ADAPTATION ACTIONS
FOR A CHANGING ARCTIC

BARENTS AREA

OVERVIEW REPORT

AMAP

> "Of course, I understand that it's the 21st century, computers, big cities, mobilization and so on. In this case, those who want to become a reindeer herder and live in the forest would be very few. But why does everyone think in clichés? We can perfectly combine our traditions and new traditions and new technologies, and not only combine, but also extract the maximum benefit from it."
>
> EALLIN workshop participant, quoted in EALLIN 2015

The following is a short description of what can be found in this overview report and the underlying AACA Science Report for the Barents area.

Describing the Barents area

The Barents study area in the AACA project is a diverse area covering parts of four countries. This sections describes the people living in the area, that is has a huge population compared to other Arctic regions and that parts of the Barents area is highly industrialized. This section also tells about the ecology of the area and that climatically it is heavily influenced by the sea.

Climate change in the Barents area

The report describes future climate conditions in the Barents area. It describes what can be expected of temperature rise, future extreme weather events and sea-level rise. The section also describes that change is already taking place and that adaptation to climate changes is a part of people's daily life.

Photo: Carl-Johan Utsi/carljohanutsi.com

Socio-economic drivers of change

The report considers the major demographic, economic, technological and political drivers and how they might affect the area in the medium to long term. It highlights resulting multiple and interacting changes that have impact on resilience of Barents communities by undermining their economic wellbeing, causing out-migration, reducing their ability to source food, increasing conflicts over land use or degrading the infrastructure they rely upon among other effects .

Laying the foundations for adaptation

The key elements for increasing adaptation capacity are presented in the report that can help inform decision makers in government, civil society, business and academia as they prepare to adapt to anticipated change in the Arctic. Examples of tools and methodologies that could be utilized to overcome uncertainty and knowledge gaps are available to help with development of adaptation strategies.

Concluding remarks

This section sums up the overview report. The section describes how multiple drivers of change affect the area and that adaptation strategies should therefore reflect a broader context than climate change alone. The implications of environmental and socio-economic changes will depend on the Barents area's natural and human resources, their institutional characteristics, and the policies adopted.

Introduction

In 2011, the Arctic Council requested the Arctic Monitoring and Assessment Programme (AMAP) to: "*produce information to assist local decision makers and stakeholders in three pilot regions in developing adaptation tools and strategies to better deal with climate change and other pertinent environmental stressors*".

Following significant interactions with both the Arctic science and decision-making communities, AMAP's response to this request led to the establishment of a new initiative called Adaptation Actions for a Changing Arctic (AACA). This initiative provides integrated stakeholder engagement and science-based information that can ultimately be synthesized and translated into knowledge that is useful and useable for making effective adaptation actions within a rapidly changing Arctic. Furthermore, the AACA is structured to promote stakeholder engagement, including participation from many different professional and public communities in the identification of the most relevant issues and challenges associated with a changing Arctic.

Three regions, Baffin Bay/Davis Strait, Barents and Bering-Chukchi-Beaufort, were chosen for an initial pilot phase. These three regions were chosen to provide a diverse range of socio-economic and ecological conditions, as well as to include as many Arctic Council nations as possible.

Each of the three regional reports provides a scientific assessment of the types and state of changes within the specific regions, along with a discussion of current levels of change, and the related impacts, effects and consequences of these changes, past, present and future.

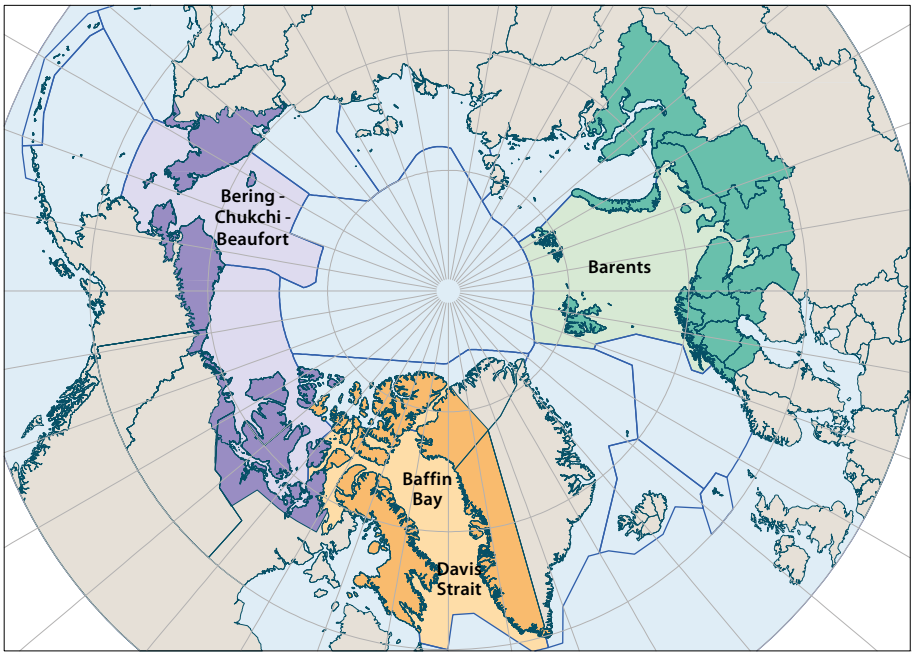

Figure 1: The three AACA pilot regions.

DEFINING ADAPTATION

The Intergovernmental Panel on Climate Change defines adaptation as: "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects".[1] For the purposes of this study, we also consider non-climate drivers of change.

This information, which combines scientific and available traditional and local knowledge, forms a knowledge base that can subsequently be used to better inform specific adaptation actions being taken by decision-makers. Thus, the AACA is truly an iterative process between the stakeholder, scientific, indigenous and local communities, focused on providing a sustained level of updated information for a diverse array of local, regional, national and international audiences.

This overview report is based upon the AACA science assessment for the Barents area. The study focuses

1 IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, pp. 117-130

on the diverse challenges that residents have experienced and the adaptations they have begun to plan and implement in response to the rapid changes in climate, landscape, wildlife, and social and economic systems that have occurred in recent decades and are expected in future. It considers the environmental and socio-economic changes to which inhabitants in the area are and will be adapting to, and provides a number of observations intended to help inform decision makers about how they might help their communities adapt to future changes.

It is important to note, however, that adaptation has its limits, both in the rate and the amplitude of change that can be accommodated. Our focus here on adaption actions and potentialities should not be construed to mean that adaptation is an effective substitute for mitigation of greenhouse gas emissions. The two processes must proceed in parallel. Mitigation actions at national and international levels will improve the chances of successful adaption to Arctic climate change by local/regional actors, by decreasing the rate of change to which ecosystems and human systems must adapt, and by eventually limiting the ultimate amplitude of that change.

The tufts of reindeer fur on her hood are from the ears of the reindeer she owns. Yamal, Russia

Peter Prokosch / www.grida.no/resources/3589. Murmansk, Russia

Describing the Barents Area

The Barents Region was defined in 1993 as an area of political cooperation between Norway, Sweden, Finland, and Russia, but, for the purposes of this report, it is extended northwards to include Svalbard and Franz Josef Land in the High Arctic, eastwards to incorporate Yamalo-Nenets, and includes the Barents Sea, to constitute the Barents study area (see figure 2).

The Barents Region is vast in size, but is inhabited by only some 5 million people, with an average population density of 2.9 inhabitants per square kilometer, although it also includes sizeable cities, including Murmansk and Archangelsk in Russia, Oulu in Finland and Umeå in Sweden. Its inhabitants include Swedes, Finns, Norwegians, Russians, and a number of Indigenous Peoples, Sámi (Norway, Sweden, Finland, northwestern Russia), Nenets (Nenets Autonomous Okrug, Nenets AO) and Veps (Karelia).

Compared with other Arctic regions, the Barents Region is a highly socio-economically and politically developed area that has relatively little in common with other Arctic areas in terms of development trajectories and overall societal integration. Given its size, complexity and history, the Barents study area covered by this report is not one region, but many – with highly varied socio-economic conditions and challenges.

Across most of the Barents area there has been a trend toward Indigenous self-determination. Sámi parliaments have been directly elected by Sámi since 1989 in Norway, 1993 in Sweden, and 1996 in Finland. In Russia, the interests of Indigenous Peoples are represented from the regional to federal level by the Russian Association of the Indigenous Peoples of the North (RAIPON), which was founded in 1990. RAIPON works with the State Duma and the Government of the Russian Federation on legislation related to Indigenous Peoples' issues.

Within the region, the population is generally aging and becoming more urbanized, especially among younger people. Employment statistics show a trend towards an urbanized workforce, with the secondary workforce sector – processing, production, and construction – accounting for most work in Fennoscandia and some

Russian areas. In the Nordic part of the area, the services sector is the largest employer.

In terms of primary sectors, forestry is important in northern Sweden, Finland and northwest Russia, while fishing and energy (mainly oil and gas) are important in northern Norway and northwestern Russia. The area is an important source of hydro-electricity, for both local use and for export outside the region. Mining is economically important in parts of each country. Tourism and reindeer husbandry are also important locally, although these are smaller activities. However in some areas, such as northern Finland, the sector is an important source of employment, and its importance is growing in other parts of the region. About 7 percent of the region's total work force is employed in agriculture, forestry, fishing and reindeer husbandry.

Ecologically, the Barents area largely comprises boreal forest known as taiga, which makes up 54 percent of the mainland area, with alpine and Arctic tundra accounting for 20 percent. Glaciers constitute about 4 percent of the land area. The area has abundant and wide-ranging freshwater ecosystems. Open wetlands cover about 14 percent of the area.

The taiga is relatively low in species richness, but many species can be found there for all or part of the year. These include reindeer, moose, red deer and roe deer. Smaller mammals include the mountain hare, and rodent species such as beaver, squirrel and voles. Predators include the Eurasian lynx, stoat, European otter, wolverine, gray wolf, red fox and brown bear. In the tundra, resident mammals and birds include the Arctic hare, Arctic fox and ptarmigan. It is also home to lemming and reindeer.

The Barents Sea hosts more than 200 species of fish, with capelin, polar cod and juvenile herring both

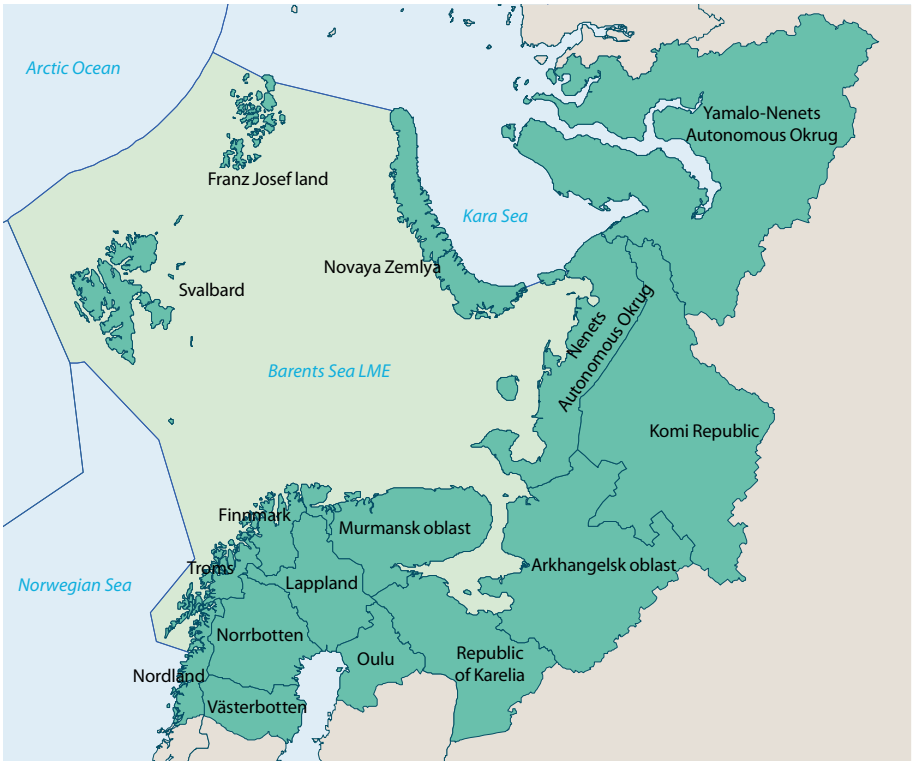

Figure 2: The Barents study area

abundant and commercially exploited, either now or in the past. The sea is also home to the most species-rich marine mammal community in the circumpolar Arctic, reflecting the rich seasonal productivity of the continental shelf area. The area also supports some of the largest concentrations of seabirds in the world.

Climatically, the area is heavily influenced by proximity to the sea and its high latitude, although the Gulf Stream makes it warmer than comparable circumpolar areas. It is a hot-spot in terms of warming, and climate change impacts on flora and fauna are already noticeable.

Climate change in the Barents area

The Arctic is warming faster than the rest of the globe, and is projected to continue to do so for some time to come. This warming is affiliated with significant climate change that will affect important physical processes, such as precipitation, snow cover, permafrost, extreme weather events, sea ice and ocean currents. These changes will interact with each other, and will be subject to large year-to-year variations, making understanding future impacts more challenging.

While global climate models offer a rough picture of local and regional characteristics, they have been scaled down to provide more useful estimates of future climatic conditions within the Barents study area.

Temperatures in the Barents area increased by an average of 1-2°C over the period 1954-2003, with stronger warming in winter. Under a mid-range scenario for emissions growth (RCP4.5, *see RCP definition on page 9*), average temperatures are forecasted to rise 3-10°C between 2010 and 2080, and by up to 20°C by the end of the century in winter.

Rising temperatures, and the reduction in sea ice (leading to increased evaporation) are forecast to lead to increases in **precipitation** of up to 50 percent in the Arctic, with more falling as rain as opposed to snow.

A combination of rising temperatures and changing patterns of snow fall is leading to reductions in the extent and depth of **permafrost**. The duration of snow cover is expected to be about 30-40 percent less in 2050 than in 2011.

DEFINING RCP

In the RCP-4.5 scenario (RCP= Representative Concentration Pathways), reductions in emissions lead to stabilization of greenhouse gas concentrations in the atmosphere by 2100 and a stabilized end-of-century global average temperature rise of 1.7–3.1°C above pre-industrial levels. RCP-8.5 is a high-emission business-as-usual scenario, leading to a global non-stabilized temperature rise of 3.8–6°C by 2100.

The timing of the spring flood has also changed, a result itself of the change in the timing of snowmelt. Ice formation on water ways has occurred progressively later in the year.

The effects of warming on **extreme weather** are hard to predict. It is unclear whether these changes will lead to more or fewer so-called synoptic storms, hazardous mid-latitude storms that bring high winds and waves, and which can disrupt transport and threaten infrastructure and human life. There are projected to be fewer polar lows – small and short-lived, but intense low-pressure systems – in Norwegian coastal waters, but more in the northern and central Barents area.

Rising temperatures will also affect the Barents Sea, the state of which is crucially important for weather and climate in the surrounding area. The Barents Sea is expected to become the first Arctic region free of **sea ice** all year round by mid-century. The declining extent and volume of sea ice will influence ocean temperature, salinity and density structure, with resulting effects on deep-water convection, global ocean circulation, weather and marine life.

Sea-level rise is expected to vary, depending on vertical uplift of land as ice sheets melt. Along the Norwegian coast, for example, sea-level projections vary by as much as 0.5m from place to place.

These changes will have profound and wide-ranging impacts on ecosystems and human societies. These include the northward shifts of marine and terrestrial species, and increased penetration of invasive species, pests and diseases. Barents food webs will be altered, while species relying on sea ice will be negatively affected.

Change is already taking place in the Arctic, and some of the impacts call for urgent action to address their effects. While adaptation has become a major new policy priority across the Arctic, it is also a normal part of everyday life. Unpredictability within harsh environments has long been the reality for Indigenous populations. The North Sámi have the concept of árvitmeahttun, which translates to English as "unexpected" or "unpredictable", and reflects Sámi perceptions of the world as characterized by emergence and manifestation.

Socio-economic drivers of change

Climate change is an important driver of societal change, but it is not the only important driver. The AACA pilot considers demographic, economic, technological and political changes that will affect the Barents area. These changes interact with climate change in complex ways.

The Barents area has always been influenced by global developments, whether through migration or trade. What is new today is the scale, scope and intensity of these external socio-economic linkages and interactions. While it is impossible to predict the future, the AACA report considers the major drivers facing the area, and how they might affect it in the medium to long term. Most projections extend to 2050, although any socio-economic projections beyond 15-25 years should be considered highly uncertain and thus need to be treated with caution.


Photo: iStock


Photo: iStock

Population trends

Demographic trends are easier to forecast than other factors, with population growth linked to rates of birth, death and migration, which tend to change slowly.

The main uncertainty in population trends is future immigration, which is difficult to estimate. Meanwhile, populations in these countries are ageing, implying a greater dependency ratio, with a relatively smaller working age population supporting a growing number of retirees. The age composition of the population and the ability to integrate immigrants will thus have large consequences for the economy, government expenditures and many aspects of social life in the Barents area countries.

Urbanization is also changing how people live in the area. In the four countries of the Barents area, a large proportion of the population already live in urban areas. In 2014, the share was 86 percent in Sweden, 84 percent in Finland, 80 percent in Norway, and 74 percent in the Russian Federation. By 2050, these shares are projected to increase.

Demographic developments are influenced by factors including economic disparities, reorganization of industries, people's aspirations and preferences, and public efforts to maintain settlement in the Arctic.

Within the Barents pilot study area in Sweden, population decline is projected for Norrbotten, but a moderate increase is forecast for Västerbotten, with most growth in Umeå. Finland projects population decline in Lapland and Kainuu, but population growth in North Ostrobothnia concentrated in the Oulo region. Under Statistics Norway's medium scenario, the counties of Finnmark, Troms and Nordland will all have a larger population in 2040 than in 2015 although, at 11 percent, the rate of growth will only be half of the national average. In northwest Russia, which has already seen more than a fifth of the population leave the area since the disintegration of the Soviet Union, further population decline of up to 15 percent, in the worst-case scenario, is projected by 2031.

Economic growth

The economic performance of the four Barents area countries will have a bearing on how they adapt to change in the years to come. The world economy is projected to grow at around 3 percent per year over the next 40 to 50 years, although the recent slowdown in China has seen more recent forecasts revised downwards. GDP growth will vary widely between countries and regions – and, according to projections from the OECD, the Barents area countries will see economic growth rates well below the world average. Nonetheless, all four countries will roughly double the size of their economies between 2015 and 2050, with the highest real GDP growth in Sweden (110 percent) and the lowest in Russia (93 percent).

In Norway, Sweden and Finland, per capita economic growth in the northern regions has traditionally lagged behind the respective national averages, due to less diverse industrial bases and lower labour market participation. In the Russian Federation, in contrast, the resource-rich northern regions have the highest GDP per head.

> Reindeer are the foundation of our life in the tundra. Thanks to our traditional knowledge accumulated over centuries while living in harmony with animals, the land and the climate, we Nenets have kept our traditional lifestyle of herding and thriving in the harsh climatic conditions of the Arctic, all the while our region is undergoing dramatic and in some cases, irreversible change.
>
> Igor Slepushkin, a Nenets reindeer herder from Yar-Sale, Yamal Nenets AO.

The future prospects of the Barents area, however, will depend to a large extent on the development of its extractive industries and the tax regimes and government expenditures that will be allocated to investment and infrastructure, etc. Some places may see boom (or bust) related to oil and gas, mining, fisheries, and shipping, but the most diversified centres, which are able to attract skilled people, have the largest growth potential.

Tourism has been labelled one of the four main drivers of economic growth in the Nordic countries. Growth in the Barents tourist industry will continue with an increasing emphasis on large cruise vessels and land-based summer and winter tourism. Tourism is an integral part of local economies, and has become an alternative source of income for many local communities.

Agriculture is important for the economic and social viability of rural areas and stronger liberalization of agricultural policy provide greater flexibility for farmers to change.

The fishery in the Barents Sea, and fishery-related activities and support industries, are also of significant economic importance. The future economic growth of the Barents fishing industry is dependent on factors such as management of the fish stocks and possible migration due to warmer waters.

Economic growth, and infrastructure development in particular, will have particular implications for Indigenous Peoples in the area, in that it could lead to fragmentation of land used for reindeer herding.

Technological innovation and development

Technology, too, will influence how people in the area respond to change. Technological change is taking place at an unprecedented speed, creating new products, materials, jobs, business models, and ways of living, learning and keeping healthy. It is also increasing global connectivity, reducing disadvantages related to distance and creating new economic opportunities. Technological development will also change how the public sector operates, allowing for the provision of health and social services by local communities in more cost-efficient ways. However, technological change also risks polarizing labour markets and destroying some low-skilled jobs.

The small, open Nordic economies have historically been quick to adapt to new economic and technological conditions. This has been possible due to a well-educated workforce, a constant upgrading of infrastructure, traditions of co-determination between workers and company owners, a high level of trust, and developed social security systems. Therefore, these countries are assumed to be well positioned to meet future technological upheavals and the challenges associated with the globalizing knowledge economy.

The Russian Federation represents a different socio-economic and political model. Depending on its future path of economic and political development, it will potentially face greater challenges in modernizing its economy and governance systems.

Also, new technology enables a higher level of automation and enhanced steering at a distance. New mega-projects may not necessarily go hand in hand with increased settlement in the area. Instead, workers can be flown in and out for a limited construction and operation period, as is already seen in several of the oil and gas projects in the Yamalo-Nenets Autonomous Okrug.

Demand for natural resources

A growing world population and economy will demand more natural resources, including those used for energy. Global energy demand is forecast to grow by one-third between 2013 and 2040. Fossil fuels are still expected to account for close to three quarters of primary energy supply by 2040, unless urgent action is taken to address climate change by moving to cleaner forms of energy generation. To put this in perspective, by 2050, the world is set to consume three times more natural resources, according to the UN Environment Programme.

All four countries of the Barents area have been eager to exploit their natural resources. Their Arctic strategies and policy statements emphasize that this must take place in a sustainable way, but the visions include large-scale oil and gas development, new mining, and the promotion of the Northern Sea Route as a major transcontinental shipping lane.

New technologies and a warming climate will improve accessibility, and – recent increases in East-West tensions notwithstanding – the region has benefited from political stability that is lacking in other resource-rich parts of the world.

The future development of natural resources in the north will depend on world market prices that are high enough to justify huge investments in an area with a harsh climate, limited infrastructure, and which is far from end markets. The end of the commodities boom, driven by Chinese demand, raises doubt over the outlook for resource extraction in the area, while the increasing penetration of renewable energy could significantly reduce demand for, and therefore prices of, fossil fuels.

Indeed, the area will remain an extremely challenging environment for extracting natural resources. A warming climate will thaw permafrost on which infrastructure has been built, melting ice can disrupt offshore activities and shipping, and more extreme weather risks damaging assets.

Global governance

International law and agreements influence the response to complex challenges, with the UN Convention on the Law of the Sea (UNCLOS) providing the basic legal framework for managing marine activities in the Arctic, while a number of conventions and treaties, ranging from international trade to Indigenous Peoples, apply to the area. The UN Framework Convention on Climate Change is becoming of great significance to the area, especially in the context of the 2015 Paris Agreement, which promises to accelerate global action to reduce emissions. Specifically, the EU and Norway have pledged to reduce greenhouse gas emissions by 40% below 1990 levels by 2030, while Russia has adopted a 25-30% reduction target.

Since the Cold War ended, the Barents area has seen increasing openness and collaboration, but is currently experiencing a more strained East-West relationship. The geopolitical climate affects the trust and cooperation among the Arctic states in all fields, including knowledge exchange and joint policies. This has consequences for the stability and prosperity of the Barents area.

Nonetheless, the countries in the region have shown their willingness to cooperate, abide by international legal frameworks, and develop new joint rules and regulations. These include two Arctic legally binding agreements, governing cooperation in maritime and aeronautical search and rescue, and cooperation in oil spill response; as well as rules governing fisheries in the central Arctic Ocean. In addition, under the Ilulissat Declaration of 2008, the five Arctic Ocean coastal states (Canada, the Kingdom of Denmark, Norway, Russia and the USA), declared that the law of the sea should form the basis for Arctic Ocean governance.

The implications for adaptation

As can be seen from the above, multiple interconnected factors are affecting people and the natural environment in the Barents area. These environmental, social and economic drivers are having impacts on food and water security, infrastructure, and the goods and services provided by the area's ecosystems.

These multiple and interacting changes may reduce the resilience of Barents communities, whether by undermining their economic wellbeing, causing out-migration, reducing their ability to source food, or degrading the infrastructure they rely upon. Health services face additional pressure from the northward expansion of some diseases, and increased exposure to contaminants. In addition, conflicts over land use will become more intense, as new activities, such as wind farm development, increased natural resource extraction, and traditional activities such as reindeer herding come into competition.

> The most important issue for Karelians and Vepsians is education, the teaching of national languages and their transmission to the next generations
>
> Alexey Tsykarev, United Nations Expert Mechanism on the Rights of Indigenous Peoples, Chair-Rapporteur, Petrozavodsk, Karelia

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Laying the foundations for adaptation

Adaptation to change is underway, at various scales, and taking various forms depending on resources, capacity and access to knowledge. The Barents area has significant human, social, infrastructural and biological resources to draw upon. However, there are wide variations in adaptive capacity, within countries, and between urban and rural communities. The capacity to adapt is dependent upon, for example, environmental and economic diversity, social and organizational networks and mobility.

The AACA reports contain a wealth of material that can help inform decision makers in government, civil society, business and academia as they prepare to adapt to anticipated change in the Arctic. The below presents key foundational elements that decision makers should consider in their work on adaptation: the initial six elements are intended to be information; the last four offer suggestions for action.

ECOSYSTEMS AND PEOPLE IN THE AREA FACE A COMPLEX, INTER-RELATED RANGE OF IMPACTS FROM CLIMATE AND OTHER DRIVERS

Communities in the Barents area are affected by interacting environmental and socio-economic changes. Some of these impacts will create new challenges, while others will present opportunities.

These impacts include changes to ecosystems and local ecology, and resulting environmental impacts on food production, reindeer herding, local livelihoods, tourism and the recreational use of nature.

Climate change presents opportunities for additional maritime activity, increasing access for tourism, shipping and commercial fishing. It is also likely to increase possibilities for natural resource extraction, although increased incidence of extreme weather, thawing permafrost, more frequent flooding and landslides and icing events all pose threats to the infrastructure on which such economic activities depend. In addition, resource development in the Arctic is dependent on market demand.

The AACA Barents area study also clearly showed that there are a range and variety of linkages between and within ecosystems across the regions, social and cultural attitudes and concerns, and socio-economic practices within an increasingly globalized world. These linkages are particularly important for those people in the Arctic who combine traditional subsistence lifestyles with access to the formal economy, but they are relevant for all those living and working in the area.

ADAPTATION ACTIONS MUST BE PLACED IN A BROADER CONTEXT THAN CLIMATE CHANGE ALONE

Climate change is not the only or always the most salient driver of change in the area; it interacts with socio-economic, political and cultural changes – and, in many cases, it exacerbates current challenges.

For example, for reindeer herders in the area, the direct effects of climate change are less important than restricted opportunities for adaptation, socio-economic challenges, and the cumulative effects of multiple impacts, including loss of land to other uses and limited influence in governance systems. In Norway, municipalities have relegated climate change below other more urgent responsibilities, while in the Kola Peninsula in Russia, the measurable effects of rising temperatures appear to be secondary issues compared with the challenges of population decline, a shrinking workforce and aging infrastructure.

In this context, there is concern over the relative powers of local governments and communities on the one hand, and national governments or corporate actors on the other. There is also concern about the degree to which Indigenous peoples' rights are respected, not least in relation to land use conflicts.

Adaptation in agriculture and forestry is primarily a response to changes in economic, structural and social factors, and to a lesser degree to climate change impacts. Currently, adaptation action is shaped by the local context of fewer jobs within the sectors, coupled with an increased focus on technological adaptations.

Adaptation to current and future changes must therefore be seen in terms of historical and traditional responses to weather and climate, in local contexts and with regard for existing governance structures.

ADAPTATION IS A PROCESS, NOT AN END IN ITSELF

The inevitable uncertainty about the future makes it necessary to consider adaptation as a strategy and a long-term process rather than an end in itself. Specifically, it should be considered as a social process, where responses are shaped by policy, culture and socio-economic factors.

While earlier approaches to adaptation tended to focus on technical responses to specific climate change impacts, adaptation approached as social process shifts attention towards the social actors and institutions that generate adaptation practices and actions. The long-term adaptive capacity of these actors and institutions needs to be enhanced, along three dimensions:

- Processes for learning: Building knowledge is an adaptation tool and a social process that involves actors with various world views and capacities to communicate their specific insights or values. Building knowledge for adaptation actions therefore requires processes and arenas for communication and sharing of insights. The integration of traditional, local and scientific knowledge is required to make adaptation decisions robust (see below).

- Holistic understanding: Adaptation planning needs to be cross-sectoral and holistic, although most adaptation work in the Barents area to date has been sector-based. Studies in Norwegian municipalities found that those that coordinated adaptation in a holistic and horizontal manner came to long-term decisions, while those that followed a more sectoral approach often resulted in shorter-term measures. Restructuring institutions to enable holistic adaptation planning should be considered a long-term priority to strengthen adaptive capacity.

- Conflict resolution: Different actors often have different preferences for adaptation actions. There can also be trade-offs between adaptation measures taken at different scales. For example, providing a licence for a mining company can generate jobs and tax revenue for the local municipality, but may restrict access to land that is necessary to allow other resource users, such as reindeer herders, to adapt. Successful adaptation requires the creation of cross-sectoral mechanisms to resolve conflict.

RESILIENCE SHOULD BE AN OBJECTIVE OF SUCCESSFUL ADAPTATION

The ability to respond to a range of future impacts – resilience – is ultimately the best guarantee that communities will be able to adapt to change in the Arctic.

The Arctic Resilience Interim Report defined resilience using what has largely become a standard working definition for research pertaining to social-ecological systems: as "the capacity of a system to absorb disturbances while retaining essentially the same function, structure, identity and feedbacks".

A focus on resilience involves viewing humans and nature as linked parts of the same complex socio-ecological system, which interact and feedback with each other. This is particularly compatible with human activities in the Arctic which, in contrast to much of the industrialized world, have traditionally been closely entwined with local ecosystems and continue to be so.

Building resilience requires: the assumption that change will take place; fostering sufficient diversity to enable effective responses; sustainable livelihoods; ongoing learning and knowledge development; and the capacity for self-organization.

Acknowledging change as the norm makes communities better equipped to manage change when it happens. Diversity – whether ecological, economic, social or in terms of knowledge – broadens the range of effective responses, as do the existence of sustainable livelihoods. Put another way, poverty is a non-resilient condition.

Change also requires that communities have the ability to build upon and modify existing knowledge, while communities also need to have sufficient control over their own affairs to adequately respond to change.

Another way of thinking about adaptation outcomes that support resilience is to consider their direct and indirect impacts on human security. Two aspects of human security that are important in the Arctic context are food security and health.

It is also important that tools are developed to assess whether adaptation actions taken today do not risk undermining the long-term ability of communities to adapt in the future.

INTEGRATING TRADITIONAL AND SCIENTIFIC KNOWLEDGE IS VITAL

An important aspect of communities' ability to adapt to change is diversity of knowledge about the environmental, social and economic conditions that Barents communities find themselves in, and how these are likely to be affected by change. Diversity in knowledge is strengthened when conventional science is combined with traditional and local knowledge.

Indigenous people observe changes to the climate at first hand, because of their close connections to an environment that provides subsistence and cultural and social identity. For successful adaptation of the Barents area to current and anticipated changes, traditional as well as scientific knowledge must serve as a background for understanding challenges and developing responses. In addition, tradition and local knowledge should be utilized in future planning steps and towards adaptation.

There are good examples of how knowledge forms can be combined, such as in the collaboration between researchers and reindeer herders. Such collaborative efforts require rethinking how issues are framed, to ensure they are relevant for all parties, for example by talking about weather phenomena rather than more abstract climate change. Participatory methods, that use narratives as a communication interface, can help overcome potential disconnects between experts and practitioners.

Access to relevant knowledge can affect the perceived need to adapt. Most climate-related information is produced at the national or international level. However, communities have called for specific tools and relevant information to help them identify key vulnerabilities and appropriate adaptive measures. These include regional maps, cost-benefit analysis of adaptation options, and statistical data. Understanding cumulative impacts and the future consequences of the drivers above would help local and regional decision makers plan future development and adaptation strategies.

Developing adaptation strategies using all available knowledge will ensure a more holistic approach, and one that offers security and a more predictable future for Indigenous societies in the Barents area. Engaging Indigenous communities and including their traditional knowledge in planning for adaptation action in the area is thus essential.

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TOOLS EXIST TO HELP DECISION MAKERS RESPOND TO UNCERTAINTY

While change is inevitable, its precise form and pace is difficult to accurately predict. It is not always possible to associate a given driver of change to perceived or documented consequences. There will also be complex cumulative impacts of different drivers. However, even in the face of this uncertainty, there are ways to explore what the future will look like.

For example, we have sufficient knowledge to assess climate-related changes over the next couple of decades, especially at the regional level. But it can be harder to make nearer-term predictions, or to forecast with any accuracy how global or regional trends will impact at the local level – such as how climate change will affect weather. It is also difficult to anticipate global economic development, market behaviour, political events, or technological advances.

However, uncertainty should not paralyse decision-making. Tools exist to help overcome the fact that we cannot know what the future will look like, but must nonetheless take decisions with long-term consequences. The AACA work has described these tools in some detail. They include:

Modelling the impacts of human induced pressures on ecosystems, such as with the GLOBIO3 model, which can help support decision-making around development and adaptation. It can be used to assess the integrated impacts on biodiversity from land-use change, infrastructure development, fragmentation, nitrogen deposition and climate change. In the Barents pilot study, it has been applied to Finnmark County, Norway, and Nenets AO, Russia, to gather information to raise awareness about the consequences of multiple drivers of change on Indigenous Peoples' societies. The Finnmark study found that, by 2030, the main drivers of biodiversity change will be climate change and plans for new infrastructure development. Meanwhile, the Nenets model run found potential for significant local impacts on biodiversity and traditional land use from prospective hydrocarbon and mining development.

As one example, forestry in the region faces a range of inter-related drivers and impacts. A changing climate will allow invasive species and pests to threaten forests, while longer growing seasons and the northwards expansion of forests will benefit the sector. Meanwhile, it is exposed to demand from international markets, technological developments, and the availability – or otherwise – of a local workforce.

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Scenarios, which allow us to consider different ideas of how current development paths might change, for better or for worse. Scenarios have been used extensively to explore future climate change and impacts in the Barents area, and they have been used to provide plausible information about how the climate may change based on different socio-economic forecasts. In recent years, climate scenarios have been developed at increasingly smaller scales. The AACA report provide examples of how explorative scenarios can be used for assessing the local and regional impacts of global trends. Explorative scenarios are simplified descriptions of how the future may develop, based on a set of assumptions.

Narratives are a communication tool that can help overcome an observed disconnect between experts and practitioners. Narratives, or story-lines, are internally consistent qualitative descriptions of how the future might develop, and they can help translate scientific data into a more comprehensible format, while also teasing out assumptions that may not initially be framed in scientific language. Narrative workshops organized as part of the AACA project showed the value of this approach, stressing the linkages of local adaptation to global developments and highlighted a need for better knowledge about social trends that are difficult to quantify.

Resilience indicators, which can help develop a better understanding of what factors contribute to resilience, and help decision-makers respond to complex issues around adaptation. They can help define baselines, assess the direction of change, and assess the effectiveness of policies. Establishing appropriate indicators is, however, challenging and can reflect existing biases. Indicators also, by definition, provide only a limited view of reality.

There is no single methodology or tool that can be used to address all types of issue. Instead, different approaches can be used to focus on different scales, human activities, specific places or systems, or on particular stressors or hazards. Similarly, methodologies can have different purposes, including for raising awareness of risks and opportunities, adaptation planning, or advancing scientific research, for example.

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The following are action-oriented statements based on the findings in the Barents regional science report.

UNDERSTANDING ADAPTATION OPTIONS REQUIRES AN ACKNOWLEDGEMENT OF BARRIERS AND LIMITS

General capacity to adapt does not automatically translate into successful adaptation to change, due to barriers and limits to action. These barriers can be expressed as an absence of the factors that support adaptation, but it is also important to understand the reasons behind the barriers and limits.

These include:

- **Motivation and the perceived need to adapt**
- **Motivation to act may be driven by impacts on economic outcomes, such as the effects of climate change on natural resource production. Conversely, some groups may perceive that they do not specifically need to adapt to climate change, because they have always adapted to change.**
- **Trade-offs between adaptation concerns and mandatory and more pressing tasks**
  Long-term concerns, such as climate change, are likely to be relegated to more immediate priorities, such as the provision of healthcare, education, etc.
- **Inadequate knowledge**
  Studies have shown a lack of available and relevant knowledge about future climate change and how it will affect communities or sectors.
- **Lack of resources**
  A limiting factor in the municipal sector is funding and time for municipal employees to integrate attention to adaptation in their daily practice.
- **Insufficient priority and guidance from national and regional authorities**
  Local decision makers expect guidance and support from above – climate change is not generally given sufficient attention at the national level.
- **Unclear responsibilities and insufficient frameworks**
  Successful adaptation requires a clear distribution of responsibilities of different actors, and clear and long-term funding. Generally, the lack of cross-sectoral measures is a concrete barrier to adaptation.
- **Ignoring traditional and local knowledge**
  Local and traditional knowledge play a significant role in developing efficient and relevant adaptation measures. Such knowledge has hitherto not been used in local adaptation plans in the Barents area.

STRENGTHENED GOVERNANCE IS NECESSARY TO MANAGE ADAPTATION PROCESSES

Adapting to the interlinked and cumulative changes faced by the Barents area poses a significant governance challenge, and more effective governance options and actions are needed.

Governance is required to steer adaptation processes. Governance tools include cooperation at the international, national, and regional levels, distribution of responsibility for adaptation, developing legal, regulatory and policy frameworks, producing handbooks and guidance, and facilitating networks and knowledge exchange. International cooperation across the Barents area appears to be particularly effective in developing adaptation strategies.

Climate change adaption should be integrated into existing policy and governance. Such 'mainstreaming' can help identify opportunities for adaptation. For effective governance of adaptation to take place, a clear distribution of responsibility for adaptation at different levels is necessary, and there is a need for conflict resolution mechanisms to mediate between actors with diverging priorities.

Adaptation governance also needs to take into account the decision-making power of the actors involved – an issue which was raised at several of the stakeholder workshops conducted as part of the AACA project. This relates to the relative power of various levels of government, local or Indigenous people, and corporations, not least in disputes over land-use.

A key message throughout the report is that adaptation planning must be cross-sectoral and holistic in its approach. However, most planning to date has been sectoral. Holistic approaches tend to lead to longer-term decisions. Co-management and ecosystem-based approaches to natural resource management are being tested, and have been found to strengthen the adaptive capacity of resource users. For example, the Norwegian-Russian fisheries co-management regime is credited as being one of the main reasons for the healthy state of Barents Sea fish stocks.

IT'S NECESSARY TO STRENGTHEN THE INTERFACE BETWEEN SCIENCE AND POLICY

For Indigenous Peoples, traditional knowledge, culture, and languages provide a foundation for adaptation processes. However, the rate and magnitude of current and future changes also requires better ways to incorporate both scientific and experience-based knowledge in ways that create holistic approaches and communicate across (sub) cultures.

Locally and regionally relevant and concrete knowledge, such as maps, statistics and databases, is needed at different levels to inform adaptation action, and to reframe adaptation as a meaningful and salient issue. However, developing effective adaptation policies requires consensual and usable knowledge. There are many knowledge producers and keepers in the area, with different resources to participate and influence discussions about appropriate adaptation plans, strategies and programs as well as with different perceptions, values and interests.

However, there is no direct, easy or simple way of transforming knowledge into action: knowledge is communicated and negotiated by various knowledge producers and keepers, through different media and used in different ways through often complex, somewhat unpredictable political processes, in changing political and economic situations, constraints and opportunities.

It is possible to develop guidelines, tailored to local conditions, to help support evidence-based local- to Arctic-wide adaptation policy. Such guidelines should begin with the needs of users, prioritize processes over products; link information producers and users; build connections across disciplines and organizations; stress the need for long-term stable support; and incorporate the needs for flexibility, adaptability, and learning from experience.

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MORE KNOWLEDGE IS NEEDED ABOUT CURRENT CONDITIONS AND HOW THEY MIGHT CHANGE

Adaptation to climate change takes place in the context of other changes and challenges in the Barents area. What we currently know and have gleaned from empirical research and observations is merely scratching the surfaced of the factors and processes that drive adaptation options. Greater knowledge and understanding is needed about current conditions, and how they might change in the future. Comprehensive, relevant and usable knowledge is needed to support social learning and the development of adaptation governance at different levels.

Adaptation occurs in the context of demography and economic diversity, conflicting interests, decision-making power and capacity, and access to salient knowledge. However, we do not have sufficient knowledge as to how climate change will interact with changing conditions.

Generally speaking, there remain significant gaps in knowledge on how to develop and apply climate- and socio-economic scenarios, singular and combined. Another aspect of impacts are the economic and societal costs of climate change damages, risk mitigation, and adaptation efforts versus no adaptation. This is essential knowledge for adaptation decision-making across nations, sectors, livelihoods, and here we can point to significant gaps.

Specific knowledge gaps include:

- How to incorporate research findings and assessments of climate risks and impacts into the sustainable development agendas of particular federation subjects in the Russian north;
- The effects of climate change on food production, particularly the development of crops that can thrive in a warmer climate but are also adapted to long summer nights;
- How urban development will affect local communities and how the increased migration of refugees will affect the demography of the area.

Given the role of governance tools in adaptation processes we need to develop our knowledge about the effectiveness of current adaptation processes, level of implementation, lessons learned, best management practices, and how to consider future adaptation measures.

Concluding remarks

The Arctic and the regions explored as part of the AACA project are complex systems undergoing rapid environmental and societal change. It is evident that climate change is an important driver of change, but it is not the only one. Adaptation strategies should therefore reflect a broader context than climate change alone. By integrating knowledge from many different fields of expertise, and across regions with large cultural diversity, multiple uses and users of local resources, and ambitious development plans for the future, AACA has broken new ground. Using a multidisciplinary approach, applying this across wide geographical and societal scales, and looking decades ahead has been a challenge.

Global warming, when seen in conjunction with changing socio-economic and political conditions, will have consequences for both Indigenous and non-Indigenous communities. Experts expect both direct and indirect impacts on livelihoods, primary industries, tourism, infrastructure, and public sector responsibilities such as flood prevention and health. The most significant trends that will require adaptation in the Barents include climate change, urbanization and unbalanced outmigration by gender from the rural areas. It is clear that the on-going and projected impacts will have consequences along a number of dimensions that will lead to both challenges and opportunities in the area.

The implications of environmental and socio-economic changes will depend on the Barents area's natural and human resources, their institutional characteristics, and the policies adopted. The Barents report has moved beyond an analysis that focuses on drivers of change and the impacts to which society has to adapt, and has emphasized adaptation as a social process. The report highlights the need for continuous learning in ways that can embrace complexity and lead to acceptable solutions across groups with diverging interests. According to the report, it is increasingly important to recognize the importance of natural resources and ecosystem services to strengthen resilience in both nature and society. Adaptation,

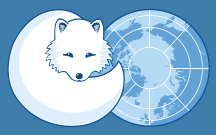
as a sustained social process, is best informed by both traditional and scientific knowledge and shaped by continuous cross-sectoral cooperation and policy integration.

There are a number of adaptation tools available to both decision makers and practitioners in the Barents area. These include modeling, scenarios, narratives and resilience indicators. The tools provide insight from different perspectives and can have different but mutually dependent purposes, such as advancing scientific research, adaptation planning and raising awareness of risks and opportunities.

However, there are barriers and limitations that the Barents area will have to overcome. Today adaptation in the area is challenging due to abstract and general knowledge on climate change, sectoral and fragmented approaches to adaptation and limited local decision-making power. On the one hand, the Barents report identifies many of these barriers, and at the other hand underlines the value of understanding the barriers as a way forward. The report also stresses that uncertainty does not preclude action, it should inform actions.

This study has shown that building shared knowledge and understanding of cumulative and cascading impacts is key to developing effective policy responses. However, as this has been a pilot project not all aspects of science to knowledge to decision-makers have been addressed. An even closer connection between scientists, Indigenous peoples and other decision-makers are needed. Adaptation to change, and building adaptive capacity and resilience, is an evolving and dynamic process, constantly responding to an increasing knowledge base as well as to the actual or expected effects of change. It is a learning process, in which the Arctic Council and its working groups can play a constructive role in future years.

This document presents a summary overview of the scientific report detailing the results of the Adaptation Actions for a Changing Arctic (AACA) – Barents regional pilot study coordinated by AMAP. More detailed information on the results can be found in the AACA 2017 science reports.
For more information, contact the AMAP Secretariat.



ARCTIC COUNCIL

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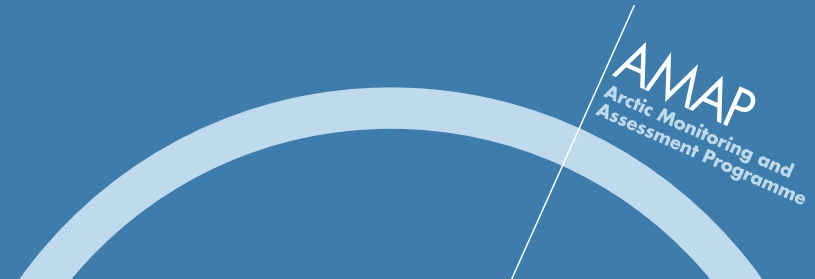

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