in selected areas. This entails strengthening international cooperation in priority areas and fields and with priority partner countries and regions.

The Research Council's Strategy on International Cooperation 2010-2020 will provide the basis for realising the objectives of international cooperation, in part by ensuring that all Research Council initiatives have clearly-defined objectives and plans for international cooperation.

The Arctic and northern areas are a highly international arena for research and as such provide a good basis for cultivating increased research cooperation across the entire range of relevant thematic areas between circumarctic countries and with other countries that have interests and research activities in the north. Key partners for Norway will be the US, Canada, Russia and the Nordic countries as well as China, India, Japan and South Korea. Another key objective of research on the northern areas is to strengthen cooperation within the framework of the EU.

Russia is a priority partner country for Norway

Norway has established extensive research cooperation with Russia both in the form of activities carried out under Research Council programmes and through research cooperation under the EU framework programmes that encompass collaboration with Russia. Research funding for European countries and Russia is made available through European research networks. Cooperation with Russia would be further strengthened by the signing of an agreement on research and technology between Norway and Russia.

Ensuring that both countries take part on an equal footing is an important principle for bilateral research cooperation with Russia. The Research Council promotes bilateral cooperation with research funding institutions in Russia aimed at the humanities, basic research and innovation. The Russian authorities are seeking closer integration into the world economy and are interested in a targeted research effort to meet the major challenges they are facing. This provides a constructive foundation for further developing research cooperation with Russia.

Measures and knowledge needs:

- Promote research cooperation with Arctic nations.
- Develop instruments that support long-term institutional cooperation between Norwegian institutions and corresponding institutions both in the Arctic states and elsewhere in the world.
- Design measures to enhance the qualifications of Norwegian researchers and companies in international and competitive arenas, not least within the EU.
- Increase the emphasis on international cooperation and mobility in the grant application assessment process.
- Open relevant research programmes to joint funding announcements in cooperation with other countries in order to strengthen international research cooperation.
- Promote multilateral cooperation with Russia through European research networks.
- Promote bilateral research cooperation with Russia and cooperation with Russian research funding institutions on the preparation of joint funding announcements.

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