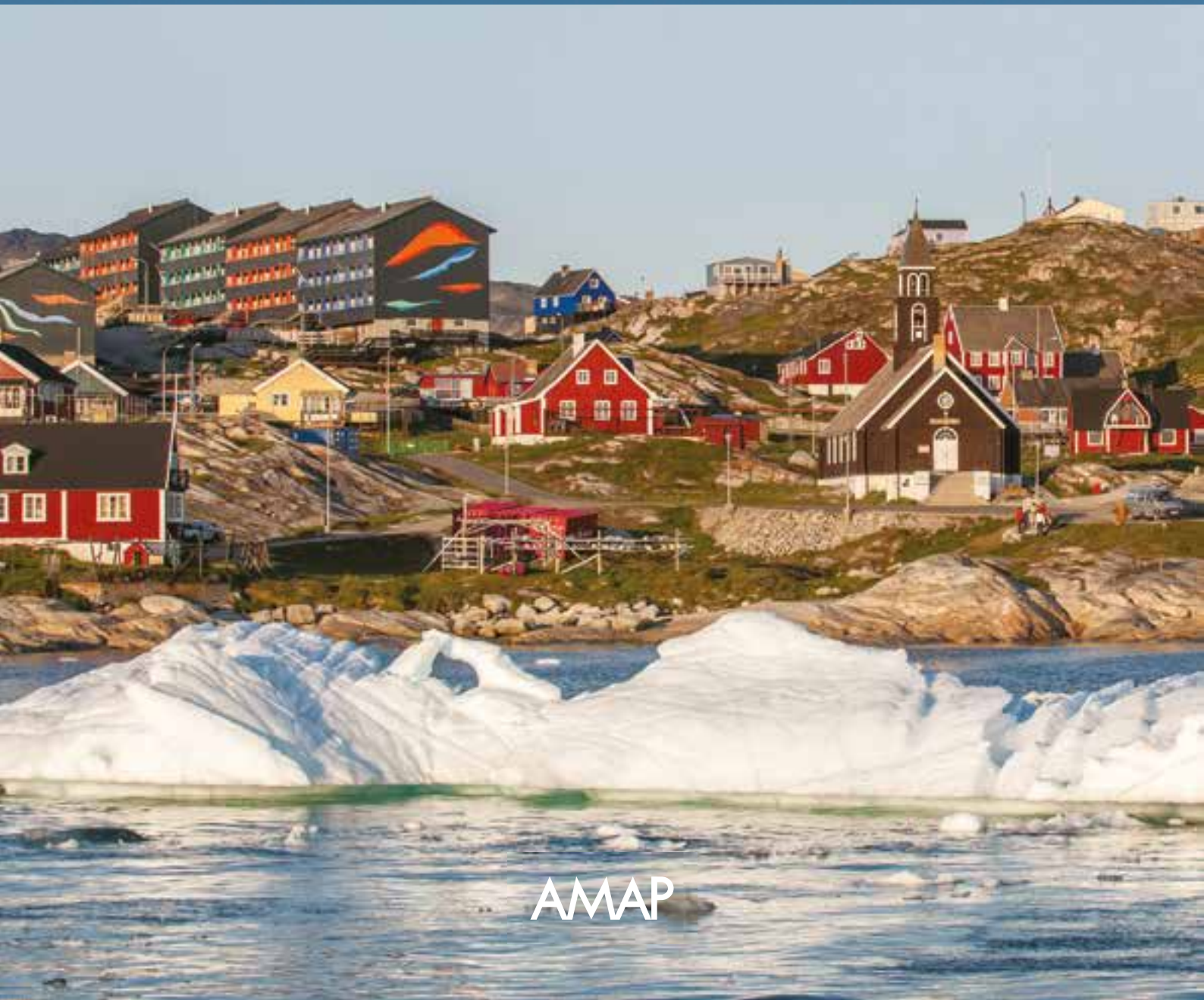




ADAPTATION ACTIONS
FOR A CHANGING ARCTIC

BAFFIN BAY / DAVIS STRAIT REGION

OVERVIEW REPORT



AMAP



The following is a short description of what can be found in this overview report and the underlying AACA science report for the Baffin Bay/Davis Strait (BBDS) region.

Describing the BBDS region

The BBDS region includes parts of Nunavut, which is a territory in Canada and the western part of Greenland, an autonomous part of the Kingdom of Denmark. These two land areas are separated by the Baffin Bay to the north and Davis Strait to the south. The report describes the entire region including the significant differences that are found within the region; in the natural environment and in political, social and socioeconomic aspects.

Climate change in the BBDS

This section describes future climate conditions in the BBDS region based on multi-model assessments for the region. It describes what can be expected of temperature rise, future precipitation, wind speed, snow cover, ice sheets and lake ice formations. Further it describes expected sea-surface temperatures, changing sea-levels and projections for permafrost thawing.



Socio-economic conditions

This section gives an overview of socio-economic conditions in the BBDS region including the economy, demographic trends, the urbanization and the infrastructure in the region. The report shows that the Greenland and the Canadian side of the region have different socio-economic starting points about how to adapt to future development.

The impacts of change

Environmental changes and socio-economic factors will have profound impacts on people living in the BBDS region, which will interact with each other in ways that will be complex and difficult to anticipate. The report describes such impacts for seven themes; human health, education, non-living resources, living resources, tourism, shipping and infrastructure.

Laying the foundations for adaptation

The report contains a wealth of material to assist decision-makers to develop tools and strategies to adapt to future changes. This section lists a number of overarching informative and action-oriented elements for adaptation and the science report gives more detailed information.

Concluding remarks

This section sums up and describes point to the fact that adaptation is a complex issue and strategies to meet the future need to reflect a broader context than climate change alone. The report points to essential factors for adaptation and the relative importance of these will vary depending on scale and context.

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.

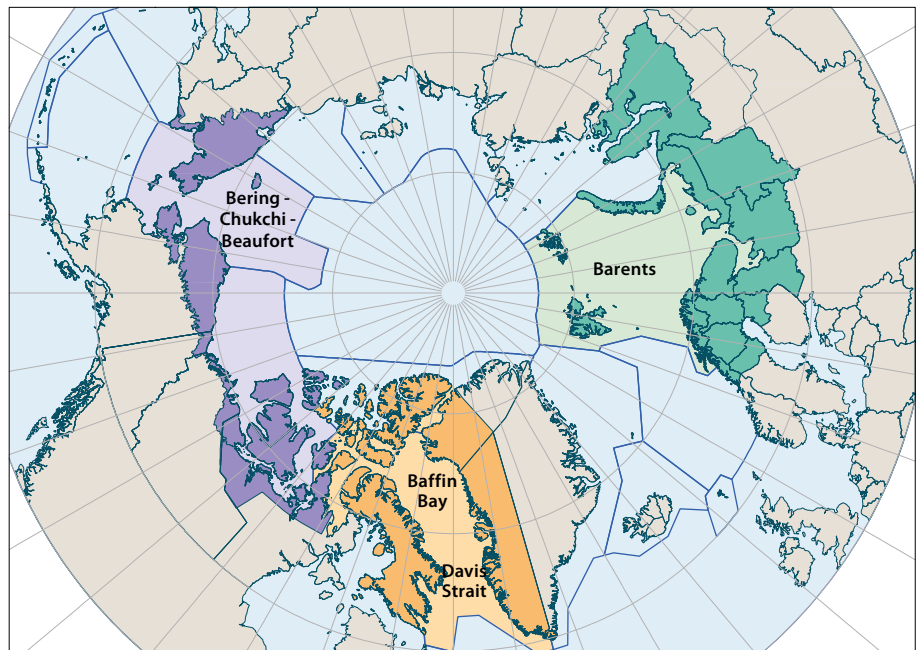


Figure 1: The three AACA pilot regions.

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 be used to better inform adaptation actions being taken by the 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 scientific assessment for the Baffin Bay/Davis Strait (BBDS) region.

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

Difficulties in finding the most appropriate actions to respond to climate change are compounded by the fact that climate is not the only driver of change in the region. A common feature is the need to build flexibility and adjust to increasing variability and new extremes – considering the cumulative impacts of weather or/and other socio-economic drivers.

Based on dialogue with stakeholders in the region, including representatives of the public and private sectors, and residents in both Greenland and Canada, seven themes were chosen for analysis: Living resources; Non-living resources (such as mineral extraction); Education; Human health and well-being; Tourism; Shipping and Infrastructure. For each of the themes, the authors considered the current knowledge regarding climate change and other stressors, and described potential options for future planning and actions.

It is important to note, however, that adaptation has its limits, both in the rate and the amplitude of change that can be accommodated. Mitigation actions at national and international levels will improve the chances of successful adaptation 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. While acknowledging the importance of continued climate change mitigation efforts, the emphasis of AACA is on identifying adaption options.



Shutterstock / Disko Bay, Greenland



Lawrence Hislop / www.grida.no/resources/1087. Uummannaq, Greenland

Describing the Baffin Bay/ Davis Strait Region

The Baffin Bay/Davis Strait (BBDS) region includes most of the Qikiqtaaluk administrative region in the eastern part of Nunavut, which is a territory in Canada and the western part of Greenland, an autonomous part of the Kingdom of Denmark. Between these land areas are Baffin Bay to the north and Davis Strait to the south. Although the entire BBDS region is inside the Arctic climate zone, significant differences are found within the region; in the natural environment and in political, social and socioeconomic aspects.

While Nunavut and Greenland share a range of qualitatively similar challenges, they must also engage in adaptation actions from two very different points of departure. Most notably there are important differences in terms of demography, distribution of population, migration, degree of industrialization and infrastructure that mean that Greenland and Nunavut may have different adaptation priorities.

The majority of the population of the BBDS is Inuit. The Greenlandic population in the region is approximately 52,500, more than twice the population of the Nunavut side, of around 19,500. With approximately 17,000 inhabitants Nuuk, the capital of Greenland, is double the size of Iqaluit, the largest town in Nunavut, with approximately 7,500 inhabitants. The population on the Nunavut side is also distributed among far fewer communities (nine) compared with the Greenlandic side (64 towns and settlements).

On the Greenland side, open water south of Disko Bay (usually with unconsolidated ice), a productive ecosystem, and deep-water ports, allow for an intensive fishery, carried out both with modern trawlers in the offshore waters and smaller boats and dinghies in the inshore parts. This industry has been the main vehicle of a comprehensive industrialization that has transformed Greenlandic society dramatically since the 1960s. However, it does not sustain the entire Greenlandic economy and a primary concern for the Greenlandic self-government is how to ensure current standards of modern welfare and further economic growth and independence – e.g. by means of economic diversification.

On the Nunavut side, marine resources are generally exploited on a subsistence harvest basis, and mining plays a large role, constituting 18% of Nunavut's gross domestic product in 2014. Employment is largely provided by the Federal and Territorial governments, tourism and mineral exploration. Traditional



have access to a more developed air- and sea-based transport and communication infrastructure.

Nunavut's Qikiqtaaluk Region offers primary, secondary and post-secondary education, but there is no university in the Canadian Arctic. School graduation rates in Nunavut are slowly improving but, at 57 per cent, remain the lowest in Canada. Greenland offers a range of secondary, college and university education, and the trend here is also towards improved levels of education; the number of Greenlandic youth with a completed education above primary school has increased by 6 percent to around 15,000 persons, (or 34 per cent of the population) from 2003 to 2013

activities such as hunting, trapping, fishing and gathering, as well as arts and crafts, are important for providing households with food, income and a connection with the environment.

Infrastructure is a shared challenge throughout the region. But towns, settlements and businesses in the Greenlandic part of the region benefit from a stronger starting point as they

The Baffin Bay Davis Strait region is largely made up of mountains and open tundra, with sparse vegetation. The Nunavut side is classified as continuous permafrost, while the Greenlandic side is considerably warmer, meaning that the ground in the south is mainly seasonally frozen or discontinuous permafrost, while there is continuous permafrost further north.

The differences in the natural environment are mainly governed by the sea surface currents, which brings relatively warm water from the Atlantic up along the West Greenland coast. This has a profound influence on the sea ice conditions, where a large part of West Greenland remains ice free or without consolidated ice throughout the year allowing navigation even in winter. In contrast to this, the Nunavut side is blocked by sea ice often until mid-summer.

Terrestrial mammals on the Greenland side of the region include fox, hare, and caribou. Wolves, stoats, muskoxen and lemming are also found in the northernmost part of the region. On the Canadian side, the number of mammal species is higher, with the occurrence of an additional species of lemming, the wolverine *Gulo gulo*, and seven distinct caribou herds.

The marine environment supports one of the most productive food webs in the Arctic, where upwelling along the continental shelf break on the Greenland side brings water and nutrients from the deeper layers to the surface. This attracts marine mammals and millions of seabirds. The marine fauna is characterized by relatively few but well-adapted species, including seals. The benthic fauna is an exception as the number of species is very high. The regional circulation of ocean currents has a profound influence on the coastal climate, helping to create milder, low-Arctic conditions along the West Greenland coast.

The marine environment is also characterized by a number of polynyas. These are geographically fixed areas of year-round open water surrounded by sea ice. These create refuges for marine mammals and birds, and allow primary production to begin earlier in spring than in ice-covered water. Because of year-round open water and abundance of marine mammals, the BBDS is attractive to Inuit hunters.



Figure 2: The BBDS study area

Socio-economic conditions

The ability of people within the BBDS region to adapt to the effects of change depends both on the magnitude and speed of the environmental changes they face as well as on socio-economic factors, some of which will, in turn, be influenced by climate change.

Foremost among them is the **economy**, which is challenging in the BBDS region. After strong growth in the 2000s, Greenland's economy dipped between 2011 and 2012, and was flat over 2012-14, before growing slightly in 2015-16. Prospects beyond the existing fisheries-based economy are uncertain. Declines in global commodity markets means that earlier optimism about the prospects for the oil and mining sectors is fading, although there are several licensing rounds and mining projects underway. There is scope for increasing value added in fisheries and tourism, but these activities are not likely in themselves to have a decisive growth impact unless challenges to tourism development are overcome.

The Greenland economy is based primarily on fishing, supplemented by tourism and mineral extraction (totalling approximately 3 billion DKK), and the balance supported by a block grant from Denmark, (of 3.64 billion DKK), with earned income.

Nunavut's economy grew between 2011 and 2014, before shrinking in 2014-15. It is expected to embark upon a prolonged period of economic growth, driven by fisheries and tourism. Mining offers potential for major capital investment, while infrastructure projects are also set to be a major contributor to growth.

Economic factors will also weigh on **demographic trends** in the region. Where birth rates are high In Greenland, net outmigration has kept the population somewhat constant, while in Nunavut, high birth rates are likely to continue the Nunavut trend towards a young and rapidly growing population.

Two factors could lead to population inflows: resource development and, for Nunavut, devolution of government institutions. Both would likely lead to more non-Inuit moving to the region. However, in the resource extraction sector, common practice on the Canadian side is to fly workers in and out, leading to limited permanent immigration of labor (but also less local economic benefit). Greenland also plans to fly in workers for its developing mining industry.

Socioeconomic impacts related to mineral resource development in the region are regulated in accordance with best international practice, and are therefore addressed in social impact assessments prior to major activities taken place. In addition, impact benefit agreements are negotiated between the mining company, the government and the local municipality(ies) in order to agree on concrete targets related to local involvement, procurement, education and other socio-cultural matters, etc.





Photo: Peter Prokosch / www.grida.no/resources/4473. Pond Inlet, Canada

Other demographic factors are also at work, including **urbanization**. Iqaluit, the capital of Nunavut, has seen its population steadily grow (by 8.3% between 2006 and 2011 according to Statistics Canada) and this trend is likely to continue. In Greenland, Nuuk, the capital, has seen a similar pattern, with its population growing 12% between 2010 and 2016, although the number of people living in settlements and small towns has declined by almost one third since 1999.

Meanwhile, **connectivity** with the rest of the world influences both economic opportunity and social outcomes. The Canadian side of the BBDS is poorly connected to the rest of the world, with no deep-sea port, and only one regional airport able to accommodate the types of jet typically used for international flights. Mobile phone service is limited, and Internet access is via satellite, and can be very slow and unreliable. Internet access could become much faster in parts of the Qikiqtaaluk region if the Arctic Fibre project – an underwater fibre optic cable that will eventually run from Japan to the UK – proceeds according to plan.

Nunavut has a development strategy to improve its transportation network, so connectedness is expected to improve in Nunavut in the coming years. The strategy

identifies key actions such as improving air links, developing strategic deep-water ports, connecting communities to resources and responding to the effects of climate change that will facilitate access to economic opportunities and put Nunavut on an equal footing with the rest of Canada.

Greenland is seeing steadily improving connectedness. The transportation infrastructure is relatively well developed with, currently, two international airports, a network of domestic airports expanding to most towns, ports in all major towns and seasonal passenger vessels connecting Southwest Greenland towns. A port authority is planned to represent 13 ports, including Nuuk, Aasiaat, and Sisimiut, facilitating industry and the transportation of goods. In 2009, the cities of Nuuk and Qaqortoq were connected to the Internet through a fiber cable running to Iceland and Canada. The remainder of the west coast is connected to the Internet through a 1410 km chain of radio stations and the east coast and northern part of the Greenlandic west coast is connected via satellite. Even many isolated households have satellite-based internet.

Climate change in the Baffin Bay/Davis Strait Region

The residents of the BBDS region are living through a period of profound change in the Arctic. Regional and global climate projections show that future changes will continue to pose significant risks, challenges, and opportunities to the health and well-being of both humans and ecosystems. Synthesizing the understanding of the changes in the Arctic climate with other changes in society and the environment informs the range of possible futures, choices, and actions available to decision-makers of the BBDS region.

The Earth's climate is warming due to anthropogenic greenhouse gas emissions and will continue to do so throughout the century. In common with other parts of the Arctic, the climate of the BBDS is undergoing rapid change. Recent and continuing rises in temperature are driving significant impacts and effects to the Arctic cryosphere and oceans, which is in turn having consequences on ecosystems and the region's human inhabitants.

The climate projections for the BBDS region are generally based on multi-model assessments for the entire BBDS region. In addition to this, both parts of the region have produced regional climate data sets, specifically a report for Greenland based on downscaling with the Danish Meteorological Institute climate model system, and the Ouranos CRCM. However, the climate data sets for Greenland and the Canadian side are somewhat different and therefore difficult to compare.

Under two different emissions scenarios (the baseline RCP4.5 and the high-emissions RCP8.5 scenarios defined by the Intergovernmental Panel on Climate Change), BBDS mean near-surface **air temperatures** are projected to increase in winter by about 1 to 4 °C by 2030 and 1.5 to 10°C by 2080. Summer air temperatures are projected to increase 0.5 to 2 °C by 2030 and 1 to 5 °C by 2080. Under high emission scenarios (RCP 8.5), the length of the thawing season is forecast to increase by about 1 to 2 months by the end of the century.

Projections of **total precipitation** (i.e. rain and snow) show an increase over most areas, with the largest relative changes in winter in the northwestern parts of the region.

It is difficult to reach clear conclusions about **wind speed** trends in the BBDS region; adaptation plans should consider ± 5% changes in mean wind speed for the period 2016-35, and ± 10% changes for 2080-99.

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.

Higher temperatures will lead to later snowfall, reducing the number of days of **snow cover** by the end of the 21st century between 40 and 60 days, with reductions more pronounced in coastal areas.

Maximum **snow depths** on the Canadian side of the BBDS have decreased by an average of 20% since 1950.

Permafrost is projected to warm the most in the coldest areas of the BBDS region, and to thaw considerably in warmer areas such as southwestern Greenland.

Ice sheets in the region are projected to lose mass in the 21st century, with increased melt run-off expected to double or triple in amount and thus outweighing the effects of any potential increase in snowfall.

Projections from current climate models indicate **lake ice** will form 5-10 days later by 2050, and break-up will occur 10-15 days earlier compared with the late 20th Century.

The **sea-surface temperature** in the Baffin Bay is expected to warm by about 0.2°C per decade over the next 50 years, and will become less saline as a result of increased precipitation and ice melt run-off. This is expected to reduce convection depth in winter and increase stability during the ice-free months. The largest reductions in sea ice cover (15-20% by 2080) are expected during fall and are related to later freeze-up, while a decrease in sea ice cover of 10-15% is expected in spring due to earlier break-up. Winter ice thickness is projected to decrease by around 20-30cm during this century, with the largest decreases in more northerly regions.

Globally, **sea-levels** are expected to rise by 36 to 71cm this century under the baseline scenario (RCP4.5), but in the BBDS region, they are likely to fall, with a range of +10 to -90cm. This is due to a combination of the decreased gravitational pull of a shrunken ice sheet, and 'crustal uplift', as the land rises as the weight of the ice sheet diminishes.

The overall picture for the BBDS over the next century shows some general trends: the atmosphere will be warmer and wetter with uncertain changes to the winds; the snow cover period will be shortened, with decreased snow depth, while the melting of ice sheets is expected to continue; sea ice will continue to decrease substantially; and changes in ocean circulation and mixing are uncertain, but sea level will fall regionally (but rise globally). There is a significant range of possible conditions and related effects owing to both uncertainty in what scenario will most closely approximate actual future global emissions as well as uncertainties in the models and their outputs. Adaptation planning will need to continue to account for these uncertainties and the related range of plausible future conditions.



The impacts of change

Environmental changes and socio-economic factors will have profound impacts on people living in the BBDS region, and which will interact with each other in ways that will be complex and difficult to anticipate. Based upon feedback from stakeholders, the BBDS regional report focused on seven themes: human health; education; non-living resources; living resources; tourism; shipping; and infrastructure.

Health impacts

The health impacts of climate change will be direct, resulting from changes in temperatures and/or extreme climate events, or they may be indirect, resulting from how climate change affects livelihoods, infrastructure, wildlife and bacteria and viruses. Direct risks include new vector-borne diseases, an appearance of diseases such as tetanus that are not currently a problem in the Arctic, and the declining quality of surface water causing problems for drinking water provision in some parts of the Arctic.

Changes to precipitation patterns and to the timing of snowmelt will create challenges for water management. For example, the Geraldine Lake reservoir system, which supplies Iqaluit and which is already stressed, will be highly sensitive to changes in spring run-off and timing. Warming may also worsen water quality in residential storage tanks in Nunavut.

Education

The impacts from climate change on education will be predominantly indirect. These indirect impacts include increased outmigration from small communities, and impacts on traditional and local learning and traditional values, which are closely connected to hunting, fishing and gathering activities that are becoming more challenging as a result of climate change. Development may also have negative impacts on traditional and local learning, if knowledge holders are increasingly employed in situations that regularly take them away from community and family.

The evolving economy of the region is also impacting on the education system in the BBDS. In Greenland, for example, educational institutions are making efforts to adapt to climate-related drivers by offering new educational programs in areas such as natural resources, tourism, etc. to support sectors that that might benefit from a changing climate.

Non-living resources

Of most impact on the potential for mining and oil and gas extraction in the BBDS will be developments in

global commodity markets, with high prices encouraging development in frontier areas. Regarding oil and gas development, current low prices and high infrastructure costs make development in the near future unlikely, although it remains a long-term goal for Greenland. A number of mining projects in Greenland have reached a stage where permitting has been granted and, in Nunavut, mining is seen as a key part of its future development.

Within this context, a warming climate may facilitate development as a result of improved shipping access, fewer days of extreme cold, and glacier retreat allowing for prospecting. In turn, the development of these industries could promote related economic development, further driving socio-economic and environmental change in the BBDS region.

Climate change would also, however, have negative impacts on resource development. Increased extreme weather events, the effects of permafrost thaw on existing and planned infrastructure, reduced availability of winter ice roads, and changing precipitation regimes affecting water management would all pose challenges for extractive industries in the region.

Living resources

Climate change has wide-ranging implications for terrestrial and marine wildlife resources. Observed impacts to date have been mostly negative, relating to reduced availability or accessibility of traditionally harvested resources. However, benefits of climate change have also been noted, including expanding open waters and new fisheries opportunities, and increasing abundance and availability of some marine mammals.

These benefits may be short-lived, depending on future changes to ecosystems as a result of continuing climate change.

Industrial activities may also add stress to Arctic species. Increased underwater noise can disturb the migration of marine mammals and affect their health due to increased levels of stress, while, if not properly regulated, contaminants released from mining can

affect locally harvested foods. Industrial developments can also directly conflict with harvesting activities. However, long-range pollution from the industrialized world, especially mercury, is the most significant pollution threat at present to locally harvested foods in the region.

The management of living resources within the BBDS will be a significant mediator of the impacts of climate change, in that it will enable economic opportunities to be seized that will offset some of the negative effects of change, benefitting local communities and the Greenlandic and Nunavut economies at large.

Tourism

As with resource extraction, the development of tourism within the BBDS region will be dictated by the strength of the global economy, and demand for the sort of tourism available in the region. Sea-ice retreat has already enabled rapid growth in marine tourism, and a niche market in 'last chance' tourism is developing.

However, negative impacts include risks involved with the industry expanding into largely uncharted regions, with associated dangers of accidents occurring. The absence of a central authority for governing the cruise ship industry, a lack of guidelines for operations, other logistical and financial barriers, and environmental challenges may also limit the sector's growth.

On the other hand, new regulation, namely the IMO Polar Code entered into force in 2017. Access to the National Park in Northeast Greenland and access to the inland ice is already regulated. Further to this, activities related to tourism in Greenland are regulated in accordance with new tourism concession legislation focusing on local involvement and socioeconomic aspects. Supporting infrastructure is under development, with the construction of a new deep-water harbor in Nuuk and international airports planned at Nuuk and Ilulissat.

Shipping

Less sea ice in the region is extending the navigable season for shipping, creating opportunities for new shipping routes, increasing accessibility for larger fishing and cruise ships, and increasing the viability of northern ports. These changes have the potential to facilitate mining and oil and gas development by reducing shipping costs and improving accessibility, and could provide opportunities for economic development in BBDS communities, as well as improving the ability of delivering supplies, especially in Nunavut where the seasonal sealift is the main access-route with a limited ice free window for operation.

Although changing sea-ice extent is recognised as a driver for future shipping, it is a relatively minor determinant of change compared to industry and market constraints, as well as geopolitics, including the deepening of the Panama Canal (in 2016) and of the Suez Canal (deepening in 2009, doubling in 2016).

Again, increased marine traffic will increase risks to ships from ice and other marine hazards, although, on the Greenland side, pilotage is requested for ships with more than 250 passages. The associated noise and pollution will also add to stresses faced by ecosystems in the region.

Infrastructure

The impacts on housing, municipal and industrial building, and transport infrastructure in the region will mainly be from permafrost thaw, changing patterns of precipitation, and increased incidence of extreme weather, for example the effects of more frequent ice storms on electrical wires. Coastal erosion and changes in sea level also are likely to impact infrastructure in the region, and falling relative sea levels caused by reduced icecap mass could potentially leave ports stranded.



Photo: Knud Falk / Qassiarsuk, South Greenland



Laying the foundations for adaptation

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 following presents key foundational elements that decision makers should consider in their work on adaptation: the initial five elements are intended to be informational; the last five offer suggestions for action.

HOW ADAPTATION CAN BE INTEGRATED INTO DECISION MAKING IN THE BBDS REGION, SHOULD BE ENHANCED

Despite increasing recognition of the need to adapt to change in the region, knowledge about adaptation, and how adaptation can be integrated or mainstreamed into policy making and practical planning remains limited. There is also a need for more 'usable' knowledge on how to adapt, and limited research exploring and prioritizing response options.

Adaptation options cross scales, from personal and household decisions, to community/local, national and international levels, with actions at one level often influenced, constrained, or enabled by developments on other scales.

Much of the recent thinking on adaptation has been climate-focused, that is, designed to address direct, predictable and significant impacts of climate change, such as protecting buildings from permafrost thaw. However, it is increasingly recognized that, for adaptation to be effective, responses needed to target other drivers of



Photo: Knud Falk / Nuuk, Greenland

PEOPLE IN THE BBDS REGION ARE VULNERABLE TO CLIMATE CHANGE

Climate change presents opportunities for people in the BBDS region, such as new fisheries, increasing abundance of some sea mammals, improved access to mineral resources, increased tourism, and improved regional connectivity through increased shipping. If exploited, as Greenland's fishing fleet is doing with new harvestable resources, these opportunities could increase the capacity of communities to adapt to climate change.

However, working against this are underlying social, cultural and economic factors that make people vulnerable to climate-related risks.

Indicators of wellbeing in the BBDS region are typically lower than those in non-Arctic regions of Canada and Denmark: Nunavut, for example, has the highest documented rate of food insecurity in Canada. A 2014 study found that 11% of schoolchildren in Greenland often or always go to bed hungry. The region has high rates of premature death, disease and accident, and health systems do not have sufficient capacity to respond to existing and emerging health problems.

BBDS communities face high rates of poverty, and access to housing is well below non-Arctic populations. Small Arctic communities in the region also experience high levels of livelihood insecurity, where changes in global markets, or policy developments from outside the region can have major impacts on employment.

Efforts to reduce vulnerability and enhance adaptive capacity therefore need to be built into policy initiatives around human development, poverty alleviation, and livelihood security.

change, including social-economic-demographic conditions and development trajectories. Such a 'vulnerability-focused' approach seeks to build capacity to adapt and promote resilience.

However, few studies to date explicitly incorporate projections of how socio-economic-demographic trends and projected climate impacts will combine to affect regional and community vulnerability, resilience, and adaptation options. Instead, the majority of research focuses on current and experienced risks, underlining a need for futures-orientated work in the region, and across sectors.

The assessment work has found, generally, that the combined uncertainty in climate and socio-economic drivers tend to undermine the practical value of looking several decades into the future in integrated studies. However, more focused climate-related predictions of, for example, permafrost thaw, have considerable practical value for designing infrastructure.

Policy development also needs to consider how a changing climate might in turn undermine initiatives to build social and economic resilience. For example, efforts to promote traditional food consumption must take into account levels of contaminants, changes to wildlife availability and accessibility, while increased housing provision should consider the impacts of permafrost thaw and changing climatic conditions.

EDUCATION IS A KEY FACTOR FOR ADAPTING TO CHANGE IN THE BBDS REGION

Offering an education in sparsely populated areas and small communities in the Arctic is challenging. Climate change will have a variety of indirect impacts on education. For example, if traditional hunting and gathering activities become harder, traditional learning could be undermined.

Stakeholder consultations in the region showed strong interest in continued development and modernization, as well as the pursuit of more traditional livelihoods, often in combination. Education is important to help people in the BBDS prepare for both opportunities for waged employment and to pursue traditional subsistence activities such as hunting.

Improved education can help people adapt to change – it is a 'no regrets' adaptation option that pays dividends regardless of the nature of change in the future. Strengthening the education system in the BBDS region will also prepare people to exploit economic opportunities that might accompany change. Language programs would be particularly useful in Greenland, where English is



Martin Fortier / ArcticNet

often a third language. Better language skills would allow people in the region to take advantage of distant learning and working opportunities created by technological advances, find work in tourism or for international resources companies or, indeed, enable migration as an adaptation option.

Promotion of and support for traditional and local knowledge is also important. Climate change is undermining some aspects of this knowledge, such as the ability to forecast weather conditions and predict animal migrations. However, it is making other traditional skills even more important – such as the ability to identify hazard precursors, survival skills and knowledge of animal behavior. Anticipated changes in the BBDS region therefore supports arguments for more culturally relevant schooling in Greenland and Nunavut, and for alternative approaches to strengthening the passing on of traditional and local knowledge.

STAKEHOLDER AND COMMUNITY INVOLVEMENT, SOCIAL NETWORKS AND TRADITIONAL AND LOCAL KNOWLEDGE OFFER SOURCES OF RESILIENCE IN THE FACE OF CHANGE

Traditional knowledge underpins many aspects of community life and culture. It can play a vital role in helping communities, households and individuals adapt to change.

The evolution and transmission of traditional knowledge is being threatened. While economic development is strongly desired by many people within the region, it provides alternative livelihoods that are less connected to the land, urbanization weakens links with the environment, and connections between young and old are becoming weaker.

Initiatives that help maintain and revitalize traditional and local knowledge, such as culture camps, cultural events that support a sense of place, and school programming, are important to ensure traditional and local knowledge is passed on to younger generations, helping to build resilience to the challenges facing northern communities, including climate change.

Maintaining and strengthening social networks is in general important in adapting to change. Maintaining traditional and local knowledge, as well as local involvement in wildlife management, and community-led initiatives to address social problems can all help to strengthen these networks.

More broadly, it is widely recognized that communities and decision-makers need to be engaged in adaptation research, planning and implementation. Engaging stakeholders, in a sustained way, is essential for adaptation in the BBDS region.

Approaches to adaptation need to take into account the scale and impacts of anticipated developments, which implies the involvement of affected communities and the relevant governance structures. The understanding of the problems to be tackled, and the cultural, political and socio-economic context in which they are addressed, will inevitably influence decisions about adaptation actions. It is therefore evident that approaches to adaptation in the BBDS region need to take into account community concerns and traditional and local knowledge and cultural values.

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

IMPROVED ECOSYSTEM APPROACHES TO MANAGEMENT ARE NECESSARY TO PROTECT BIODIVERSITY IN THE BBDS REGION

All major activities in the region – whether traditional hunting and fishing, commercial fishing, tourism, shipping and even extractive industries – rely on healthy ecosystem functioning.

Commercial fisheries are of particular economic importance to Greenland, and commercial fisheries are also expanding off the coast of Nunavut. Meanwhile, terrestrial and marine living resources are an important part of the local culture. Their harvest is an important supplement to nutrition, clothing, and artistic expression in coastal communities. BBDS communities also derive revenues from the sale of harvested goods and from visiting tourists drawn by hunting and the unique Arctic fauna.

In addition to these economic and cultural benefits, healthy ecosystems maintain other essential natural services, such as carbon storage and nutrient recycling.

Limited long-term monitoring data, and the effects of other intervening factors, make it difficult to assess the impact of climate change on ecosystems, biodiversity and population size for many species. Recovery from overexploitation, or changing harvest or management practices may have a greater impact on population size than climate change. An exception is the High Arctic zone, with its associated characteristic ecosystems. It is being pushed to the extreme north, with its habitats at risk of disappearing altogether, in a process that can only be slowed down by decisive global climate change mitigation efforts.

Below the High Arctic, wise ecosystem management can strengthen the capacity of the region's ecosystems to adapt to change. This management should build on robust scientific and traditional and local knowledge about harvested or sensitive species

and their ecosystems. It should focus on protecting 'biodiversity hotspots' – that is, areas with many unique species, and should take into account critical areas for various life stages (breeding, feeding, roosting, molting). Such areas include significant polynyas, such as Pikialasorsuaq/North Water Polynya, and important areas of resilient multi-year sea ice.

Given the scale of forecasted changes that will often result in substantial habitat displacements in the Arctic, it is important that protected areas are large or flexible enough to safeguard critical habitats for target populations. They should also be strategically selected (i.e. forming ecological networks of sites) and actively managed in coordination with other approaches that support the overall resilience of regional ecosystems and species. In addition, management plans will increasingly require concerted action across borders, sectors and disciplines.



ADDRESSING CURRENT HEALTH VULNERABILITIES WILL HELP BBDS RESIDENTS ADAPT TO THE CHALLENGES EXPECTED TO BE EXACERBATED BY CLIMATE CHANGE

As noted above, climate change will have both direct and indirect impacts on health in the BBDS region. However, few studies in the region have examined how health outcomes will be affected by climate change, although it is generally expected that existing risks will increase in magnitude and frequency, although there will be some benefits from reduced exposure to extreme cold.

When assessing health vulnerabilities in the region, the underlying determinants of health, such as physical environments, health services, education and coping should be taken into consideration. The discussion around the social determinants of health underscores the need to understand health beyond illness, and wellness beyond absence of disease. In particular, the importance to people in the BBDS region of nature to culture, and culture and land to physical and mental health should not be overlooked. This will also be an important parameter when considering a community's vulnerability, and hence its capacity to adapt to change.

Climate change will have significant impacts on people's connection to the land and marine environment. For example, the health of Arctic residents who rely on subsistence foods is closely connected to the health of the related wildlife populations. This suggests that new and emerging stressors related to the connection of human and wildlife health must be better understood and anticipated.

There should also be a focus on increasing and improving data collection on the health of BBDS residents, given that accurate information is the foundation for the health planning process.

In general terms, addressing current vulnerabilities in relation to health, socio-economic risk factors, and other development gaps will help to build resilience. Solving current challenges will prevent them getting worse in a changing environment.

CROSS-CUTTING APPROACHES ARE NEEDED ACROSS SECTORS

The interconnected nature of the social, economic and environmental changes expected in the BBDS region, and the multiple stresses involved, means that adaptation planning will need to be strategic, ongoing, and carried out across geographic scales and sectors of society.

To date, adaptation research and policy responses in the region have been focused at the community and regional level, which is the appropriate scale to respond to many climate-related risks. However, national-level policies can either enable or limit the ability of communities to adapt. For example, building codes in Nunavut and Greenland largely reflect southern conditions.

Meanwhile, a cross-sectoral approach is needed to limit the impacts of social and economic activities on ecosystems. For example, developing codes of conduct for harvesting living resources, and for tourists and operators would reduce impacts on wildlife, helping to both protect the quality of wildlife tourism as well as protecting resources that

are important for biodiversity and to local people for cultural and food security reasons.

Similarly, developing marine activities in the BBDS, including fisheries, cruise tourism, shipping and resource exploration, depends upon coordinated investment in enhanced information, safety measures and regulations regarding contingency planning, operational guidelines, improvements in ice monitoring and warning capabilities.

More collaboration and planning across sectors among and within each country can open for a more efficient development and adaptation process. In this respect, cross-sector adaptation planning by national and local governments could play a key role. Mainstreaming climate risk management is key to ensuring climate information is guiding long-term development and that all major planning decisions are also assessed in relation to its climate change adaptation/mitigation and resilience building potential.

Further knowledge transfer and co-operation across national borders in the region would be rewarding, and here the circumpolar body, the Arctic Council, including permanent participants such as the Inuit Circumpolar Council, could possibly expand their facilitating role.



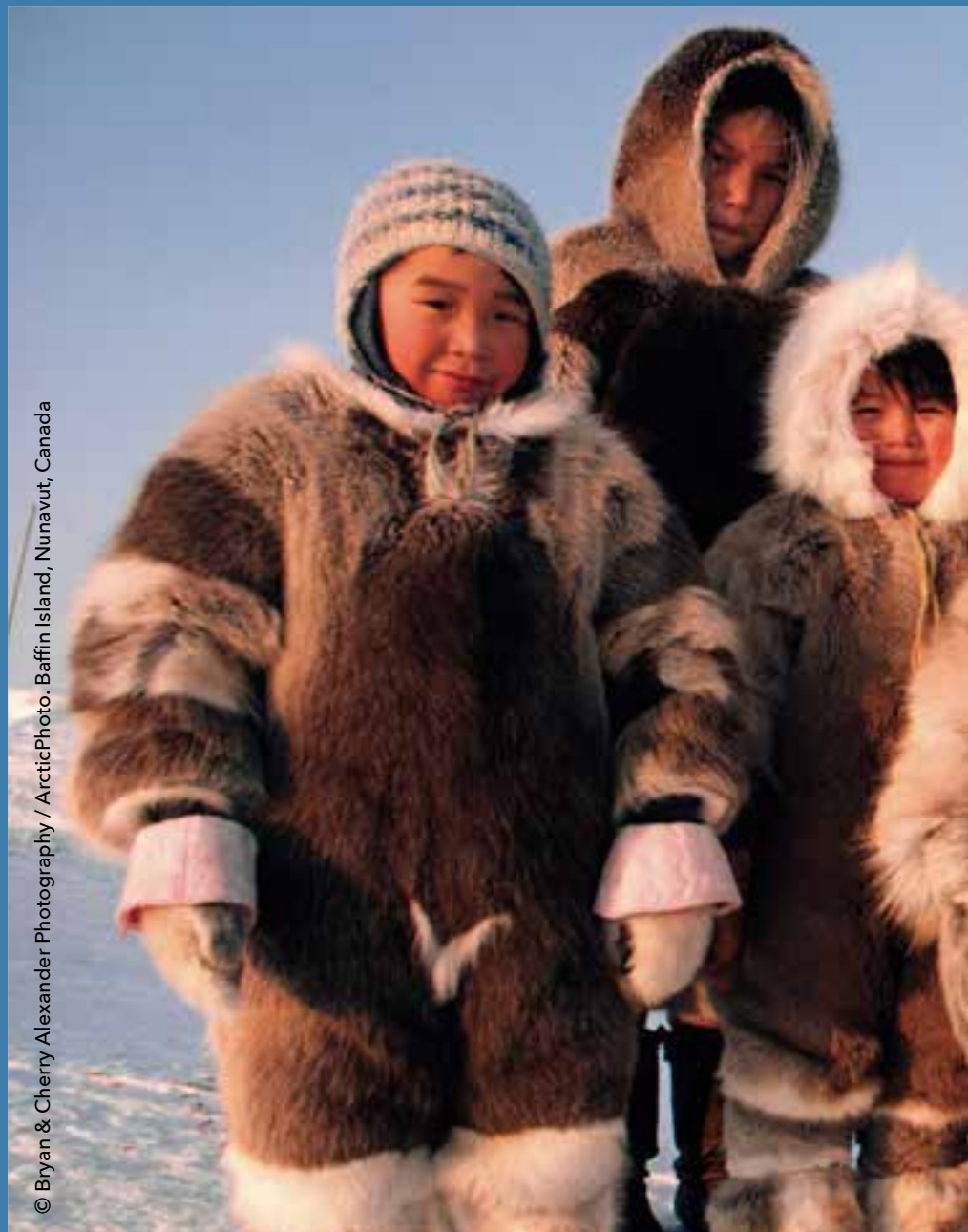
THERE IS A NEED FOR BETTER LINKS BETWEEN SCIENTISTS AND DECISION MAKERS

Understanding about practical aspects of adaptation across levels of government and the private sector is generally low in the BBDS region. For example, studies assessing perceptions of climate change impacts and adaptation with resource industries (primarily mining) has indicated that decision makers responsible for designing, building, maintaining and decommissioning industrial infrastructure have limited understanding of the likely impacts of future climate changes, as well as limited guidance on how to adjust to the likely changes. These data needs, among others, have been requested by the sector at AACA stakeholder meetings.

Hence there is a need for increased capacity within government throughout the region and, in particular, more effective dialogue between producers and users of scientific information; this include contributions from physical, biological and social sciences to shape tools for supporting vulnerability-focused adaptation.

In addition, there is a need for further research, specifically which actively involves decision makers and potential users of information within communities and the private sector.

However, it is not sufficient to simply provide decision makers with information. To effectively inform adaptation policy and catalyze action, decision makers need to be actively involved throughout the research process, which should be informed by the needs of users and which should be accompanied with targeted outreach and support on how to use findings.



© Bryan & Cherry Alexander Photography / ArcticPhoto. Baffin Island, Nunavut, Canada

Integrated assessments such as AACA and the ArcticNet Integrated Regional Impact Studies for the Canadian Arctic, and Greenland's sectorial climate adaptation plans can play an important role, by synthesizing key information on climate impacts and adaptation options. They involve targeted knowledge mobilization – going beyond traditional research outputs, such as journal articles, to produce targeted policy briefs, presentations and ongoing discussions of the results of research projects that are of direct relevance to adaptation in the Arctic.

Some ongoing efforts for mainstreaming climate risk management into relevant sectoral legislation, policies, financing streams – and in local (municipal and community) planning – are on the right track, and could be speeded up. To help the process it might be considered whether additional capacity building and education in sector ministries and elsewhere may be required to build momentum. The mainstreaming efforts should also apply to climate change mitigation efforts.



POLITICAL LEADERSHIP IS NEEDED ON ADAPTATION, AND GOVERNANCE NEEDS TO BE IMPROVED

Political leadership is important in initiating adaptation processes. There have been good examples of leadership from: lower levels of government within the BBDS region; from the government of Nunavut, which developed a strategic adaptation plan in 2011; from the Canadian federal government, with targeted funding for vulnerability assessments and adaptation planning; and from Inuit organizations lobbying on climate change domestically and internationally. The Greenland government has focused integration of climate change into relevant

sector plans, namely fishing and hunting, shipping, and agriculture, and, in 2015, decided to mainstream climate change adaptation into sectoral planning.

Adaptation intervention and planning is particularly effective when a single government agency takes the lead or an interagency group is created to oversee adaptation activities; governments have an important role in coordinating action to ensure coherence, long-term planning, and the integration of adaptation into climate-sensitive policies across government.

Meanwhile, public support is important in developing adaptation programs, especially where adaptation actions involve taking unpopular decisions. There is evidence that concerns about the issue in the region are growing, and there are examples of ‘adaptation champions’ in communities and governments. However, an ‘adaptation consciousness’ has yet to emerge in all communities and across all levels of government.

Such support will also be required to ensure that adaptation policies and programs are properly funded – and this resourcing needs to be incorporated into baseline funding to be effective.

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, considering social, economic and ecosystem factors. By integrating knowledge from many different fields of expertise, including traditional and local knowledge, 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.

Nonetheless, the pilot study was able to examine adaptation options for the BBDS, and specifically for the seven themes on which the BBDS report focused. For each of these seven themes, it suggested structural/physical, social and institutional adaptations to help people within the region respond to change.

To build readiness to adapt in the region, the report also notes six essential factors, the relative importance of which will vary depending on scale and context. These are political leadership, institutional organization for adaptation, local and regional leadership, the need for usable science, and sufficient funding and public support for adaptation.

In terms of specific adaptation processes, the report also identifies a range of tools that are available to help guide decision makers. These include tools that focus on developed countries and urban areas, as well as those offered through the UN Framework Convention on Climate Change that are more generic.

In examining adaptation options for the BBDS, we should recognize that the worldviews of residents, officials, and politicians will differ, and that this will affect the priority and relevance that they assign to any adaptation option.

This AACA pilot 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, residents and decision-makers is 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) – Baffin Bay/ Davis Strait (BBDS) 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.



This document was prepared by the Arctic Monitoring and Assessment Programme (AMAP) and does not necessarily represent the views of the Arctic Council, its members or its observers.

AMAP Secretariat

Gaustadalléen 21
N-0349 Oslo
Norway

Tel. +47 21 08 04 80

Fax +47 21 08 04 85

amap@amap.no

www.amap.no

AMAP
Arctic Monitoring and
Assessment Programme