

Chapter 14

Community Adaptation and Vulnerability Integrated

Grete K. Hovelsrud, Jeremy L. White, Mark Andrachuk, and Barry Smit

Abstract The goal of the CAVIAR project is two-pronged: capturing the particular social and environmental conditions that combine to create exposure-sensitivities and require adaptation in case study communities across the Arctic; and applying a common framework that anchors integration of results in a pan-Arctic assessment of community vulnerability and adaptability. At the core of the CAVIAR project is designing and framing the research in collaboration with the local communities allowing us to understand the particular processes and conditions in each locale, which is a prerequisite for understanding adaptation and vulnerability to change. This undertaking has required a fundamentally interdisciplinary collaboration, across and between social and natural sciences, and between scientific and local/traditional knowledge. By involving the local communities in setting the parameters of the research we have identified the aspects of Arctic communities (such as livelihoods, income, social interactions) that are susceptible to changing conditions. The purpose of integration, on the basis of the case specific particularities, is to generalise the processes and conditions which shape vulnerabilities in the Arctic, and gain insights into adaptive capacity to deal with future changes. It is clear that the lives and livelihoods of people in the Arctic are sensitive to the effects of a changing climate, but they are also sensitive to changing economic, institutional and social conditions. While natural resource based livelihood dependence had a large share of attention, other prominent issues included municipal services, infrastructure and the impacts of industrial expansion.

Keywords Vulnerability · Adaptation · Integration · Scientific and traditional/local knowledge · Adaptive strategy and capacity · Climate change

G.K. Hovelsrud (✉)
CICERO, Center for International Climate and Environmental Research – Oslo,
P.O. Box 1129, Blindern, 0318 Oslo, Norway
e-mail: g.k.hovelsrud@cicero.uio.no

14.1 The Scope and Intent of the Book: A Summary

The CAVIAR project has two main elements. The first of these is to apply a common framework that anchors the collection of particular social and environmental conditions across the Arctic that combine to create exposure-sensitivities requiring adaptation by case study communities. The second element involves the integration of these results to identify characteristics of vulnerability that are shared or similar across the Arctic and those that are distinct to places or cultures. An underlying feature of the CAVIAR approach is the determination to design and frame the research in collaboration with local communities. This has allowed us to understand the particular processes and conditions in each locale, a prerequisite for understanding the ways that communities are exposed and sensitive to changing conditions and the adaptations they have employed. The purpose of integration is to generalise about the processes and conditions which shape vulnerabilities across the Arctic, and gain insights into adaptive potential with respect to future challenges.

The case studies have required an interdisciplinary collaboration, across social and natural sciences, and between scientific and local/traditional knowledge. By involving the local communities in setting the parameters of the research we have, as researchers, committed ourselves to address aspects of societal and environmental systems that are pertinent to Arctic people, in order to understand interactions between human and physical processes. For example, community susceptibility to flooding events requires an understanding of hydrology and processes relating to occupancy and hazard management; the sensitivity of fishing communities and the fishing industry requires knowledge of marine fisheries ecology, ocean-atmosphere interactions, and decision-making in the industry in order to understand variation in the distribution and abundance of commercially important fish stocks and how this may affect fishers; and to explain the vulnerability of community infrastructure requires knowledge of geomorphological processes relating to permafrost and coastal erosion and of infrastructure design and function. These have been necessary challenges for assessing community vulnerabilities.

Employing a common framework enabled integration of research results from a variety of disciplinary backgrounds encompassing differing theoretical and methodological approaches. Despite these differences, the case studies are unified by seeking to identify attributes of communities pertaining to vulnerability: current exposure-sensitivities, current adaptive strategies, future exposure-sensitivities and future adaptive capacity. A challenge in integrating the CAVIAR research results is to extract commonalities with regard to the framework without losing the uniqueness of each case study.

Chapter 1 described the CAVIAR framework and how the concepts of exposure-sensitivities, adaptive strategies, adaptive capacity and vulnerability are applied. The conditions and processes presented in this volume, and integrated in this chapter, are those that were identified locally as being important

to the wellbeing of the respective communities. While natural resource based livelihood dependence had a large share of attention, other prominent issues included municipal services, infrastructure and the impact of industrial expansion.

14.2 Overview of Communities

Of the 14 chapters in this book 11 present evidence drawn from 16 case studies, situated throughout the Arctic. These cases not only represent geographical distribution, but also encapsulate a broad range of demographic, economic, institutional and cultural diversity. The case studies have provided insight into the opportunities, constraints and complexities encountered by Arctic communities in attempting to reduce their vulnerability to a multiplicity of stressors. In achieving this, the case studies have drawn attention to discernable features, some unique others common, across these communities. Prominent amongst these are, community size and location with respect to larger urban and commercial centers, the position of the community within municipal and wider governance frameworks, the degree of reliance upon a natural resource base and or primary industries, and the role of indigenous people's traditional activities.

Chapter 1 describes the CAVIAR framework and case study methods employed, most of which are familiar to the disciplines of ethnography, sociology, social anthropology, geography, resource management, health research and sustainability and development initiatives. All studies were grounded within the CAVIAR framework, and applied a collaborative and participatory approach, to determine together with local partners, the particular focus and study parameters. See [Table 14.1](#) for an overview of the communities.

The degree of natural resource economic dependency provides a compelling metric to review community diversity, especially as this constitutes one of the central themes within the case study chapters. Case study communities range from near single resource dependency, as described in the studies of the reindeer herders of Yamal and Nenets Autonomous Okrug (Tyumen and Archangelsk Oblast), to areas and regions supported by a more diversified economic base such as in Whitehorse and Hammerfest sustaining a combination of industrial, service and public sector employment. The positioning of indigenous or traditional economic activities also varies considerably within the communities, from providing essential subsistence support in the cases of Fort Resolution, Arctic Bay, Tuktoyaktuk and Ulukhaktok, as part of a mixed local economy, to comprising the entire livelihood base of reindeer herders in the Nenets region of North West Russia.

Chapter 4, documents the most complete example of single resource economic dependence associated with the Nenets traditional reindeer herding activity. Reindeer herding also constitutes the main economic activity in

Table 14.1 Case study communities description

Chapter no.	Case study communities	Region and country	Community population	Approximate indigenous population ^a
	Lebesby	Eastern Finnmark, Norway.	1350	5% Sámi
2	Hammerfest	Western Finnmark, Norway.	9,500	n.a.
	Vestvågøy	Nordland County, Norway.	11,000	n.a.
3	Tuktoyaktuk	Inuvialuit Settlement Region, Canada.	950	97% Inuit
4	Ulukhaktok		400	99% Inuit
	Krasnoye, Naryan-Mar	Nenets Autonomous Okrug, Russian Federation.	6400 ^b	15% Nenets ^c (R)
	Priuralskij district	Yamalo-Nenets Autonomous Okrug, Russian Federation.	26,435 ^d	5% Nenets (R)
5	Arctic Bay (Ikpiarjuk)	Nunavut, Canada.	690	84% Inuit
6	Nelmin Nos, Naryan-Mar	Nenets Autonomous Okrug, Russian Federation.	6400 ^b	15% Nenets (R)
7	Fort Resolution	Northwest Territories, Canada.	500	92% Métis, Chipewyan Dene ^e
9	Ivalo	Inari Municipality, Finland.	6861	33% Sámi ^f (R)
10	City of Whitehorse	Yukon Territory, Canada.	26,000	18% First Nations, Métis and Inuit ^g
11	Qeqertarsuaq	Disko Island, Greenland.	1013	90% <i>Kalaallit</i> – Greenlandic Inuit
12	Kangerluk Gällivare Municipality	Norrbottn County, North Sweden.	42 18,959 ^h	20% Sámi
13	Unjárga/Nesseby Municipality	Eastern Finnmark, Norway.	878	70% Sámi

^aAn (R) is written where the percentage refers to the indigenous population in the wider region. Otherwise the proportion refers only to the case study community

^bThis figure refers to the population of European Nenets in the entire Nenets Autonomous Okrug (2007)

^cProportion of European Nenets in NAO. Barentsinform.org <http://www.barentsinform.org/?Deptid=26342> This differs from the 2002 Russian census which showed 7754 Nenets in NAO, constituting 18.7% of the NAO population

^dPopulation and proportion of Nenets in Yamalo-NAO. Figures from Russian 2002 Census <http://www.perepis2002.ru/index.html?id=87>

^eFort Resolution 2006 Census data. Statistics Canada. <http://www.statcan.gc.ca/start-debut-eng.html>

^fInari Municipal Website: <http://www.inari.fi/web/index.php?id=3>

^gYukon Bureau of Statistics 2006 Census. Available from: <http://www.eco.gov.yk.ca/stats/>

^hFrom Facts about Norrbotten 2007, produced by the County Administrative Board of Norrbotten

Nelmin Nos, and is perceived as crucial to the identity of the region. However livelihoods in the region are supported by other subsistence hunting activities, and forced sedentarisation policy has led to the development of alternative urban opportunities in the region, coupled with the extension of extractive industries. The contrast between the nature of community resource dependency and wider regional resource diversity, especially in the case of extractive industries, is particularly stark in the case studies from North West Russia, and reappears as a frequent theme in a number of the other case studies.

Indigenous peoples and their degree of dependence upon traditional livelihoods and activities is a perpetual source of variance between CAVIAR sites. In the two Inuvialuit communities of Tuktoyaktuk and Ulukhaktok subsistence hunting and fishing continue to be practiced by the majority of residents, and retain a central cultural and economic importance, not least as providing food security for many families. However, these communities are reliant on a diversity of occupations ranging from extractive industries, such as oil and gas, the service sector including shipping and retail, and public service employment in education or health services. A similar pattern is seen in Arctic Bay, and the wider Nunavut region, where predominantly coastal communities base their economies on a combination of subsistence harvesting (primarily marine), wage employment, and tourism in some areas. Alternative employment opportunities and economic diversification have reduced the economic dependence of Dene and Métis in Fort Resolution upon subsistence hunting and fishing activities, however in similarity with the communities described above, and for a combination of both economic and cultural reasons, many livelihoods remain centered on land based activities.

The communities of Gällivare, Lebesby, Vestvågøy and Unjárga/Nesseby are perhaps more typical of the Northern European region in retaining a dependence upon renewable resource based livelihoods such as multi use forestry, fishing, fish processing (stockfish in Vestvågøy), small scale agriculture and animal husbandry (particularly reindeer in Gällivare and both sheep and reindeer, by coastal Sámi, in Unjárga/Nesseby). In addition traditional Sámi subsistence hunting and gathering activities continue. However the nature of some of these livelihoods has altered as technological developments have contributed to industrial intensification, mechanisation and occupational specialisation. The economic bases of these communities are also supported by a range of public sector employment and support mechanisms, in addition to the development of new diversified income opportunities such as wind farms and tourism.

The study of Qeqertarsuaq in Western Greenland presents a picture not altogether dissimilar to the case studies described above, in terms of mixed cash-subsistence economies. Traditional, typically marine foods are a vital resource for inhabitants in terms of a subsistence component to the local economy, diet and cultural value. In addition Qeqertarsuaq has a strong commercial economy, with a low unemployment rate, predominantly based on fish processing. Integration of community economies beyond community or even regional boundaries, as in the case of the Qeqertarsuaq's fish exporting industry, raises an

additional complexity to the notion of resource dependency. The extent to which prosperity is connected to processes beyond that community or region is highly pertinent in communities such as Vestvågøy or Qeqertarsuaq, where the strength of their local economy is intrinsically linked to international fisheries markets.

In terms of scale the cities of Whitehorse and Hammerfest constitute the largest case study sites. Whilst the city of Whitehorse is supported by a large proportion of public sector employment, the chapter also discusses the role played and vitality of the cities service sector, particularly adventure tourism. Hammerfest has grown in recent years from a community predicated primarily on the fishing industry, to an important shipping port and the base for the Norwegian oil and gas extraction from the nearby Melkøya facilities (in the Barents Sea). This in turn has encouraged the growth of the city's service sector. In contrasting two large Arctic communities it seems apparent that Hammerfest exerts greater natural resource dependency, and is more intricately integrated into global resource markets.

14.3 Summary of Findings

Case study researchers investigated aspects of livelihoods, economies, culture, geomorphology and infrastructure that influence the current exposure-sensitivities, current adaptive strategies, future exposure-sensitivities and future adaptive capacity. Some common features have emerged across many of the cases and will be reviewed in the sections below. These include, in broad terms, the consequences of changes in coupled social-ecological systems with respect to: resource accessibility, allocation and extraction policy; limited economic opportunity and markets access constraints; demographics; attitudes and perceptions of change; local-global linkages; infrastructure; threats to cultural identity and well-being; transfer of local and traditional knowledge; economic and livelihood flexibility, and enabling institutions. These aspects are rarely independent of each other and frequently combine across scales and sectors.

14.3.1 Current Exposure-Sensitivities

In the absence of a deliberate focus upon climate change by the researchers, discussions of local weather and environmental conditions took place in the context of resource use and access, travel, food security and livelihood flexibility. Climate change alone is not viewed as the most salient factor causing vulnerability in the communities, but as a force that is exacerbating risks and stresses related to resource use and overall wellbeing. Observations of

variations in climate and weather are brought to the fore to the extent they have consequences for livelihoods, recreational activities, municipal services and health. Climatic and weather conditions determine *inter alia* access to resources, safety while travelling, fishing or hunting, infrastructure stability, resource productivity, power generation, and the recreational use of nature. Environmental variability is a feature of the Arctic and its resources, but unprecedented changes, such as the magnitude of storms and seasonal dislocation, are posing further challenges to local/traditional knowledge, create hazardous and risky conditions, and alter the resource base. Among the indigenous cases it is recognised that travel safety, resource use and food security may be compromised and challenged should in-depth traditional knowledge be lost and not transferred to young people.

Changes in societal and environmental conditions affect livelihood activities, culture and wellbeing in many of the cases. Recent changes in the generational transfer of local and traditional knowledge are reported in a number of the cases and are influenced by several factors. Detailed local and traditional knowledge concerning environmental conditions, weather and the resource dynamics is important for ensuring safety at sea and upon land, and for the success of the hunting or fishing activity. Changes to time spent hunting or upon fishing activities and practices, due to employment diversification or diminished prey availability, reduce the opportunity for the transfer of knowledge. In addition, less time spent amongst generations diminishes opportunities for knowledge transmission and there are widespread concerns that traditional knowledge will be lost over time. The reduced attainment of traditional knowledge combined with rapidly changing socio-economic conditions, leads to risks associated with travel that may have otherwise been avoided with better awareness of hazards and survival skills. Changes in livelihood conditions and the environment are experienced and perceived as being beyond current knowledge systems, which has in some cases created insecurity on the part of knowledge keepers.

Most of the case communities are located at the periphery of larger commercial or administrative centres, and are dependent upon reliable infrastructure (roads, ice roads, rivers, sea ice, air/sea transport) for receiving goods and selling products. Infrastructural responsibility typically belongs to regional or national governments and the communities are thus dependent upon district policies for infrastructure maintenance and new construction. The provision of adequate infrastructure to ensure the transportation of local products, such as foodstuffs and goods to Whitehorse, is one determining factors in marking current exposure-sensitivities. Another includes facilities to enable the processing of local products, such as sawmills and slaughter houses, and fish landing facilities. Furthermore, several communities face risks to existing infrastructure due to coastal erosion, permafrost degradation, rock slides and/or snow avalanches. The level of community exposure-sensitivity is linked to the manner in

which national policies address the maintenance of peripheral communities through financial and political commitments.

Disputes over land and resource-use may contribute to current and emerging exposure-sensitivity in many of the case studies. Some case studies describe the tensions, and contested land use between the sectors such as reindeer husbandry, forestry, tourism and extractive industries. Increased industrial use of the land or sea, such as logging, mining, and petroleum activities has been to the expense of traditional (both indigenous and non-indigenous) and more localised uses, such as hunting and gathering, coastal fishing and reindeer husbandry. In other instances local land use is evolving towards more service oriented activities, such as tourism, posing challenges and opportunities for local communities. Increased resource exploitation has in some cases required increased infrastructure support, such as roads, fences and power lines. These developments are viewed by some as an encroachment, while others perceive these activities in terms of employment opportunity and economic development. An added factor is the changing climatic conditions which have likely ramifications for marine species composition and abundance, grazing conditions or the period of time that people may safely travel over the sea ice.

The patterns of land and natural resource use are also influenced by changing environmental and climatic conditions. Closely linked to resource use exposure-sensitivities are observations of change in the range of resource bases, changing climatic conditions have ramifications for the abundance and distribution of fish stocks and marine mammals, a reduction in reindeer grazing lands, and decline in berry harvests. Current management systems, policies and regulations need to be flexible to allow hunters, fishers, or reindeer herders to adapt to ongoing changes in the resources.

Cultural differences between indigenous groups and non-indigenous governmental institutions create current exposure-sensitivities for both. Time spent engaged in herding or harvesting practices may preclude indigenous groups from participating in decision-making processes, and have negative consequences for their livelihoods. Lack of access to decision-making processes and institutions at the appropriate level results in indigenous peoples having to operate under management regimes with which they do not necessarily agree. Likewise if governmental decisions about land use do not take into account indigenous perspectives this may weaken resource management effectiveness, and create local economic or social problems.

14.3.2 Current Adaptive Strategies

Peoples in the north emphasise and take pride in their claim to have successfully adapted to great long-term natural variability in climate, weather and the resource base. Climate change is generally viewed as being beyond local control and to which adaptation is inevitable. In some of the cases, communities believe

that traditional practices and knowledge will be sufficient for dealing with future changes. In other cases, communities recognize that climate change may bring new circumstances in their resource based and require new strategies for successful adaptation. Across the case studies, current adaptive strategies address a range of environmental and societal changes, but are not typically initiated with specific regard to climate change.

Adaptive strategies are motivated by joint environmental (e.g. sea ice, weather, wildlife) and societal (e.g. regulations, laws, social dynamics, demographics) exposure-sensitivities. By analysing how the multiple drivers of adaptation are linked, and what adaptation strategies are employed, we are better able to understand community vulnerability. For example, the success of reindeer herding is influenced by grazing conditions (snow, ice, encroachment by roads and industrial activities) and the income that herders can generate from their activities. Adaptive strategies pertain to both, such as moving the herd to better pastures, providing supplemental feeding, ensuring an optimal herd size and maintaining social relations and networks to assist in herding activities. Fisheries are influenced by stock size, fish cohort composition and distribution, market opportunity, fisheries regulation and retention of local facilities to support fishery activities (e.g. processing plants, shipyards, distribution networks). Adaptive strategies include keeping abreast of current regulations and influencing future policy generation, targeting different fish species, and diversifying income sources.

Some of the larger communities, or those less reliant upon hunting and fishing, are affected by poor infrastructure provision which disrupts the flow of goods and services, causing vulnerabilities to extreme weather events. Adaptation strategies may include ways to reduce dependence on for example fossil fuels, and plan for a more sustainable community in terms of resource use. In the larger communities there is evidence of long-term planning which considers climate change, while throughout the Arctic there is very little evidence of the same in smaller communities.

Many of the cases emphasise problems associated with the disruption of knowledge (local and traditional) transfers. Communities have devised a variety of adaptation strategies to ensure continued intergenerational transfer of knowledge. These actions include inviting elders and hunters to teach about the local environment and resource use in schools, developing curricula which include local and traditional knowledge, and involving youth in monitoring programmes. This adaptive action is essentially investing in capacity to meet current and future conditions.

Common across the cases are current adaptive strategies that accommodate the multiple drivers of globalization and market integration, environmental change and governance, in order to maintain or increase the productivity of natural resource use activities such as logging, fishing or tourism. These adaptive strategies tend to reside beyond individual communities due to their broad societal prevalence. They are housed within political or managerial decision-making processes, such as national fisheries management, industry groups

developing new markets for local products, or cultural groups rejuvenating their language and traditions.

Many adaptive strategies are costly in economic terms and require a steady income to enable action. In some cases, adaptive actions are reliant upon external expertise and advice, such as construction of barriers to reduce the impacts of avalanches or coastal erosion. The ability of communities to seek such advice is influenced by resources available to local institutions and economic provisions.

The role played by municipal or higher level government, in terms of responsibility and preparedness, in facilitating or constraining adaptation determines the central focus of some studies. Other studies provide a contrast by showing that the role of governance is more fragmented and less encompassing in reducing vulnerability. Thus the different case studies describe a significant diversity with respect to the adaptive approaches by governments and institutions.

Current adaptive strategies also pertain to increasing safety while engaging in harvesting and herding activities both in terms of travel and harvesting methods used. Travel is often compromised by changing environmental conditions, thus finding new routes, or adopting new equipment and technology are adaptive strategies that reduce vulnerability. When preferred species become less accessible because of environmental change an adaptive strategy is to target other species as substitutes.

An important integrating theme is the multiple conflicting interests in land- and resource-use, requiring potentially incompatible adaptive strategies, thus creating winners and losers (logging versus reindeer herding, hunting and gathering versus mining or increased shipping, fishing versus petroleum extraction). Adaptation in one area, by for example logging companies, may lead to increased exposure-sensitivity in another, such as reindeer herding, and the added effect of climate change may act as a constraint or facilitator for one or the other interests.

14.3.3 Future Exposure-Sensitivities

Commonly cited future exposure-sensitivities relate to changes in the natural resource base as a consequence of a broad range of stresses which include globalization and socio-cultural pressures, increased industrial pressure, increased competition over resources, and changes in resource management regimes out of step with climate change (see Table 14.2).

Future climate change is seen as important for a range of coupled environmental and societal consequences. These include shorter sea-ice seasons and changing sea-ice conditions with implications for access to and the abundance of resources, in turn affecting wellbeing, hunting costs, safety, price of country foods and food security; melting permafrost with consequences for reindeer herding, infrastructure such as damaged roads and buildings, reduced access to certain communities or hunting grounds; increased likelihood of icing

Table 14.2 Current and future vulnerabilities

Attributes of current vulnerabilities	Drivers of future vulnerabilities
Stress for traditional livelihood activities and culture	<ul style="list-style-type: none"> ● Globalization and socio-cultural pressures ● New large-scale resource developments ● Migration to urban centers ● Change or loss of culturally important wildlife ● Cost of living (linkages to global economy) ● Increased interest in Arctic for resources, tourism and development
Lack of infrastructure for provision of adequate goods and services	<ul style="list-style-type: none"> ● Warming temperatures, changes in precipitation patterns, and longer warm seasons ● Increased need and use of infrastructure by industry
Land use disputes	<ul style="list-style-type: none"> ● Displacement from large-scale resource developments and associated activities ● Economic diversification ● Changes in resource management regimes ● Resource management lacking flexibility to adjust to climate change impacts
Shifting resource bases	<ul style="list-style-type: none"> ● Shifting wildlife due to climate change impacts ● Travel risks and reduced access to harvesting and pasture areas ● Changes in resource management regimes ● Resource management lacking flexibility to adjust to climate change impacts ● Economic diversification
Cultural mismatch between local resource users and resource policy makers	<ul style="list-style-type: none"> ● Resolution of indigenous land claims/commitment of national governments to land claim settlements ● Changes in resource management regimes ● Increased interest in Arctic for resources, tourism and development

conditions and later onset of winter which degrade reindeer pastures and influence animal health, with consequences for reindeer herders livelihood and wellbeing; and increased ocean temperatures affecting the fish species' distribution, abundance and species composition with consequences for coastal fisheries in terms of access, safety, fish quotas, technology and management. In addition, a warmer climate will shrink the glaciers that feed the headwaters for hydroelectric power, with consequences for some communities. Climate change will further exacerbate the current stressors if these are not reduced in the future. On the other hand, the consequences of climate change may provide new opportunities, reducing the net negative impact. For example, the arrival of new species may not be initially welcome, but may bring potential for new harvesting or commercial activities. Extend growing seasons may allow for greater biological productivity and communities may be able to take advantage of new agricultural opportunities.

A complication in assessing future exposure-sensitivities is that current and future policies will determine the extent to which climate change will impact environments and resources. Current resource management regimes are to some extent taking climate change into consideration when setting policy to protect, for example, marine mammal and fish stocks or prevent habitat degradation. It is highly likely that resource managers, to a much greater extent will have to consider the consequences of climate change on both the resources and the resource users in the future.

Discussions of future exposure-sensitivities reveal that it may be easier for communities to relate to projected future changes in climate than to projected changes in societal conditions. This is also reflected in the fact that we have more tools available for projecting changes in weather related phenomena such as increased temperature or precipitation, and the future of fish stocks than we have to project community development and demographics. Changes in climate occurring together with changes in societal conditions may create 'tipping-points' which cannot be predicted on the basis of current understanding of change. For example, land claims are negotiated between indigenous groups and national governments, and it is not possible to project the outcome of unsettled claims or the impact that they will have on local culture, resource management, or economic conditions.

Construction of new infrastructure, power lines, expanding industrial areas are considered encroachments on wilderness and nature, reindeer grazing land, wildlife and hunting grounds, and on human wellbeing and are common future exposure-sensitivities amongst the cases. The tensions and conflicts that may arise from diverse stakeholder interests in land- and resource use add to this type of future exposure-sensitivity.

Many of the future exposure-sensitivities identified have genesis external to the communities and are related to the consequences of climate change and globalization. This includes increased interests and activities in the Arctic, and a greater reliance on Arctic food sources from outside of the region.

14.3.4 Future Adaptive Capacity

A major determining factor of adaptive capacity emerging from the case studies includes flexibility along several dimensions such as livelihoods, institutions, management, and culture. Other critical factors include institutional capacity, enabling institutions, mechanisms for applying and maintaining traditional and local knowledge, and financial and human resources to facilitate adaptation.

The cases illustrate that local/traditional resource understanding is an important input for governance and management of resource access and activity. A common finding from the case studies is the existence of enabling institutions whose policy and actions reduce the potential for conflicts over land use and resource access. The cases show that when local decision-makers

have a greater understanding of changing conditions they are in a better position to engage in short- and long-term planning for climate change impacts on resources, infrastructure and culture. Common throughout the cases are institutions as barriers or facilitators to adaptation. The role of institutions is critical for facilitating or constraining adaptation, and policy restrictions (in terms of restricting diversified income), or institutional regulations (restricting grazing or encroachments) may in some cases serve as barriers for adaptation.

Another related dimension is that future adaptive capacity is contingent upon the connections between the local level and the broader socio-political institutional context of the northern regions. The regulation of natural resources, both access and productivity, is determined at regional and national levels, and may fail to address the combination climatic and societal changes at the local level, where consequences will be most severely felt. Capacity to adapt to future change at the local level is to a large extent dependent upon enabling institutions across societal levels. The role of societal values such as informal social networks and engaged individuals will also be important for future adaptive capacity. Indigenous peoples' capacity to adapt is also contingent upon the outcome of treaty negotiations, relating to resource ownership and access rights, and changing governance systems. Disputed land and access claims are inextricably linked to wider concerns of resource use and livelihood diversification. Central to the discussion of indigenous adaptive capacity was the question of Aboriginal rights, achievement of which would secure land access and use jurisdiction.

With respect to natural resource use a common feature is the increased awareness of the need to monitor the resource base to detect changes and initiate regulatory and management plans. The institutional level at which such monitoring takes place varies between the cases, and depends on the community and management structure, and the prevalent local exposure-sensitivity (e.g. coastal erosion, local wildlife, or fisheries).

A general lack of flexibility in resource management regimes, in terms of not considering climate change impacts on the resource, and by restricting the flexibility of resource users, reduces the ability of hunters and fishers to better respond to environmental (including climate) and societal (including economic) change. Flexibility is seen as a prerequisite for successful adaptation across the cases. In some cases the institutional structure (e.g. tax systems) does not allow for flexibility in livelihood activities, limiting the possible local adaptive strategies and thereby weakening the adaptive capacity.

In several of the cases discussions with government officials revealed that adaptation to climate change was perceived as synonymous with mitigation of greenhouse gases. This may indicate that adaptation to the combined consequences of climatic and societal change may not be understood as important, relevant or high on the institutional agenda. By not acknowledging the need for current and future adaptation, the result may be inadequate future adaptive capacity because of lack of institutional preparedness and lack of flexible, responsive policies.

It is pointed out that current changes will likely be exacerbated with increased warming, and adaptive strategies to deal with these changes will be 'more of the same'. In other words, current strategies will be expanded and/or improved. Thus the perception remains that future exposure-sensitivities will increase in rate or magnitude along the same path as current environmental changes, requiring a similar development of future adaptive strategies. Indicative of this pattern is that few of the cases discussed the possibility of completely new and different adaptive strategies for meeting future challenges or opportunities. This is likely related to the problem of projecting future socio-economic changes to current societal, economic and political development and how this in turn will change the local communities.

14.4 Reflections on Concepts and Methods

Through an interdisciplinary approach and involvement of local community representatives in research design and set-up, we established a methodology for documenting and explaining how combinations of environmental and societal conditions create vulnerability and induce community adaptation. By analysing both bio-physical and socio-economic data, for example on how particular biophysical changes in the fisheries or flow levels in river deltas have had consequences for communities, scientists were able to generate insights on coupled social-ecological systems.

To ensure a holistic understanding of the broad social and environmental changes that are important to local communities, particular topics such as climate change were not introduced in our discussions with our local partners. In some cases aspects of climate or simply weather related topics were raised by the local participants unprompted, often in connection with livelihoods, outdoor recreation, or municipal activities. In other cases the researchers asked deliberate questions about climate and weather topics, and about social and economic change and regulations, in connection with the local activities that were previously defined by our local partners. This approach successfully brought out significant details of local concerns that, with a researcher led bias towards specific topics, would otherwise not have emerged.

When combining projections of climate change with socio-economic exposure-sensitivities we find concerns about future situations that may create irreversible changes to the natural resource base or environmental conditions. Both climate change effects and socio-economic developments are likely to require future adaptation, however as this volume of case studies makes patently clear, it would be a mistake to consider either area in isolation. The convergence of the two sources of exposure-sensitivity is unprecedented and will create a major challenge for successful adaptation. We therefore see a major challenge for future studies to fully integrate climatic and socioeconomic projections when assessing vulnerability.