Solveig Glomsrød and Iulie Aslaksen (eds.)

The Economy of the North

Statistisk sentralbyrå • Statistics Norway
Oslo–Kongsvinger

Statistiske analysar I denne serien blir det publisert analysar av statistikk om sosiale, demografiske og økonomiske forhold til ein breiare lesarkrins. Framstillingsforma er slik at publikasjonane også kan lesast av personar utan spesialkunnskapar om statistikk eller tilretteleggingsmetodar.

Statistical Analyses In this series, Statistics Norway publishes analyses of social, demographic and economic statistics, aimed at a wider circle of readers. These publications can be read without any special knowledge of statistics and statistical methods.

ISBN 82-537-7111-8 Printed version
ISBN 82-537-7112-6 Electronic version
ISSN 0804-3221

Subject
00.00.30 International overviews
01.02 Resources
01.03 Climate

Design/cover: Siri E. Boquist/Photos.com
Print: Statistics Norway

Standard symbols in the tables	Symbol
Category not applicable	.
Data not available	..
Data not yet available	...
Not for publication	:
Nil	-
Less than 0.5 of the unit employed	0
Less than 0.05 of the unit employed	0.0
Provisional or preliminary figure	*
Break in the homogeneity of a vertical series	—
Break in the homogeneity of a horizontal series	l
Revised since the previous issue	r

Preface

The objective of *The Economy of the North* is to present a comprehensive overview of the economy of the circumpolar Arctic, including the traditional production activities of the indigenous people. The report discusses the importance of the Arctic economy from a global perspective, with particular focus on the natural resources in the Arctic region. Finally, likely effects of climate change on the Arctic economy are discussed.

The Economy of the North has been produced as part of the ECONOR project, funded by the Norwegian Ministry of Foreign Affairs and the Nordic Council of Ministers. The report is the result of contributions from a network of researchers from national statistical offices and academic institutions located across the Arctic nations. Statistics Norway has hosted the editorial group that compiled and edited the contributions from the project network.

Statistics Norway would like to thank all the individual contributors and institutions who have provided data, analysis, texts, illustrations, and scientific advice for *The Economy of the North*. The present report is indeed a pilot report from a pioneer project, having encountered various challenges of statistical and conceptual nature. It is our hope that the present overview of the Arctic economy will inspire work to further strengthen the information basis from where to assess the sustainability of the Arctic communities in terms of natural wealth management and environmental challenges.

The Economy of the North was edited by Solveig Glomsrød (chief editor), Iulie Aslaksen, Mads Greaker and Bjart Holtsmark of the Research Department of Statistics Norway. Marit Vågdal did the technical editing, and Siri Boquist was the photo editor. More information is available at www.ssb.no.

Statistics Norway,
Oslo/Kongsvinger, November 2006

Øystein Olsen

Contents

List of figures

Chapter 5

Chapter 6

List of tables

1. The Economy of the North: An Introduction

Solveig Glomsrød

The Arctic Regions belong to different national regimes and a consequence of this is that information on social and economic issues has been dispersed and not easily available at the circumpolar level. This clearly applies to the information on the economy. Among several good reasons for compiling an overview of the circumpolar Arctic economy is a need for an information platform from where to assess the sustainability of the Arctic communities in terms of natural wealth management and vulnerability towards global policies and trends. A central task of this report is to contribute to filling this gap by presenting a comprehensive overview of the scale and structure of the circumpolar Arctic economy. An earlier overview is found in the Arctic Human Development Report[1], however, The Economy of the North adds to that review by moving further ahead from verbal description to statistical information. Conventional wisdom frequently points to the Arctic as mainly dependent on large-scale resource extraction and on economic transfers from «The South». It is our hope that The Economy of the North may help to replace habitual opinions with real facts.

The Arctic Region as referred to in this report is depicted in the map on page 16. It covers Northern Russia with the Republics of Karelia and Komi, the Murmansk and Arkhangelsk Oblasts, the Yamalo-Nenets and Khanty-Mansi Autonomous Okrugs, the Taimyr and Evenkia former Autonomous Okrugs, the Republic of Sakha, the Magadan Oblast, and the Chukotka and Koryakia Autonomous Okrugs. The American Arctic includes Alaska and the Northern territories of Canada (Northwest Territories, Yukon, Nunavut). The European Arctic consists of Greenland, Faroe Islands, Iceland and Arctic Norway (including the Svalbard Archipelago and Jan Mayen), Arctic Sweden and Arctic Finland.

Fortunately, the communications of the 21th century allows for mergers of knowledge and evidence from across such huge distances. The work on this report has been carried out jointly by a network of statistical officers and academics from the Arctic regions, and made it possible to present a report that provides basic economic indicators for the whole Arctic region. It is also an achievement that the data has been given a common format facilitating comparison of income, production and economic structures among the individual Arctic regions. This represents a major improvement on earlier available material and may work as building block in a further process towards a harmonized database on economic issues.

The report opens with an outlook upon the level of production and income generated by Arctic regions. Chapter 2: The Economy of the Circumpolar Arctic illustrates how individual Arctic regions differ in terms of GDP level and how regional per capita GDP level stands in comparison with that of other region's and nation's economies. Total value added of the whole Arctic region with about 10 million people is just somewhat below that of Switzerland with a population of 7.4 millions. Is the Arctic population close to being as well off then as the Swiss people? The intuitive answer is no. This report can unfortunately not answer that question, but it presents data that shows the huge variation in GDP by region in the Arctic, and identifies that the large share of resource rent from petroleum and mining is the factor behind this difference. The chapter ranks the GDP levels among Arctic regions and shows that a few regions in America and Russia have GDP per capita far above the average for the Arctic due to the dominance of the petroleum industry.

There are some particular challenges associated with such a comparison between the regional data obtained that goes beyond the question of quality and coverage of data. To add up or compare income accounted for in different countries it is necessary to transform the numbers to a common currency. The USD is frequently used for this purpose as most people have an understanding of how much a dollar can buy in the world market. However, a translation of income based on a straightforward use of market exchange rates will normally lose some of the information about the true capacity to consume in the domestic market of a specific region. To adjust for price differences in domestic markets purchasing power parity (PPP) indicators have been established as an attempt to harmonize income measures across regions. However, the PPP transformation may sometimes lead to biased assessment of income from the production activities in different regions. This problem is further discussed in Box 1, pages 14-15.

To provide a down to earth comparison between scale of production in major industries, Chapter 3: Arctic Natural Resources in a Global Perspective presents production and reserves of natural resources in physical units, including the share of Arctic reserves in the

total global reserves. The Arctic currently supplies about 16 percent of all oil and gas to the global economy and has reserves to keep on with this for quite some time. Hence, parts of the Arctic are seriously involved in the global greenhouse gas balance, which is subject to increasing concern related to global warming. Further, also the substantial production and reserves of minerals are indirectly involved in the large-scale emission of the greenhouse gases as they are processed in coal-based and polluting smelters around the world, including some Arctic regions. Thus the Arctic is not only affected by rapid climate change, activities in the region are also contributing their share to the global warming. When considering these numbers it is reasonable to ask the question how vulnerable the economies of the Arctic are against future climate policies. Fortunately, the Arctic also has resources that increasingly may play a more benign role than fossil energy with respect to climate change. About 8 percent of the world forests are in the Arctic, and trade in carbon storage, which at present is a small, but emerging market globally may turn the forests into an even more highly appreciated asset, which can earn compensation for its services in the carbon cycle. Such deals are already in place to some extent, and there is a vast potential for more transactions. Forests resources are also increasingly in demand as substitute for fossil fuels both for stationary and mobile purposes, and for long-term carbon storage in building structures. The resource wealth of the Arctic seems capable to respond to global development and possibly change its character over time. Natural resource wealth is not really a fixed fortune – in real economic terms natural wealth will develop along with our preferences and needs – including what will be perceived along with climate change and climate policies.

In resource rich communities like the Arctic regions the sustainability of wealth management is particularly important. Resources that have been extracted from the ground represent a loss in wealth that should not be counted as income. However, by national account conventions it is still included in income. Because the natural wealth is not explicitly accounted for it can easily be consumed contrary to principles of long-term sustainability. There are several reasons for this. The communities may not be aware of the distinction between resource rent and income generated by labour and capital as rent has no separate account in private or public accounting systems. The governments may take political advantage of high consumption rather than invest to generate income in the future. Institutional arrangements can help improve the sustainability of resource wealth. The Alaska Permanent Fund with its dividend program of annual financial return to individual inhabitants now makes clear to every citizen that there is a trade off between consumption today and in the future. The institutional construction of the dividend program may also defend the fund from myopic political dispositions. Norway has no similar dividend scheme, but has renamed its Petroleum Fund to the Norwegian Government Pension Fund in order to remind politicians and other in need of immediate finance of the same connection. Sustainable management of resources is not only about smoothing the income flows, but also about separating wealth depletion from genuine income.

Thule, Greenland/Scanpix

It is important to have in mind when reading this report that the statistics on income and value of production include the wealth component of natural re-

sources. As the Arctic economies generate a substantial share of their income from resource extraction, it would have been useful to have data for genuine income generation in addition to the value of straightforward resource depletion. The Arctic region has higher extraction costs than in other regions and consequently the wealth component of reported income tends to be lower. As the report illustrates, however, the shares of extractive industries in the Arctic regions are high and it therefore remains a relevant question for the Arctic communities if wealth management is sustainable from their perspective.

Chapter 4 Arctic Economy within the Arctic Nations leaves the circumpolar perspective and looks closer at the role of each regional economy in the national context. In this chapter data are presented in local currencies. The core tables in this chapter are compiled to present a consistent set of data by region, at the same level of detail by industry in order to show economic structure in comparable definitions.

This economic overview is useful as such. However, it is also important as a basis for assessment of environmental problems and policies. The economic statistics

are the basis for information about the environmental pressure generated by production and consumption activities in the region. Further, the economic statistics are a key to understand how to reduce this pressure at the lowest costs. The cost and the effect of environmental regulations and economic policy both depend on how the existing economy works. Thus, to foresee for instance the effect of a CO_2 tax on gasoline consumption it is necessary to know who is using the gasoline, their willingness to pay and their ability to substitute other transportation and commodities for gasoline. Similarly, to assess the effects of climate change on the economy it is necessary to know the scale and the technology of production activities, i.e. how the warming affects the cost of production and the cost of alternative activities as well. For instance, as the number of days with ice roads declines due to warming of the Arctic, we need to know which production and service sectors that depend on this transport option and the cost it represents to them to go around the problem. Thus, for any approach to sustainable management of a society, the economic statistics are mandatory.

The Arctic is often described as dependent on natural resources and chapter 4 shows that this generally still is the case. However, those who use and those who produce a resource share the common fate of dependency. Intuitively to own natural resources wealth is a golden endowment, and the option to mine the resources does not call for worries about dependency if managed properly. Sustainable development demands that the natural wealth is transformed into other kinds of capital rather than being consumed. In addition to identify the wealth component of the extraction revenues this calls for data on the investment activity for an overall assessment of whether capital compensate reasonably for the depletion of the natural wealth.

When contemplating the Arctic economies, the comment is frequently made that the raw materials are exported out of the Arctic region with minimal local processing. Data in chapter 4 confirm that the share of manufacturing still is low in Arctic regions. It is clear that economic diversity is a kind of insurance to the societies. However, it is less obvious that the diversity necessarily should take place as enhanced manufacturing. If consumers want fresh fish rather than processed dishes it may well be most profitable to export the raw product directly. The reasons why the share of manufacturing in the Arctic economies is low may thus be rational based on market prices and the Arctic cost levels. The inflow of cheap manufactured consumer goods from Asia has made external competition even more difficult to withstand. However, Northern Finland has diversified into a globally leading producer of mobile phones and thus demonstrates that large-scale manufacturing also is feasible in remote areas if infrastructure and human capital with appropriate skills are in place. Further, developing countries have shown capacity to develop service industries based on electronic communication and thus de-coupled from most location and transportation constraints that the Arctic struggles against. Notice, however, that secondary industries not necessarily provide diversification. For instance in fishery intensive economies, the fish processing industry will closely follow the cycles of the primary fisheries rather than reduce the problems of resource and market vulnerability.

This report has a focus on the commercial activity in the Arctic regions. However, the Arctic has a rich wildlife that provides substantial values to the Arctic communities. Chapter 5: Interdependency between subsistence and market economies in the Arctic deals with the traditional production that is so far outside the statistical accounts of production and consumption due to its informal character.

The Arctic indigenous populations combine traditional life and production with participation in the market economy. For the preservation of tradition and cultural identities it is important to picture the symbiosis of subsistence and the market, and to identify how economic incentives and institutional barriers together affect the decisions to sustain and develop the traditional basis of life. The SLiCA[2] project has particularly surveyed the social living conditions of the Arctic, adding to the substantial knowledge of social and cultural issues provided by the Arctic Human Development Report (AHDR). Based on selected results from SLiCA and contributions from researchers on reindeer herding communities, chapter 5 in this report brings in the traditional economic life of indigenous people and other hunters and herders. In this context the term economic life is particularly relevant as it goes beyond the normal meaning of production and trade. The economy of indigenous people is partly a hunters' and gatherer's genuine lifestyle of high cultural value – hence their economic life has a multitude of dimensions other than the mere market value of the output.

The traditional life and economic basis relies on the ecosystem. As Chapter 6: Climate change in the Arctic: A discussion of the impact on economic activity makes clear, the list of effects on the Arctic economy from climate change is already long, and the economic implications for further sustainable development are challenging. This chapter provides a systematic presentation of how the expected climate impacts adhere to the various economic activities. This overview gives useful guidelines on how to proceed in further economic assessment of climate change. Better documentation of the economic activity in the Arctic will help to assess the robustness of the economies against climate change and climate policies, but there is still need for more conclusive results from natural sciences to trace the effects in economic terms.

One may easily think that a statistical overview of the Arctic economy might easily be available by just adding up the data provided by the statistical bureaus of the Arctic countries. Unfortunately, this is not the situation for several historical and institutional reasons. Some Arctic regions are regions within states and it is a general phenomenon that regional economic statistics have been less developed and is less complete than the one at the national level. Geographic location has been subordinated to other dimensions of the information so that regional data are often available only after special demand is expressed and after funding for compilation is in place. It also occurs that regional data are suppressed for confidentiality reasons as the number of enterprises involved is too low. Some Arctic regions are nations or autonomous regions with small populations and minimal capacity to carry out surveys and administrative routines that constitute a necessary basis for economic statistics and national accounts. Finally, the Arctic regions are associated with states using different classifications and definitions when producing the statistics – hence Arctic economic statistics has to be decoded and rearranged to a common format in order to be presented in a reasonably harmonized manner.

The lack of compatibility and also the special problems of producing regional statistics are at the core of the limitations facing the production of this report. The major problems associated with production of regional statistics are outlined in Box 3 pages 38-39 in this report. Due to the diversity in the statistical material this report should be read with care. Contrary to natural science data, the economic statistics are indicators that are built on certain assumptions and should be interpreted accordingly.

Acknowledgements

The Economy of the North report has been produced as a part of the ECONOR-project, which is funded by the Norwegian Ministry of Foreign Affairs and the Nordic Council of Ministers. *The Economy of the North* is a pioneering work in the sense that this path has not been tread on earlier. It is our hope that the overview of the Arctic economies will inspire further work to develop an information basis for the Arctic economies.

The Economy of the North is a result of contributions from a network of statistical officers and academics across the Arctic region. The individual chapters bear the names of the authors, however, the editorial group at statistics Norway carefully acknowledges the scale and competence of the contributions from the network, without which this report could not have been produced.

The network consisted of the following persons and institutions:

Alexander Goncharov, Federal State Statistical Service, Russia

Gérard Duhaime, Université Laval, Canada

Andrée Caron, Université Laval, Canada

Helen McDonald, Statistics Canada

Birger Poppel, Ilisimatusarfik, University of Greenland

Marianne Eriksson, Statistics Sweden

Scott Goldsmith, University of Alaska at Anchorage, USA

Ilmo Mäenpää, University of Oulo, Finland

Kristine Kolshus, Statistics Norway

Lars Lindholt, Statistics Norway

Knut H. Alfsen, Statistics Norway

Gunnar Eskeland, CICERO, Norway

Line Sunniva Flottorp, CICERO, Norway

The editorial group at Statistics Norway has consisted of:

Solveig Glomsrød (Project leader)
Iulie Aslaksen,
Mads Greaker,
Bjart J. Holtsmark

Notes

1 AHDR (Arctic Human Development Report) Akureyri: Stefansson Arctic Institute

2 SLiCA- Survey of Living Conditions in the Arctic.

Box 1. The use of Purchasing Power Parities in this report

The main purpose of this report is to provide an overview over economic activity in the Arctic regions. A major challenge has therefore been to add up and compare production data for different regions in different countries. There are some particular challenges associated with such comparisons. A translation of production data based on a straightforward use of market exchange rates (MER) will normally not reflect the true production volumes of the different regions. To adjust for price differences in domestic markets Purchasing Power Parity (PPP) indicators have been applied. However, also PPP conversion may sometimes lead to a biased assessment of production and income levels.

Chapter 2 provides an overview of the economic activity in the circumpolar region. Based on PPP-conversions it is estimated that gross product of the Arctic in 2003 accounted for 0.44 percent of the world economy, or 225 billion USD-PPP, of which the Arctic regions of Russia accounted for 140 billion USD-PPP, or 62 percent. PPP-converted gross products (value added) might be considered as proxies for income. In that respect income levels in the Arctic vary from a low of 19 500 USD-PPP/capita in Greenland to a high of 49 000 USD-PPP/capita in Alaska, cf. table 2.4. It is interesting to note the differences between national and regional income within the different nations bordering the Arctic. For example, per capita income of Russia is slightly less than 9 000 USD-PPP at the national level while it is almost 20 000 USD-PPP in the Russian Arctic regions. In Norway the pattern is reversed: While per capita income at the national level is 40 000 USD-PPP, the income level of the Norwegian Artic regions is 21 000 USD-PPP. Hence, while Norway has a considerably higher national PPP-corrected income level compared to Russia, income levels appear to be relatively similar if we look at these countries' Arctic regions.

As noted the data for the different countries have originally been reported in national currencies, but have in this report been converted into a common currency using purchasing power parities. Alternatively the national currency data could have been converted into a common currency by use of the market exchange rates. The Russian share of the Arctic gross product would, for example, then have been estimated to 32 percent, instead of 62 percent, cf. also Figure 2.

In most studies comparing different countries PPP-conversion is preferred to market exchange rates. We have followed this tradition and have applied PPP-converters developed by the International Comparison Program and the OECD-Eurostat PPP-program.

The advantage of PPP-conversion is that it takes into account that price levels vary considerably between countries. A frequently applied illustration of the variation in price levels is the price of a Big Mac in different countries. Using market exchange rates the average price of a Big Mac in Stockholm was 4.53 USD in April 2006, where as the price in Moscow at the same time was 1.77 USD. This illustrates that almost identical products are priced quite differently even in the Arctic countries if we use market exchange rates as the basis for price comparisons. Consequently MER-conversion of production levels might give seriously misleading numbers as far as production and consumption levels are concerned.

When practising PPP-conversion we would have preferred to use PPP-factors specific for the Arctic regions in each country, but Arctic-regional PPP-factors have not been developed. Instead we have applied PPP-factors for the national economies.

It is difficult to judge to what extent the use of national PPP-measures is misleading. If the economies of the Arctic regions simply were downscaled versions of the economies of the respective nations and products were priced uniformly across regions, the national PPP-converters would not have been a source of error. However, the Arctic regions are quite different from their respective national economies, as discussed in chapter 4. Moreover, the general price levels are different between different regions within the individual countries. A Big Mac is, for instance, more expensive in Anchorage than in New York. Hence, just as the use of MER-based numbers would represent a source of error, using national PPP-based numbers are also a source of error.

By Bjart Holtsmark
Statistics Norway

Table 1. Share of gross product and Arctic Russia by industries. 2002. Per cent

	Russian Arctic	Total Russia
Agriculture and forestry	2	7
Fuel production	36	6
Other industries	15	23
Construction	13	8
Trade	6	20
Other services	27	36
Totals	**100**	**100**

Table 1 shows the production sectors' share of Russian gross product in 2002 and their respective shares of the gross products of Russian Arctic regions. The most significant difference is in the share of fuel production, mainly consisting of oil and gas production. The Russian Arctic region is more dominated by this type of production than the rest of the Russian economy. Oil and gas are internationally tradable goods and the relatively high average income level of the Russian Arctic is largely due to the oil and gas industry. The dominance of the fuel industry in the Russian Arctic indicates that the use of a PPP-converter calculated for the whole Russian economy will probably represent an over-correction when it is applied to the Russian Arctic regions.

Figure 1 illustrates how sensitive the estimates of regional GDP per capita are to the choice between PPP and MER. When PPP-factors are applied, regional GDP per capita in Russian Arctic are close to the income levels of the Arctic regions of the Scandinavian countries. However, as MER-factors are applied, the income levels in Arctic Russia appears to be much lower.

It should be noted that we have reported data on regional GDP, not gross regional incomes, which have not been available for all Arctic regions. Because regional GDP, contrary to gross regional income, does not include transfers between regions, regional GDP per capita does not constitute a precise representation of income levels in the different regions.

Figure 1. GDP per capita by Arctic Region 2003. USD

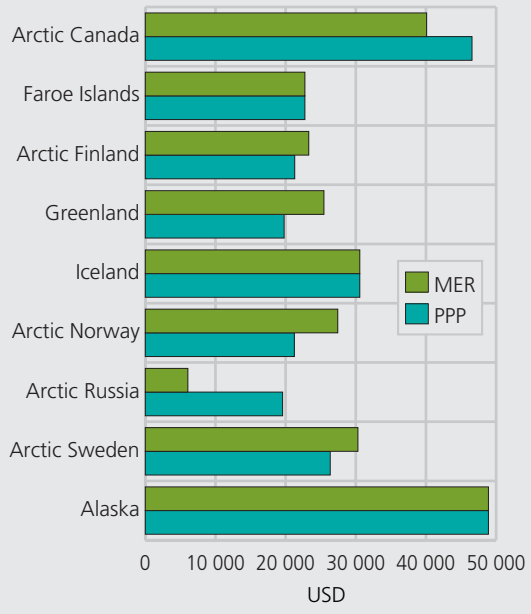
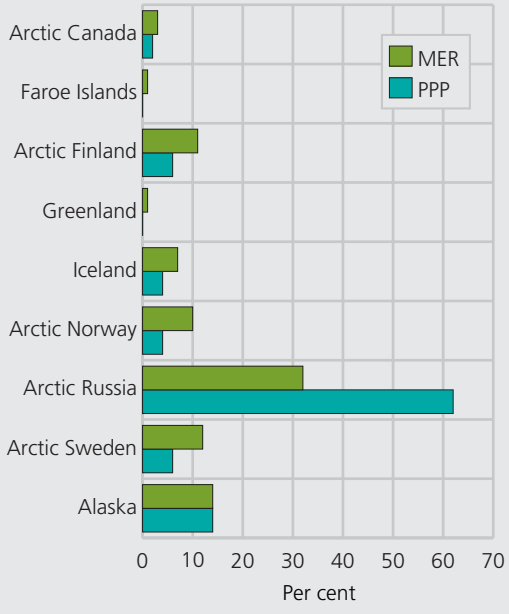
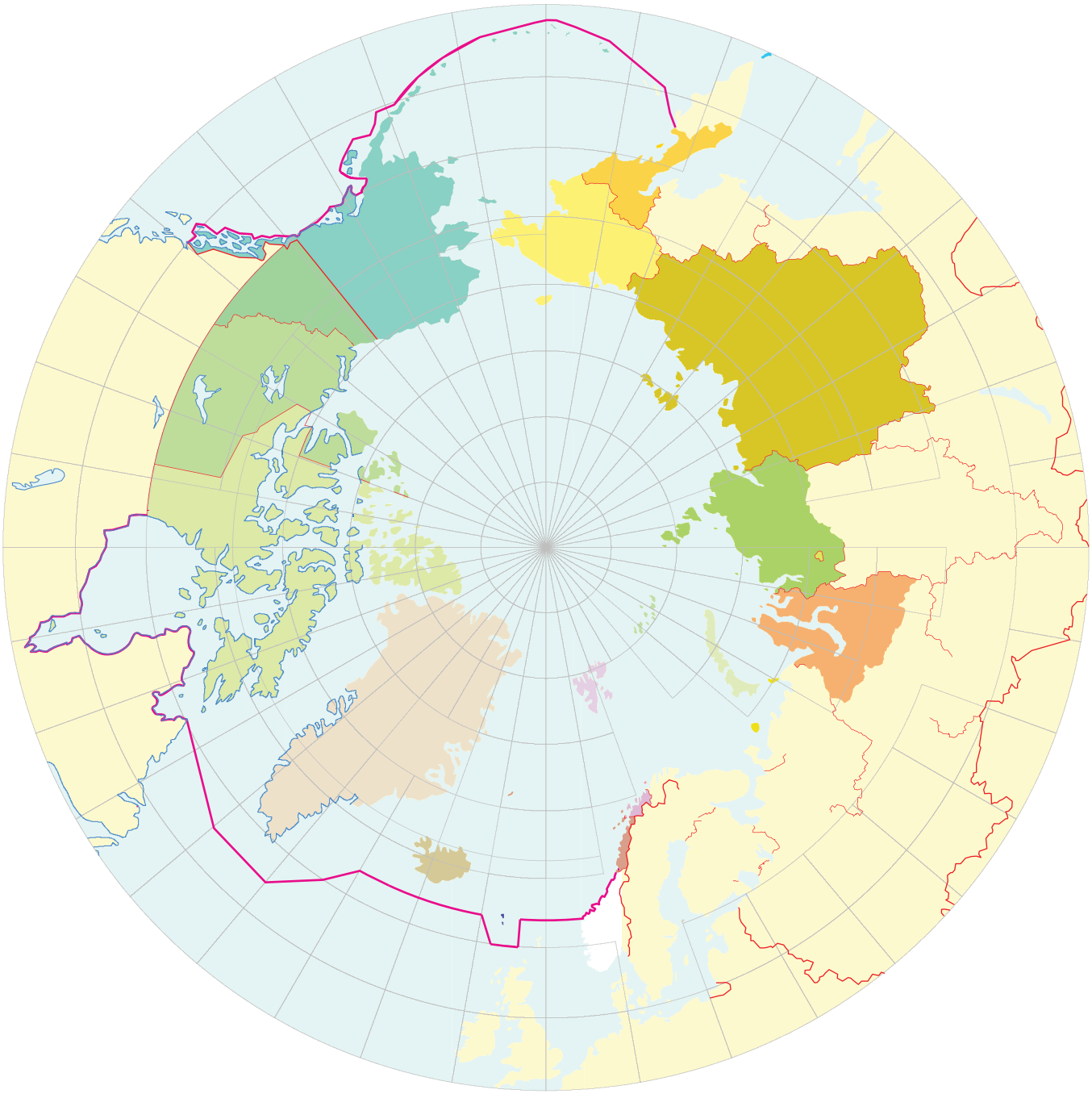


Figure 2. Arctic Region share of total circumpolar GDP. 2003. Per cent



The circumpolar Arctic



2. The economy of the circumpolar Arctic

Gérard Duhaime and Andrée Caron

The first comprehensive study on the Arctic economy using the main macroeconomic indicators was published in 2004 in the Arctic Human Development Report (AHDR).[1] According to this study, the circumpolar economy, as measured in 2001, has three distinguishing characteristics. First, the Arctic is exploited as a vast reservoir of natural resources serving the world market, and this massive extraction largely structures the rest of economic activity. Second, public services are often supported by major transfer payments from central to regional governments. Third, the customary use of living resources in activities such as family-based fishing, hunting and animal breeding continues to be important in economic terms and is now inextricably linked with the market economy.

The AHDR analysis also revealed some major characteristics of the geographic distribution of economic activity. First, while the Arctic exports to southern regions enormous amounts of raw materials for processing, it also imports a massive amount of finished goods and services for final consumption. Second, economic activity is unequally distributed among the different Arctic regions; the economic prosperity of the wealthiest regions being based on large-scale exploitation of natural resources.

The objective of this chapter is to present a new and updated analysis of the circumpolar Arctic considered as a whole. This analysis is based on an update of most of the data published in the 2004 AHDR.[2] It examines whether the conclusions reached then are still valid and, in some cases, it proceeds further in the investigation.

In the context of this chapter, the circumpolar area comprises the following 29 regions: Alaska, Northern Canada (Yukon, Northwest and Nunavut Territories and Nunavik), Greenland, Iceland, Faroe Islands, and the northern portions of Norway (Finnmark, Nordland, Troms, Svalbard), Sweden (Norrbotten, Vasterbotten), Finland (Lapland, Oulu) and the northern part of the Russian Federation (Karelia, Komi, Arkhanglesk, Murmansk, Khanty-Mansi, Yamalo-Nenets, Nenets, Taymir, Evenkia, Sakha, Chukotka, Magadan, Koryakia).[3]

The data obtained were from the most recent year available from the national statistical agencies of the different countries. They measure the total population and the gross domestic product by region and by industry of Arctic regional economic activity. To allow comparisons between Arctic regions in different national contexts, the economic indicators in local currencies have been converted into US dollars at purchasing power parity (USD-PPP), and made to refer to a single reference year, namely 2003.[4]

The Arctic and the global economy

In 2003, the economic activity of the Arctic totalled some USD-PPP 225 billion. Globally, this economy is comparable in size to that of Malaysia (USD-PPP 222 billion), which has a population of 25 million and Switzerland (USD-PPP 237 billion), which has a population of 7.4 million (see Table 2.1).

The population of the circumpolar Arctic was estimated at approximately 9.9 million in 2002. This represents 0.16 per cent of the world population and two per cent of the total population of the countries covered by the study (see Table 2.2, Table 2.3). Consequently, the Arctic GDP accounts for 0.44 per cent of the global economy, which is greater than its demographic weight of 0.16 per cent. This gap suggests that income generation is more concentrated in the Arctic than in the rest of the world. On the other hand, Arctic GDP includes resource rents from extraction of non-renewable resources, parts of which should rather be viewed as replacement of wealth from one asset into another asset than income generation.

The economic activity of the circumpolar Arctic as indicated by GDP also represents 1.6 per cent of the economy of all countries with Arctic regions, which is

Table 2.1. GDP and population for selected countries with a GDP between 200 and 300 billion USD-PPP. 2003. Million USD-PPP and N

	GDP *Million USD-PPP*	Population *Million*
Greece	220 000	11.0
Malaysia	222 000	24.8
Arctic regions	**224 766**	**9.9**
Switzerland	237 000	7.4
Austria	241 000	8.1
Bangladesh	258 000	138.1
Ukraine	262 000	48.4
Egypt, Arab. Rep.	266 000	67.6
Columbia	286 000	44.6
Saudi Arabia	298 000	22.5

Source: 2005 World Development Indicators, Table 1.1 Size of Economy and Table 2.1 Population Dynamics.
The results for the Arctic regions were calculated by the authors from the national statistical agencies GDP and population data.

Table 2.2. GDP and population, World and Arctic Regions. 2003. Million USD-PPP and N

	GDP *Million USD-PPP*	Population *N*
Arctic regions	224 766	9 915 271
World	51 401 000	6 272 500 000
Percentage	0.44	0.16

Source for the world data: 2005 World Developement Indicators, Table 1.1 Size of Economy and Table 2.1 Population Dynamics.
Other results were calculated by the authors from the national statistical agencies GDP and population data.

Table 2.3. Arctic Countries and Arctic Regions population. 2003. N

	Countries *N*	Regions *N*	Per cent of total *N*
Canada	31 600 000	111 546	0.4
Faroe Islands	47 000	47 000	100.0
Finland	5 200 000	645 272	12.4
Greenland	56 000	56 000	100.0
Iceland	289 000	289 000	100.0
Norway	4 600 000	465 200	10.1
Russian Federation	143 400 000	7 144 000	5.0
Sweden	9 000 000	508 973	5.7
United States	290 800 000	648 280	0.2
Total	**484 992 000**	**9 915 271**	**2.0**

Source for the countries data: 2005 World Development Indicators, Table 2.1 Population Dynamics except for Faroe Islands, Greenland and Iceland: Table 1.6 Key Indicators for Other Economy.
Other results were calculated by the authors from the national statistical agencies population data.

slightly less than its demographic weight (2.0 per cent). That gap, the opposite of the preceding one, could be explained by the fact that the Arctic includes relatively poor regions with high demographic weights that tends to drag the average Arctic GDP per capita figure downwards. On the other hand, many arctic regions, for instance Alaska, Yamalo-Nenets and Yukon have higher GDP per capita figures than the countries to which they belong (Table 2.4). In short, with some exceptions, economic activity seems to be more intense in the Arctic than in the rest of the world, but on average less intense in the Arctic than in the countries that encompass it. (Table 2.4.)

Primary sector plays major role[5]

The primary sector is the second largest sector in the circumpolar Arctic as a whole. Based essentially on the exploitation of natural resources, the primary sector represents roughly USD-PPP 70 billion and contributes 31 per cent to Arctic GDP (Figure 2.1).

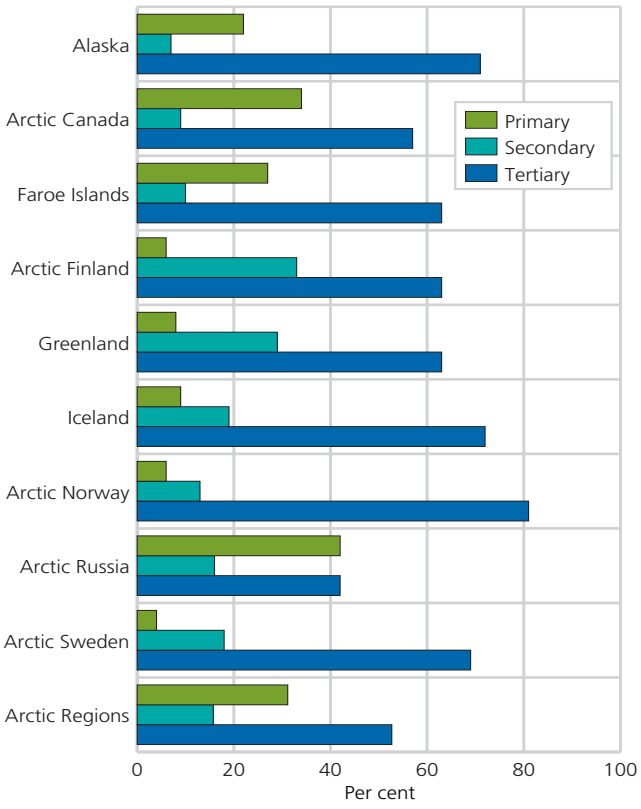
The primary sector in the Arctic consists primarily of two types of activities. The first type is the large-scale extraction of non-renewable resources, the value and volume of which is immense. These include hydrocarbons from Alaska's North Slope and the Khanty-Mansi Autonomous Okrug in Russia, nickel from Norilsk and the Kola Peninsula, diamonds from Canada's Northwest Territories and gold from Bilibinsky in Chukotka. Hydrocarbon production alone accounts for roughly USD PPP 53 billion, while the rest of mining production totals approximately USD PPP 9 billion. These activities characterize the Arctic and confirm its role as a reservoir of natural resources for world markets. The vast Arctic regions, most of which were opened to large-scale industrial exploitation in the 20th century, attract large national and transnational firms that have the necessary means to support massive operations and retain profit. Most often, this large-scale exploitation is carried out with capital, equipment and labour from outside the Arctic regions themselves. The real impacts on local and regional economic agents vary greatly. In some cases, these operations are, so to speak, parachuted into resource areas in the style of a «boom town», and are of little benefit to local businesses and manpower. This was the case with the Colomac and Tundra mines in Northern Canada.[6] In other cases, especially when the territorial rights of aboriginal residents are involved, these operations produce greater economic benefits for local and regional agents, as in the case of the Red Dog Mine in Alaska.[7] These projects also generate sizeable negative impacts. For example, they sometimes interfere with customary activities carried on by residents, in particular aboriginal residents, when they harm the environment or compete for land use.[8]

Table 2.4. Arctic Countries GDP and Arctic Regions GDP. 2003. Millions USD-PPP and USD-PPP per capita

	Countries		Arctic Regions		
	Millions USD-PPP	USD-PPP per capita	Millions USD-PPP	USD-PPP per capita	Per capitaGDP as per cent of country average
Canada	950 000	30 040	5 194	46 567	155
Faroe Islands	1 069	22 738	1 069	22 738	100
Finland	143 000	27 460	13 742	21 296	78
Greenland	1 108	19 552	1 108	19 552	100
Iceland	8 835	30 570	8 835	30 570	100
Norway	173 000	37 910	9 882	21 243	56
Russian Federation	1 284 000	8 950	139 815	19 571	219
Sweden	239 000	26 710	13 417	26 361	99
United States	10 978 000	37 750	31 704	48 905	130
Total	**13 778 012**	**28 409**	**224 766**	**22 669**	**80**

Source for the countries data: 2005 World Development Indicators, Table 1.1 Size of Economy except for Iceland Table 1.6 Key Indicators for Other Economy.
The results for the Arctic regions (including Faroe Islands and Greenland) were calculated by the authors from the national statistical agencies GDP data.

Figure 2.1. GDP by main industry. Arctic Regions. 2003. Per cent



These results were calculated by the authors from the national statistical agencies GDP data. 2002 for Iceland, Norway and the Russian Federation; 1992 for Greenland. Totals for Finland and Sweden do not equal 100, some data been classified as «non-specified». Data for the Russian Federation are estimated.

The second type of primary sector activity concerns renewable resources. In Karelia and the Faroe Islands, for example, commercial fisheries and forestry increase the value of primary activities. Compared with the first type of activity, these activities have an entirely different importance to the economic accounts and social reality. They are generally based on local investment rather than investment from outside; they are also heavily labour-intensive and the workers employed are mainly residents. These activities are carried on almost everywhere in the Arctic on a small scale. They are widespread and visible. They have broad impacts in the regions concerned, and for some of these regions, they are the backbone of the economy, even though their economic value is much smaller than that of hydrocarbons and minerals.

Uneven development in the secondary sector

The secondary sector (manufacturing and construction) is third in importance in the circumpolar Arctic, as a whole. It does not have the same importance in the Arctic regions as it has in the countries to which these regions belong, where manufacturing is generally more developed.

However, the secondary sector is not absent from the Arctic. It plays a substantial role in Iceland, Northern Scandinavia and Greenland.[9] In Iceland, for example, secondary activity exceeds primary activity in value creation. Manufacturing in the Arctic is especially robust in industries such as sea products, basic metals and metal products, machinery and various equipment, including precision instruments and transportation equipment. Overall, manufacturing is little developed in the Arctic, and therefore everyday consumer goods are generally imported from industrial centres further south.

Tertiary sector with public predominance

Lastly, in the circumpolar region as a whole, the tertiary sector (service industries) is by far the most dominant (Figure 2.1). It accounts for more than 50 per cent of all economic activity, and the figure even rises to more than 80 per cent in some regions such as Yukon or Troms and Finnmark. This situation may be explained by two major factors. The first is the weight of public administration. In general, public administration is the dominant service industry. In most regions, the total public sector, including health and education services, generally accounts for 20 to 30 per cent of all economic activity. In some regions, especially those where the primary and secondary sectors are little developed, public services may account for more than 30 per cent of all economic activity, as is the case in the Nunavut Territory where it reaches 45 per cent. The second factor that explains the preponderance of tertiary activity is the development of other industries such as trade, transportation and real estate. These industries stand out from the others because of their specific importance in the Arctic. Trade increases as basic industries expand and thus extend their economic benefits in the form of employment and consumption. Similarly, trade increases with the scale of government operations, such as investment in social housing and transportation infrastructures, and increase in public services. In the Arctic, this activity greatly benefits the transportation industry, since demand is largely for imported consumer goods, which must be brought into the Arctic.

Two development models

The Arctic displays two fairly distinct development models. In the first model, Arctic regions characterized by ancient settlements have structured their economy around the exploitation of renewable natural resources, such as fisheries or forestry. Some of these regions have managed to support this type of development, in particular through intensive industrialization, as in the case of the fishing industry in Greenland. In that region, the government has oriented development toward the harvesting and processing of groundfish and shrimp.[10] But other regions have seen this traditional foundation of economic activity approach stagnation. In these regions, such activities are still performed, but the economic context is such

that profitability is difficult to achieve or maintain. For example, reindeer herding is still practised in the north of the Russian Federation, but the reorganization of the industry in the post-Soviet period has led to a sizeable decrease in herds.[11] Also, reindeer herding is vulnerable to the degradation of pasturelands as a result of oil exploration.[12]

In the second development model, the economy is largely based on large-scale exploitation of non-renewable resources, mainly basic metals and hydrocarbons. Those regions, which have experienced major prosperity, some of it quite recently, have literally been opened to massive exploitation in support of national policies for industrial development or, more recently yet, energy security. This is the case with the gas-producing regions of the Yamalo-Nenets Autonomous Okrug to the east of the river Ob, where the Zapoliarnoie deposit was exploited from 2001.[13]

In both models, the growth of the State has accompanied these types of development or even induced them. In regions of ancient settlement, the introduction of universal services and national standards has seemingly increased the size of public administration. In regions where massive industrial projects were more recent, the presence of the State appeared to have laid the foundations for exploitation by supporting the creation of public infrastructure (health services, municipal services, housing, education, etc.). In any event, the relative weight of public administration in overall economic activity is a major characteristic of the situation in the Arctic. In all cases, industries such as trade and transportation develop in support of the basic industries.

Alaska. Photo: Photos.com

Import and export

Much of the resources extracted in the Arctic are transported outside the northern regions for processing. In particular, this is the case with hydrocarbons and minerals. Massive amounts of food products are also exported, as in the case of Greenland shrimp sold in Asia. However, not all food production is exported, as domestic markets exist in some regions. Conversely, the Arctic regions are supplied from outside with goods and services for consumption. While precise data are lacking on the circumpolar scale, there is every indication that globally the Arctic acts as an exporter of raw materials and energy and an importer of final goods and services.

The Arctic regions within the Arctic countries

An analysis of data gathered from the Arctic regions, as distinct from the country to which they belong, reveals some striking characteristics. The situation in the Russian Federation is unique. Only 5 per cent of the Federation's total population lives in its Arctic regions, but the domestic product of those regions accounts for 11 per cent of the country's overall economic activity. Nowhere else is the gap between these indicators so large. An analysis of relative results, that is, as measured per capita, yields similar findings. The per capita gross domestic product of Russia's Arctic regions is approximately twice as large as that of the Russian Federation as a whole. Again, in none of the other Arctic countries is this gap so pronounced. These differences seem to reflect the economic benefits of exploiting natural resources, especially the non-renewable resources, for which the volume and prices are high.

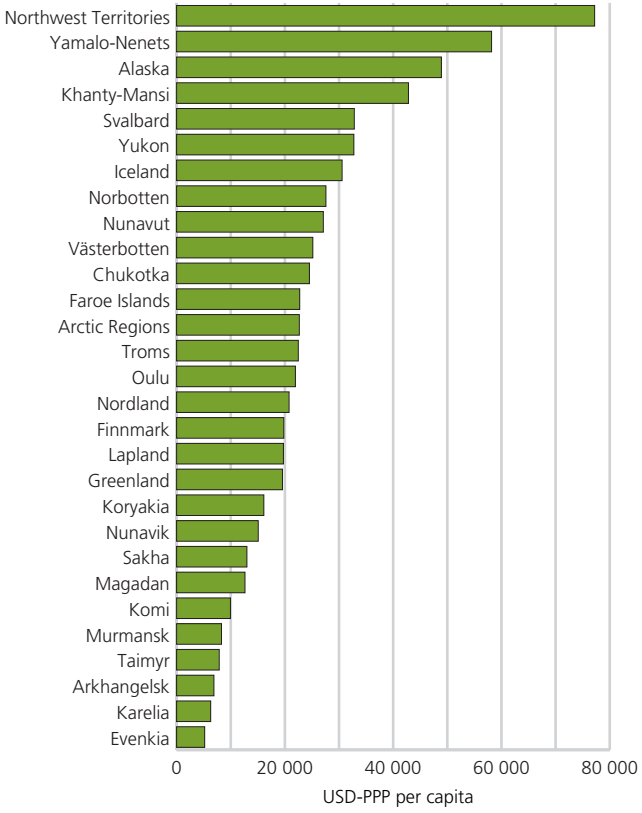
Other regions have gaps of this nature, but not of this magnitude. In Alaska and Northern Canada, the domestic product of the Arctic regions is also greater than their demographic weight. This is also true for per capita gross domestic product, which is higher in these regions than in the United States or Canada as a whole.

In Arctic regions, where the main extractive activity is in renewable resources, such as forestry in the Arctic areas of Sweden, per capita gross domestic product is closer to the average and may at times even be lower than that of the country as a whole.

Weight of the Russian North

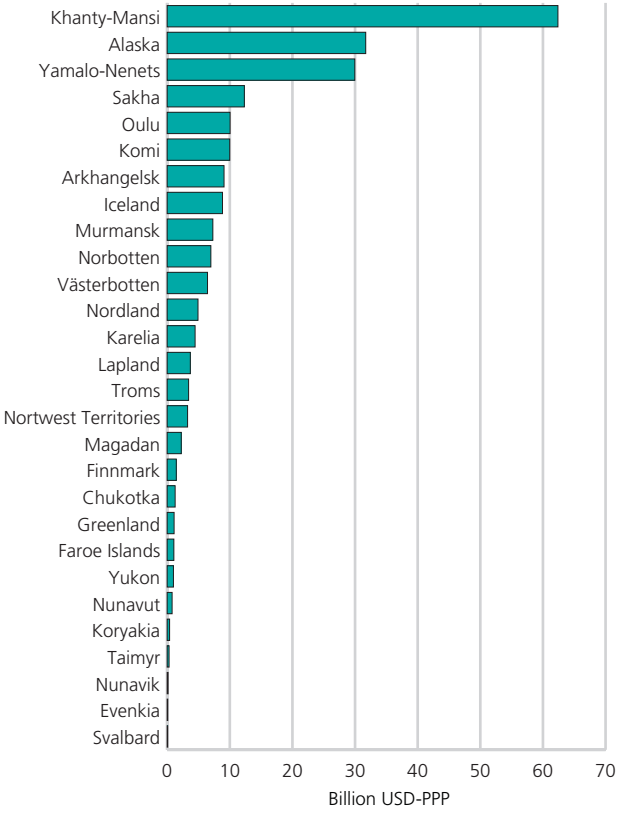
The Arctic is made up of 28 separate regions in 8 different countries. Alaska alone accounts for 14 per cent of all circumpolar output, whereas its population represents only 6 per cent of the Arctic population. This may be explained by the fact that, in Northern Alaska, there is major oil production on the North Slope and Alaska has the largest zinc mine in the world, as well as a large commercial fishing industry that has shaped its history for decades. Four regions generate more than 60 per cent of Arctic economic activity, that is, Khanty-Mansi, Alaska, Yamalo-Nenets and Sakha. Note that 3 of the 4 regions behind the 60 per cent of circumpolar GDP belong to the Russian Federation. As with Alaska, large-scale extraction activities are a major feature of the economy of these regions. Northern Russia is a major producer of oil

Figure 2.2. GDP, Arctic Regions. 2003. USD-PPP per capita



The results were calculated by the authors from the national statistical agencies GDP data except for Iceland 2005 World Development Indicators Table 1.6 Key Indicators for Other Economy

Figure 2.3. GDP, Arctic Regions. 2003. Billion USD-PPP



The results were calculated by the authors from the national statistical agencies GDP data except for Iceland 2005 World Development Indicators Table 1.6 Key Indicators for Other Economy

and natural gas, supplying both the Russian Federation and the global market.

Northern Russia alone represents two-thirds of all circumpolar economic activity. When combined with the economy of Alaska, this proportion reaches three-quarters. In other words, the economic activity of the Arctic regions of the Russian Federation and Alaska far outweighs that of the rest of the circumpolar world (Table 2.4 – Figure 2.3).

The geographic distribution of Arctic Russia's production is very unequal across the Russian Federation's Arctic territory. Apart from the regions that are particularly rich in natural resources (oil, minerals) like for instance Yamalo-Nenets , the value of the economic activity of most other Russian regions accounts for less than 1 per cent of the total circumpolar Arctic. In fact, apart from the Yamalo-Nenets, Khanty-Mansi and Chukotka regions, all the other Russian regions have a per capita GDP below the circumpolar average (see Figure 2.2).

The regional differences in the distribution of economic activity among its Arctic regions make Russia the country with the most contrasting regional differences. Some regions benefiting from the presence of strategic resources have undergone substantial development. Other regions, some of which were previously prosperous, have experienced an absolute decline, for instance, the Murmansk region, where the years following the dismantling of the Soviet Union, marked by high emigration and a decline in economic support from Moscow, were very harsh. Such regions were developed under the Soviet regime to exploit the presence of resources that were strategic at the time, such as base metals needed to industrialize the country. But the industrial infrastructure has aged considerably, while the resources themselves have been largely depleted, making the continuation of these activities much less attractive. In other cases, the support provided by the Soviet regime made it possible to maintain enterprises such as reindeer breeding in the Far East. This support ended with the dismantling of the Soviet Union, causing a major decline in this type of activity and deterioration in the living conditions of the populations affected.

Disparities among Arctic regions

When the circumpolar Arctic regions are analysed according to their per capita economic output, some noteworthy differences are revealed. The Canadian Northwest Territories have the highest per capita gross domestic product in all the Arctic (Figure 2.2). This situation is due to a low population density combined with significant diamond production. Launched at the start of the 2000s, diamond production in that region is now equal to the value of all mineral pro-

Canada. Photo: Photos.com

Iceland. Photo: Photos.com

duction in Alaska, excluding oil. This is an important industry, not only because the mining is intensive, but also because the stones mined are of great value on global markets. Indeed, this production has boosted Canada into second place, worldwide, in diamond production. Alaska, the Khanty-Mansi and the Yamalo-Nenets Autonomous Okrugs are the other regions having a per capita GDP more than twice the average for the Arctic as a whole. Like the Northwest Territories, those regions benefit from large-scale resource exploitation while their population, except for Alaska, is rather small. One should be aware, though, that high GDP per capita levels do not automatically transform to high levels of disposable income and/or consumption, in particular not in the regions with substantial extractive industries. On the one hand, resource rents and return to capital may be transferred out of the region to capital owners. Although, these figures will still add to regional GDP, they will not be available for consumption or saving in the region. On the other hand, direct state transfers will contribute to per capita levels of disposable income and/or consumption, but will not show up in regional GDP figures. Hence, a ranking of regional disposable income levels or consumption levels in the Arctic may follow a different order from GDP per capita.

Practically all the Arctic regions of Scandinavia, along with Iceland, Greenland and the Faroe Islands, have a GDP per capita around the average for the circumpolar Arctic. These regions all have relatively diversified economies, a relatively high standard of living and, at least in the Scandinavian regions, denser economic development than elsewhere in the Arctic countries. Iceland, whose fishing industry continues to be important, also has a developed tourism industry, as do the Arctic portions of the Scandinavian countries due to a road infrastructure that links the northern fringes with the rest of the European continent. Greenland, a major exporter of shrimp on world markets, as earlier mentioned, also has a relatively large tertiary sector. In Finland, the manufacturing sector, which is relatively undeveloped everywhere else, has undergone a remarkable boom in the Oulu region due to the presence of its wireless communications manufacturing industry.

Finally, the regions with the lowest production value belong to the Russian Federation, as already mentioned. These results would appear to be attributable to a combination of several factors, including the disorganization of the economy during the 1990s and emigration.[14]

Concluding remarks

This analysis confirms the earlier findings of the 2004 AHDR. The circumpolar Arctic is exploited as a vast reservoir of natural resources that are destined for the southern, non-Arctic, parts of the countries that also include Arctic regions, and more broadly to global markets. The Arctic is a major producer of hydrocarbons, minerals and marine resources, whose importance is confirmed by the very value of the resources produced. The economy of the Arctic is also characterized by large service industries, particularly through the role of the State. Finally, it is characterized by a limited secondary sector, at least in most of the regions covered.

This analysis also confirms that circumpolar economic activity is unequally distributed among the different Arctic regions. Those with plentiful natural resources, particularly non-renewable resources, have a level of economic activity well above the Arctic average. Those regions where economies are not based on large-scale exploitation of resources, or with a very limited secondary sector, generally experienced a below-average level of economic activity. Regions with GDP per capita around the average generally appear to have a more diversified economy. Not only are there sizeable divergences across the circumpolar area as a whole, but such divergences also exist within the most geographical vast countries, such as the Russian Federation and Canada.

The data presented above confirm Russia's considerable economic weight in the circumpolar world. Russian regions exhibit the main characteristics observed at the circumpolar level: large-scale exploitation of

natural resources and very unequal distribution of economic activity as indicated by GDP.

Finally, an analysis of geographically disaggregated data suggests that the Arctic regions have developed according to two distinct models, based on the type of resources exploited and the size of operations. This indicates that the economic reality of the Arctic is not homogenous. More detailed analyses, involving inter-regional comparisons, for example, could advance the study of this topic.

Notes

[1] Duhaime, Gérard et al. 2004. Economic Systems. In Einarsson, Niels et al. Arctic Human Development Report. Akureyri, Stefansson Arctic Institute, pp. 69–84.

[2] The basic data used to describe the situation of Nunavik (in Canada) are the same as those used in 2001 because they have not been updated since then. Labrador (in Canada) is still not included in this analysis, as there is no available data on its gross domestic product.

[3] In addition, the AHDR study covered an area that included some portions in the Northern Russian Federation that stretch well below the Arctic Circle. The vast oblasts of Tyumen and Kamchatka and the krai of Krasnoyarsk were included in AHDR because the economic statistics available at the time were not disaggregated enough to depict the Arctic region. Further compilation by Goskomstat Russia (now Rosstat) now provides data of the administrative territories in the Russian Federation that correspond more closely to the polar circle.

[4] The data used to describe and analyse the economy are reported in different currencies and must be converted to a common currency. However, price levels differ between countries and the transformation of GDP to a common currency by exchange rates does not properly reflect the purchasing power in the various countries. The Purchasing Power Parity (PPP) makes it possible to obtain conversion rates between currencies that eliminate differences in price levels between countries (see Box 1).

[5] This type of analysis is difficult in the circumpolar context. The Russian Federation uses an industrial classification system that is hard to compare with the systems used elsewhere. In other regions, it is easy to distinguish activities belonging to the primary sector, e.g., mining, from those belonging to the secondary sector, e.g., metal processing. The Russian data do not make these distinctions: for example, it aggregates into a single category the measures of natural resources extraction, refining and processing. Currently, the only way to get around this problem is to produce estimates using the methods employed in the 2004 AHDR. These estimates provide an order of magnitude of the primary and secondary sectors, but they overestimate the importance of the primary sector, to an extent that cannot be determined. Consequently, the findings that follow must be treated with caution.

[6] For these examples and similar ones, see: http://nwt-tno.inac-ainc.gc.ca/cd-s_e.htm#3.

[7] The legal and policy framework for resource exploitation practices seem to vary greatly from one place to another in several respects in relation to the local economic spin-offs or protection of the environment, and therefore there are equally varied impacts on the regions or communities involved. Public and private policies, corporate practices and economic and social spin-offs associated with these large projects merit further study. For examples and a discussion of the topic, see Duhaime, G. et al. 2003. The Mining Industry and the Social Stakes of Development in the Arctic. Québec, Université Laval, 20 p. www.chaireconditionautochtone.fss.ulaval.ca/extranet/doc/116.pdf.

[8] Environmental degradation was amply documented in the AMAP reports. Also, see Crawford, R.M.M., 1997. Disturbance and Recovery in Arctic Lands. An Ecological Perspective. Dordrecht, Kluwer Academic Publishers, 621 p; Nuttal, M., 1998. Protecting the Arctic. Indigenous Peoples and Cultural Survival. Amsterdam, Harwood Academic Publishers, 195 p. For traditional activities, such as reindeer herding, examples of competition include forestry companies in the north of the Scandinavian countries. These companies disturb grazing areas. In Northern Russia, competition comes from gas companies, which disturb transhumance routes. See Kankaanpaa, S. et al. (eds), 2002. Northern Timberline Forests: Environmental and Socio-Economic Issues and Concerns. Kolaari, The Finnish Forest Research Institute, 289 p.; Association of World Reindeer Herders, 2002. The 2nd World Reindeer Herders' Congress. Anar 2001. n.l. University of Lapland (Arctic Center Reports 36), 182 p.; Golovnev, A.V. & G. Osherenko, 1999. Siberian Survival. The Nenets and Their Story. Ithaca, Cornell University Press, 176 p.

[9] The analysis of Greenland data is deliberately limited here, since the data on the distribution of GDP by sector and industry date back more than ten years. However, the distribution of the labour force by sector and industry, for which the data date from 2003, tend to confirm the importance of the secondary sector. According to this source, nearly 15 per cent of the labour force are employed in the secondary sector and are distributed fairly equally between manufacturing (essentially the processing of products from the sea and other food products) and construction. See Statistics Greenland, 2005. Greenland in Figures 2005. «Employment distributed by trades and industries,» p. 12.

[10] See Rasmussen, R.O. (2001). Local, Regional and International Markets for Fish in Greenland. In Caulfield, R.A. & M. Kojima (eds). Northern Communities and the Global Economy. Proceedings of the Fifth Circumpolar Arctic Social Sciences Ph.D. Network (CASS) Field Course, Alaska 2000. Fairbanks, University of Alaska, pp. 75–87.

[11] The Chukotka reindeer herd declined from 464 000 to 148 000 between 1985 and 1998. See Newell, J., 2004. The Russian Far East. Mckingleyville, Daniel & Daniel, p. 286.

[12] For example, see Tuisku, T., 2003. Surviving in the Oil Age. In Rasmussen, R.O. & N.E. Koroleva (eds). Social and Environmental Impacts in the North. Dordrecht, Kluwer Academic Publishers, pp. 449–462; Forbes, B.C., 1997. Anthropogenic Tundra Disturbance in Canada and in Russia. In Crawford, R.M.M. Disturbance and Recovery in Arctic Lands. An Ecological Perspective. Dordrecht, Kluwer Academic Publishers, pp. 365–380.

[13] See Cabanne, C. and E. Tchistiakova, 2002. La Russie. Perspectives économiques et sociales. Paris, Armand Colin, pp. 123 ff.

[14] The exodus is substantial in the northern regions of Siberia, at the mouth of the Ob in the Bering Strait, but also further west in the European north, in the Komi Republic, the Nenets Autonomous Okrug of the Arkhanglesk Oblast, the Republic of Karelia and the Kola Peninsula. The exodus has been brought on by the closure of establishments that were opened to develop natural resources, the elimination of the benefits granted at that time to workers who agreed to live in the north (higher wages, travel vouchers), the hardships of daily life (such as power outages and difficulty and cost of obtaining supplies), etc. «Deputatsky, in northern Yakutia, had a population of 17,000 in 1990. In 2001, there remained only 3,900 inhabitants, supplied with power, as is often the case in the Far North, by a diesel-operated mini electric power plant. In February 2001, 1,400 inhabitants had to be air-evacuated because of a fire at the station in temperatures of –46°.» See Cabanne, C. and E. Tchistiakova, 2002. La Russie. Perspectives économiques et sociales. Paris, Armand Colin, pp. 39–40.

Box 2. The value of having the exclusive right to exploit a natural resource

The artic regions are rich in natural resources; Alaska, Khanty-Mansi and Yamalo-Nenets have vast oil and gas deposits, Greenland, Iceland and Northern Norway enjoy access to rich fishing grounds and Canada's Northwest Territories have found large diamond deposits. Furthermore, in other regions like Northern Norway, Murmansk and Arkhangelsk, there are great hopes for discovering oil and gas in the Barents Sea.

The natural resource sectors contribute by a large share to Arctic GDP. On the other hand, it does not follow that without the natural resources Arctic GDP would have been reduced by the same amount. GDP figures include the use of labour and capital to extract resources. Without the natural resources, both the labour and the capital employed could have been utilized in other sectors of the economy, and hence, they would have contributed to GDP anyhow.

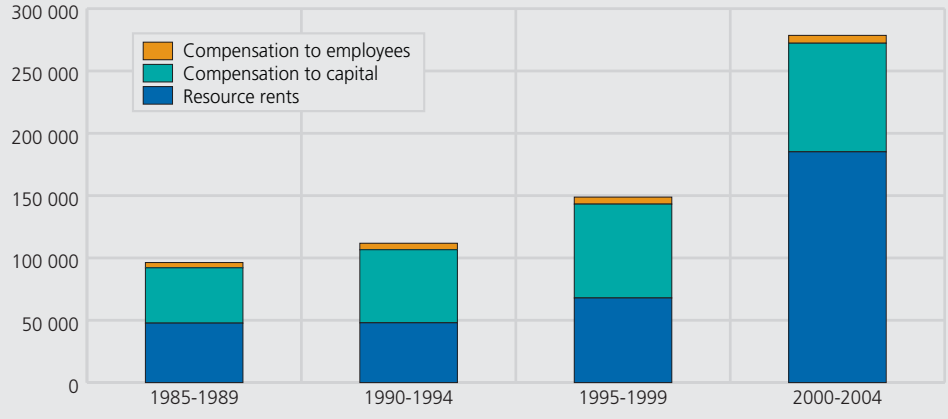
In national accounting terms stocks of unexploited natural resources should be viewed as capital assets. The value of a capital asset is usually reckoned as the total discounted net income accruing from it. With respect to natural capital this is usually referred to as a stream of *resource rents*. The resource rents are thus the additional income a nation/region obtains from having the exclusive right to exploit a natural resource.

With point of departure in the national accounts, Eurostat (2001) and SEEA-2003 defines resource rent in the following way:

Resource rent =	i)	+ Basic value of output/production
	ii)	- Intermediate uses
	v)	- Compensation of employees
	vi)	- Return to fixed capital
	vii)	- Capital consumption

When calculating compensation of employees and return to fixed capital, the idea is to use wage rates and rates of return that reflect the *alternative value* of both the workers and the capital employed to extract the resource. For Norway the *average* wage rate and the *average* rate of return to capital for all non-natural resource based industries have been used as a measure of the *alternative* value[1]. However, there is yet no consensus in the literature on the correct measure; for instance, The World Bank uses the average wage paid in the primary sectors as their measure for the alternative value of labour[2]. Below is an example from oil and gas extraction in Norway. All figures connected to oil and gas extraction accrue to a separate «off-shore» sector in the Norwegian national accounts.

Figure 1. Five-year average decomposition of gross production in the Norwegian oil and gas sector[1]

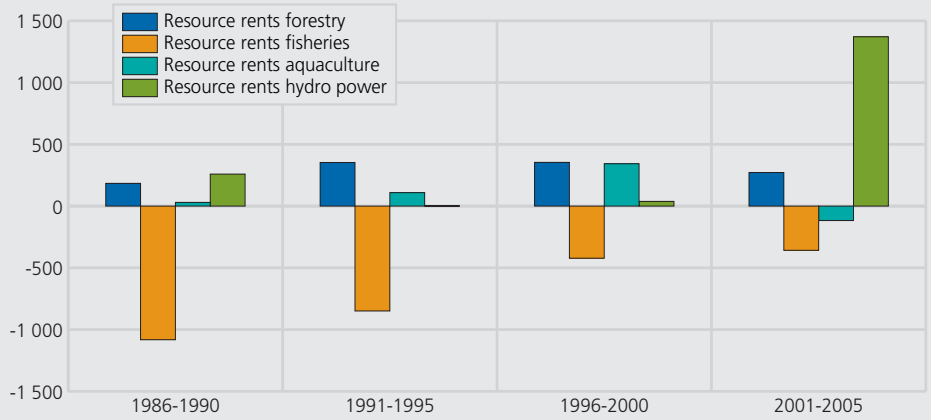


By Mads Greaker
Statistics Norway

The size of the resource rents is very dependent on world market prices of oil and gas. Output price movements can explain the large increase in resource rents from the period 1995-1999 to the period 2000-2004. Note also that the compensation to labour makes up a very small part of gross production, and that the compensation to capital makes up a large and fairly constant part. To the extent that the figures from Norway are representative for the situation in the Arctic, it is of great interest from an Arctic sustainable development perspective to study further whether resource rents are reinvested in other revenue yielding capital assets located in the Arctic.

Not all natural resources have a positive resource rent. Studies from Norway show that even though Norway has access to rich fisheries, the resource rents are mostly negative. These figures indicate that in organizing the fisheries, the Norwegian authorities do not only maximize the surplus from the fisheries, but also focus on other targets such as providing jobs in remote areas. However, from a resource rent perspective jobs is a cost because labour has an alternative value. As already mentioned, one may of course discuss whether the average wage rate in the non-resource sectors is the correct measure of this value.

Figure 2. Five-year average resource rents from the renewable natural resources in Norway[1]



[1] Greaker, Mads, Pål Løkkevik og Mari Aasgaard Walle (2005): The development of the Norwegian national wealth 1985-2004. An example of sustainable development? (In Norwegian). Reports 2005/13, Statistics Norway.
[2] World Bank (1998): Estimating National Wealth: Methodology and Results, World Bank, Washington D.C.

Liefdefjord, Svalbard. Photo: Inge Solheim

3. Arctic natural resources in a global perspective

Lars Lindholt

Large and population-rich developing countries have experienced rapid economic growth in recent years, and we see the footprint of this development in rising demand for raw materials even in remote areas where reserves are available as in the Arctic. The Arctic is endowed with petroleum, minerals, fish and forests that increasingly attract the interest and mobilize the purchasing power of the emerging economies. The Arctic is also of interest to many industrialized countries trying to find secure supplies of many natural resources. In this chapter, we examine the Arctic contribution to global production of some major raw materials. Typically, we will depict production in the natural resource extraction sector in the Arctic as a share of world production. Further, we indicate the Arctic's share of world reserves for some core resources.

Petroleum extraction

Petroleum production in the Arctic is mainly taking place in Alaska and Northern Russia[1]. Around 97 per cent of total Arctic oil and gas production is located in those two Arctic regions. Alaska contributes around 20 per cent of total US production. The centres of Russian oil and gas production are West Siberia and Timan Petchora located in the republic of Komi and the Nenets region. In both these Russian petroleum rich regions, production is land-based. Oil production in Alaska has centred around the Prudhoe Bay field on Alaska's North Slope, where production peaked in the 1980s and thereafter has been in decline in spite of the surrounding new but small field discoveries.

Figure 3.1 shows that the Arctic shares of global oil and gas production are 10.5 and 25.5 per cent, respectively. For petroleum in total, the Arctic region produces 16.2 per cent, a significant share considering the modest size of the Arctic population and economies. Like the Middle East, the cold Arctic offers large areas of land unsuitable for agriculture, but rich in resources that, earlier, were not utilized by people searching for a living.

With respect to proven petroleum reserves, gas is much more important than oil. Of the total global proven reserves of oil and gas, 5.3 and 21.7 per cent, respectively, are located in the Arctic (see Figure 3.2). Almost all of the Arctic proven gas reserves are found in Russia. Also regarding the Arctic oil reserves, we find around 90 per cent in Russia. The oil price is expected to remain high over the next two decades[2], thus Arctic resources are attracting considerable attention, in spite of the relatively high extraction costs in these areas. Consequently, the Arctic is under vigorous pressure to lift production.

In Siberia and Alaska, operations have historically mainly been pursued on land in response to the focus on land-based exploration. Beyond that, the Arctic and its waters represent virgin territory. In Alaska, areas along the northern coast (east of Prudhoe Bay) are regarded as promising for oil and gas discoveries. To US authorities, this represents an opportunity to reduce dependence on oil and gas imports from politically unstable areas. However, these plans have met strong opposition from environmental groups who argue that petroleum production might damage the vulnerable Arctic ecosystem. Russia will also intensify exploration in its Arctic regions, and production is expected from offshore fields on the Russian continental shelf in the Barents Sea and the Petchora Sea[3]. The best-known discovery is Schtokmanovskoye in the Barents Sea, with estimated reserves of around 3200 billion cubic metres of gas. Production of oil and gas for the US market is seen as an important option for development of petroleum resources in North-western Russia. However, Europe will remain a core market for oil and gas exported from this area. Explorations in the Norwegian sector of the Barents Sea (outside Hammerfest in Northern Norway) have yielded several discoveries, including the Snøhvit gas field now under development.

Figure 3.1. Arctic share of global petroleum production. 2002

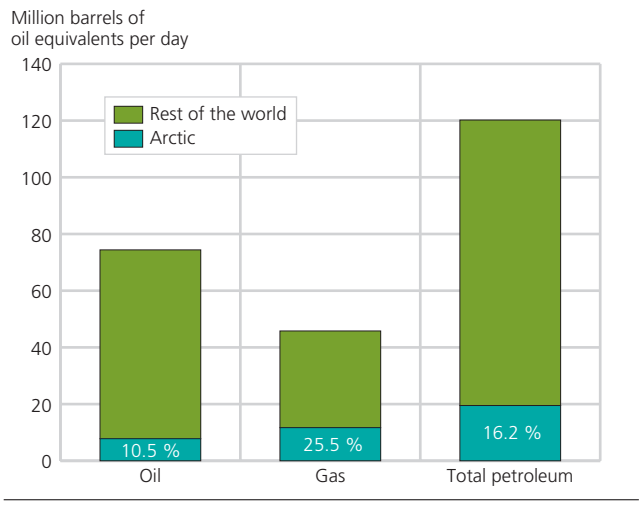
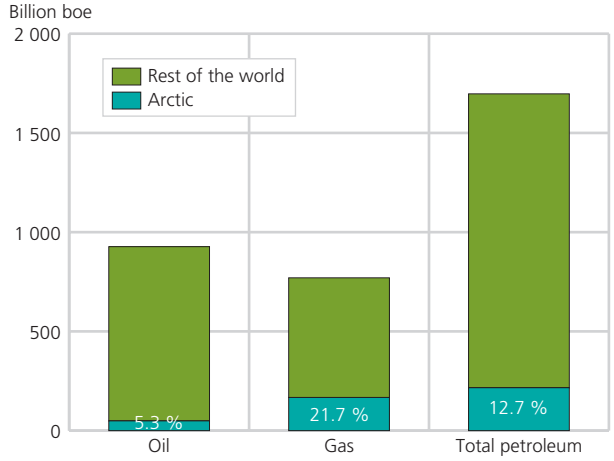
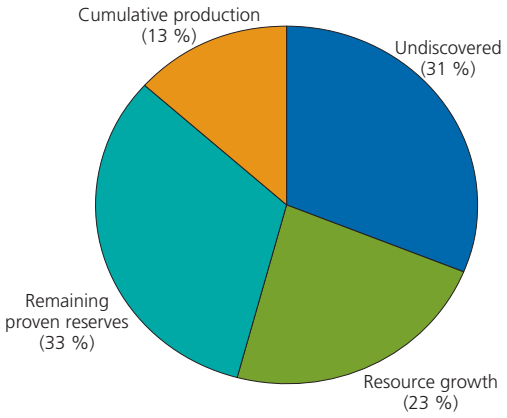


Figure 3.2. Arctic share of proven petroleum reserves.[1] 2002



[1] Quantities indicated with reasonable certainty from geological and engineering information that that can be recovered in the future from known reservoirs under existing economic operating conditions.

Figure 3.3. Global endowments of petroleum resources. 2002



The fact that discoveries are made does not in itself imply that petroleum will come on stream in the near future, particularly not in the Arctic, with such extreme climatic conditions and challenges. It has taken around 23 years to consider and develop Snøhvit, which is expected to start production in 2007. Schtokmanovskoye was proven in 1988, but it is still not under development. High oil and gas prices will tend to counteract such delays, but the environmental, biological and fishery matters represent issues that concern the respective authorities in each case. Many regard the Barents Sea as Europe's last large, clean and relatively untouched marine ecosystem.

In Figure 3.2, *proven* petroleum reserves are displayed. However, besides proven reserves, there probably exist large endowments of undiscovered petroleum resources that may add to reserves if they are discovered. Based on geological evidence and methods, such undiscovered resources can be assessed, including those shared by the Arctic.

The US Geological Survey, completed in 2000, assessed the world's conventional petroleum resources outside the United States[4]. The petroleum geology of each province was investigated and an assessment was made based on this, combining geologic analysis with a probabilistic methodology to estimate total and remaining resource potential. Probabilistic methods attach probabilities to the resource potential in the various geological sediments and regions. In Figure 3.3, we present the USGS's median estimate of resources, i.e., it is estimated that there is a 50 per cent chance of finding at least these amounts of petroleum. The USGS assessment is not exhaustive, because it does not cover all sedimentary basins of the world.

When combining this assessment with estimates for the United States, the world's endowment of recoverable petroleum (including natural gas liquids) is estimated to be at about 5.2 trillion barrels of oil equivalents[5]. Figure 3.3 shows that about 13 per cent of the world's endowment had already been produced by 2002 and an additional 33 per cent had been discovered and booked as reserves. Furthermore, the USGS attribute 23 per cent of the remaining oil and gas resources to resource growth; i.e., the observed increase in reserves for petroleum fields over their lifetime. The initial estimates of reserves in many fields are lower than the ultimate volume of petroleum produced from these fields, due to technical change and better information. Furthermore, the data suggest that undiscovered resources constitute 31 per cent of the world's petroleum resources.

About half of the estimated undiscovered petroleum potential of the world is offshore, especially outside the established provinces of the United States, former Soviet Union, Middle East and North Africa. Arctic basins, which are estimated to hold 23.9 per cent of the undiscovered petroleum resources, may make up the next great frontier (see Figure 3.4). The expected amount of undiscovered petroleum in the Arctic equals around 390 billion barrels of oil equivalents. The Arctic share amounts to 20.5 per cent and 27.6 per cent of undiscovered oil and gas, respectively.

When adding total proven reserves and undiscovered *oil* resources, we find around 13 per cent of the world reserves in the Arctic. As around ten per cent of the global oil production takes place in the Arctic today, this shows that the Arctic has the potential to continue as an important supplier of oil in the future. Various surveys indicate that global oil supplies in many areas outside OPEC will begin to decrease from around 2010–2020[6]. This may put further pressure on developing Arctic areas, especially if many oil-importing countries find this supply more stable and secure than that of many OPEC suppliers. Around 25 per cent of total proven reserves and undiscovered gas-resources are located in the Arctic, matching the Arc-

Figure 3.4. Arctic share of undiscovered petroleum resources. 2002

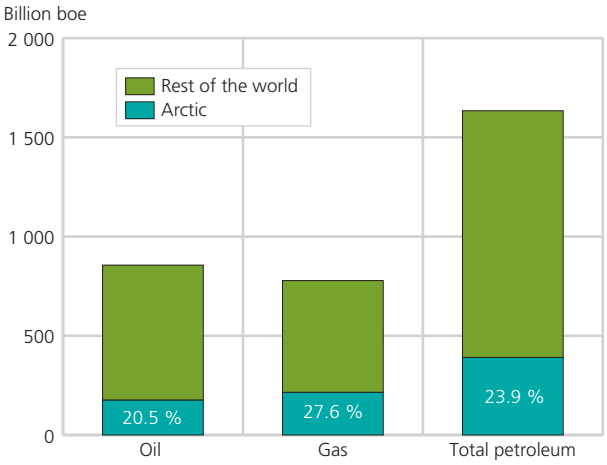
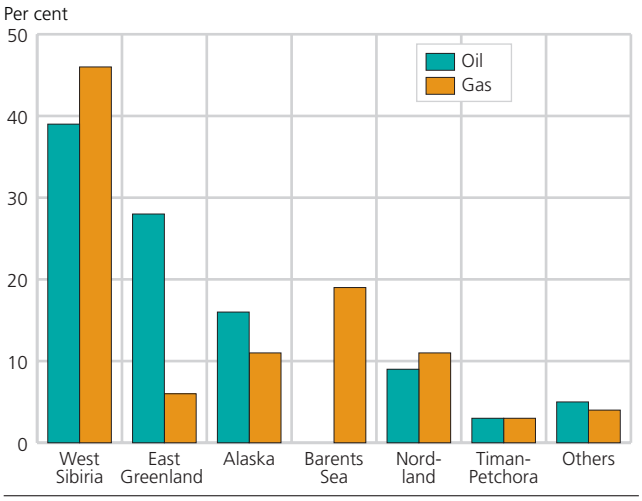


Figure 3.5. Regional distribution of undiscovered petroleum resources in the Arctic.[1] 2002



[1] Timan-Petchora is located in the Nenets region of Russia. The Barents Sea covers both Russian and Norwegian areas.

tic share of global gas production today, which is around 25 per cent. As global gas demand continues to increase in the future, the Arctic has the potential to continue to supply around one-quarter of total demand.

The Arctic Ocean surrounding the geographical North Pole is the core of the region, and its deepest part goes down to almost 5 500 metres. However, the surrounding continental shelf is wide and shallow off Europe and Asia, all the way from the Barents Sea in the west to the Bering Strait. In some areas along this coast, the continental shelf extends a long way towards the pole. The corresponding continental shelves off Alaska, Canada and Greenland are significantly narrower[7].

Norway, Russia, the US, Canada, Iceland and Denmark via Greenland all have an Arctic continental shelf. Arctic Russia embraces by far the largest area and may cover 45–55 per cent of the total volume of the undiscovered oil and gas resources in the Arctic (Figure 3.5).

Areas that contain the greatest volumes of undiscovered conventional oil include West Siberia (in the republic of Komi), Alaska and the Norwegian Sea (Norway). A significant undiscovered oil resource potential is also found in areas that do not have a significant production history, such as Northeast Greenland. Areas that contain the greatest volumes of undiscovered conventional gas include the West Siberian Basin, the shelves of the Barents and Kara Seas, offshore Norway in the Norwegian Sea and Alaska. As not all sedimentary basins in the Arctic have been surveyed, significant *additional undiscovered* gas resources might occur in a number of areas where large discoveries have been made but remain undeveloped, such as East Siberia. The Barents Sea is the least explored part of the *Norwegian* continental shelf. Since its southern area was opened for exploration by the Norwegian Storting (parliament) in 1979, only around 60–70 wells have been drilled there.

Future petroleum production in the Arctic will involve offshore investments. Developers are indeed approaching the new frontier of cold, permafrost and winter darkness, which is challenging on land but even worse at sea. The petroleum industry has not been paying attention to offshore activities in northern waters for more than a decade. To begin with, the strategy was built around massive platforms that could withstand icebergs. Now the industry sees new and better opportunities in smaller and more mobile units that can avoid collisions with heavy icebergs. The harsh environment poses very special demands on technology, and this is also reflected in the level of supply costs. Exploration wells drilled from vessels specially designed for icy waters are expensive. Total supply costs end up being somewhere between three and five times the cost of similar projects in temperate locations. Most conventional Arctic petroleum resources will eventually become profitable at long-term oil prices of between USD 20 and USD 60 per barrel[8]. Extraction of relatively low-cost resources are the type of projects already being developed, while high-cost resources have supply costs estimated at around three times higher than for conventional resources in temperate locations *outside the Middle East*. Many of the promising areas are in Russian waters north off Siberia, where the continental shelf is less than 200 metres deep, even far from the coast.

With a future oil price around USD 60 per barrel and a supply cost around USD 10 in areas outside the Arctic[9], the net value of a barrel of oil from those areas is around USD 50. If the supply costs are three times higher in the Arctic, the corresponding net value will be around USD 30. Hence, although the Arctic contains around 24 per cent of the volume of undiscov-

ered petroleum resources, our simple example shows that the *value* of these Arctic resources is around 16 per cent of the total value of undiscovered petroleum[10]. The purpose of this simple example is not to present exact figures, but simply to stress the fact that the Arctic share of the global *monetary* value of petroleum might be less than the share of the global *physical* value. However, the future cost level is also subject to further technological development based on new experiences in Arctic offshore exploration and production. Learning by doing has not yet flowed through to lower costs in Arctic offshore activities, however. The future will eventually reveal how much of the Arctic resources are recoverable given terms by the markets, the technology and environmental regulations.

Other mining

In addition to oil and gas, the Arctic region contains other abundant mineral resources. However, many known reserves are not exploited because of their inaccessibility. Arctic Russia clearly extracts the largest amount of minerals, but the other Arctic nations also have certain important extractive industries, providing raw materials to the world economy[11, 12].

Below is a survey of important minerals that are found in the Arctic, including coal, iron and ferro-alloy minerals, several non-ferrous minerals and industrial minerals. Due to the numerous types of minerals that exist, the list will obviously not be exhaustive. We also lack data on certain minerals. Some limited information on reserves of the specific mineral will be included in the comments. For information on the application of the different minerals, we have relied on different sources[13].

Mineral fuels

Coal is the world's most abundant and widely distributed fossil fuel. Coal is still the primary energy source for several countries worldwide, and it is used primarily for electricity generation and steel production. Coal is clearly a less abundant fossil fuel in the Arctic than oil and gas. From Figure 3.6 we note that 2.1 per cent of the world's coal extraction takes place in the Arctic, mostly in Russia. There is only some minor production in Norway (Svalbard) and Alaska.

Iron and ferro-alloy minerals

Iron ore is the basic raw material used for the iron- and steel-making industry. Although iron has many specific uses, e.g., pipes, fittings and engine blocks, its main use is in the production of steel. We see from Figure 3.6 that 2.3 per cent of the global iron ore extraction takes place in the Arctic, of which three-quarters is in Kiruna in Sweden.

Nickel is used in the manufacture of stainless steel, steel alloys and super alloys, which all have a major role in the chemical and aerospace industries. Nickel

Figure 3.6. Arctic share of global coal, iron and ferro-alloy mineral extraction. 2002. Per cent

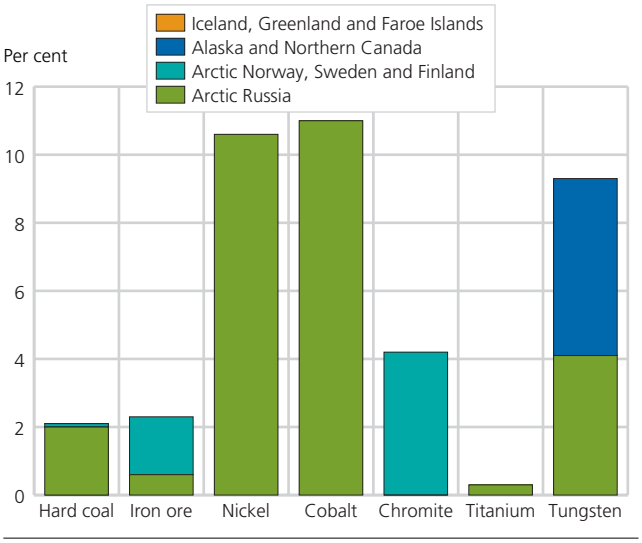
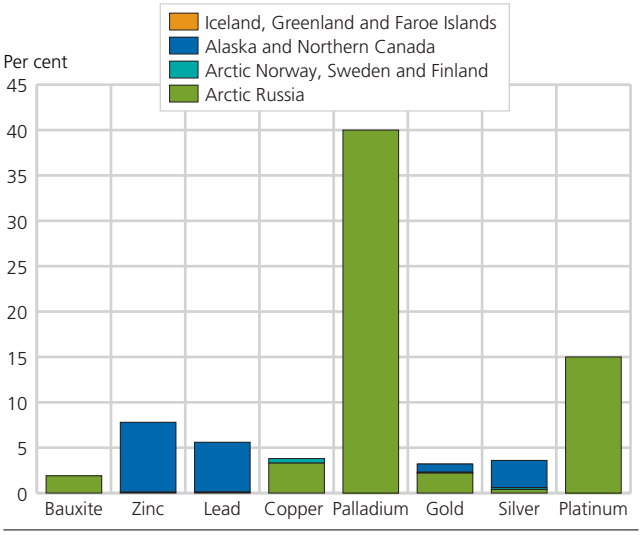


Figure 3.7. Arctic share of global non-ferrous minerals and precious metals ore extraction. 2002. Per cent



is also used in batteries and fuel cells, and as a catalyst in the production of fats and oils. Russia and Canada are two of the world's major producers of nickel, but nickel extraction only takes place in the Arctic regions of Russia. Total production amounts to 10.6 per cent of the world's production.

Cobalt is mainly used as an alloy with iron, nickel and other metals to produce corrosion- and wear-resistant products used in high-temperature applications such as jet engines and gas turbine engines. Cobalt-based alloys are also used in highly durable steels. Cobalt oxide is an important additive in paint, glass and ceramics. Arctic Russian cobalt production is around 11 per cent of global production.

Chromite is used for a host of purposes. It is considered a strategic metal, and is used in alloys for hardening and corrosion resistance. There is no economical substitute for chromite ore in the production

A general view of the diamond pipe Mir in the town of Mirny, in the Siberian province of Yakutia. Scanpix/AP Photo/Mikhail Metzel

of ferrochromium. We also find chromite in paints and glass. Northern Finland is the only Arctic producer, where we find 4.2 per cent of total global production.

Titanium is lightweight, non-corrosive, is able to withstand temperature extremes and has the strength of steel. Titanium alloys have many applications in aircraft, missiles, and space vehicles and even in surgical implants. The Arctic produces around 0.3 per cent of global titanium.

Tungsten is produced in Arctic Canada and Arctic Russia, where we find 9.2 per cent of worldwide production. Tungsten is used for hardening steel and in the manufacture of «hard metal», with a hardness close to that of diamond. Tungsten metal products are extensively used in electric and electronic equipment. It is also used in the chemical industry as a catalyst.

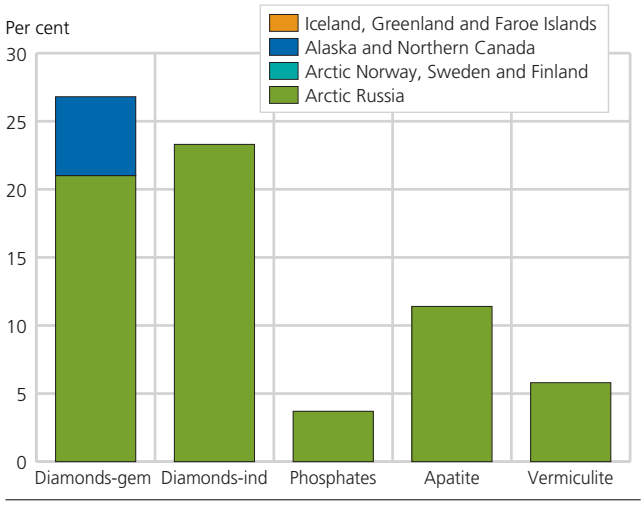
Non-ferrous minerals

Bauxite is the main raw material for the production of alumina, and ultimately aluminium. The production of alumina consumes over 90 per cent of global bauxite output. Applications of aluminium include electrical equipment, and car, ship and aircraft construction. It is also used in metallurgical processes, buildings and packaging materials. Figure 3.7 shows that Russia extracts around 1.9 per cent of global production of bauxite in its Arctic area. With respect to production of aluminium, we find the Arctic's share to be around 3.6 per cent of world production. Russia's bauxite reserves are less than one per cent of the world's total[14] and therefore nepheline and apatite are used as alternatives. These minerals have the disadvantage of needing more energy than bauxite in the production of aluminium. The Murmansk Oblast is the main region of nepheline and apatite production in Arctic Russia and these reserves are considered sufficient for 60–100 years of production.

Zinc is used in special alloys for its unique industrial properties from great strength to unusual plasticity. Zinc coating of iron and steel products makes them more corrosion resistant. Total extraction in the Arctic constitutes around 7.8 per cent of world production. Alaska extracts almost all arctic zinc, with only a small share in Russia. Production in Northern Canada was around 2 per cent of world production during 2000–2002, but the mines were closed due to depleted resources.

Lead has a variety of uses in the manufacturing, construction and chemical industries. The manufacture of lead-acid storage car batteries, chemical products and cables dominate the end uses of lead. Lead is also used in X-ray shielding equipment and at nuclear plants. Environmental regulations (particularly in the western world) now control the use of lead in end-products such as tetra ethyl, paint and as a petroleum additive. A large amount of lead is recycled (from old car batteries), resulting in quite a large «secondary»

Figure 3.8. Arctic share of industrial mineral extraction. 2002. Per cent



production amounting to about 50 per cent of current global lead production. The Arctic produces around 5.6 per cent of the world total, mostly in Alaska and to a minor degree in Russian Arctic regions. Production in Northern Canada was around one per cent of world production during 2000–2002, but, as was the case with zinc, the mines were closed due to depleted resources.

Copper has its end uses in construction and in the electrical and electronic sector. The Arctic produces around 3.8 per cent of total copper production, mostly in Russia and to a minor extent in Northern Finland.

Palladium is mainly used by the car industry for making catalytic converters. It is also used as a catalyst, in the production of nitric acid and in laboratory equipment. Palladium is also used in the electronics industry and as a dental material. Arctic Russia alone produces as much as 40 per cent of the world's palladium. Data suggest that Arctic Russia has around ten per cent of global reserves[15].

Precious metal ores

Gold has historically been used for jewellery and as a base for global monetary reserves. However, gold's role as a monetary reserve has been changing over recent decades, with several banks selling their reserves. This is seen as a move to disconnect gold from currencies. However, most countries hold gold as official reserves and large stocks of gold and jewellery are still held by banks and individual investors worldwide. Gold also has a wide range of uses from catalysts in industrial processes to dental material and for decorative purposes. Of the world's gold production, the Arctic has a 3.2 per cent share, primarily in Arctic Russia and to some extent in Alaska and Northern Canada. A small amount of production also takes place in Northern Finland and Sweden.

Silver is often classified, along with gold and platinum, as a precious metal. Silver is primarily used in photographic paper and film, and for medical and dental purposes. It is also used as jewellery and in the electronic sector. The Arctic extracts 3.6 per cent of the global amount of silver. Around 80 per cent of Arctic production takes place in Alaska, and there is also some production in Arctic Russia and Northern Sweden. In addition, there is some minor production in Arctic Canada.

Platinum is used in jewellery, laboratory equipment, cars, electrical contacts and dentistry. Around 15 per cent of the world's platinum extraction is found in Arctic Russia.

Industrial minerals

Diamonds are famous for their use in jewellery. However, not all diamonds are of gem quality and, in fact, most diamond deposits contain a varying proportion of industrial and gem-quality stones. Industrial diamonds make up about 40 per cent of global production by weight. Industrial diamonds' main use is in lens manufacture and in wires in electrical circuits. Originally, crushed diamonds were used for these purposes, however synthetic diamonds are now being produced in laboratories and pose a threat to global industrial diamond mine production. Synthetic diamonds have replaced natural diamonds in more than 90 per cent of industrial applications. Figure 3.8 shows that Arctic Russia produces 21 and 23 per cent of global gem-quality diamonds and industrial diamonds, respectively. There is an increasing diamond production of gem quality in Northern Canada. In 2002, it constituted around 5.8 per cent of world extraction, but in 2004, the production figures more than doubled[16].

Phosphate rock minerals are the only source of phosphorus globally, and phosphorus is essential for plant and animal nutrition. We see from Figure 3.8 that Arctic Russia produces 3.7 per cent of the world's phosphate minerals of which *apatite* is the most important. Most of the phosphorus is consumed in fertilizers, which are used on food crops. Arctic Russia is one of the world's major producers, extracting 11.4 per cent of global production. As mentioned earlier, apatite is an important raw materials in the production of aluminium in Russia.

Vermiculite is a kind of clay, which is very useful for many industrial purposes. It is very light, chemically non-reactive and fire-resistant. Vermiculite can be used to soak up toxic liquids such as pesticides. This ability makes vermiculite useful as bedding for pets and livestock. In addition, vermiculite can be used in concrete and ceramics as a heat-resistant additive. Of total global production, Russian Arctic regions provide 5.8 per cent.

Table 3.1. Marine fishery in the Arctic. 2002. Million tonnes

Species	North-east Atlantic	Eastern Bering Sea	Western Bering Sea	Central North Atlantic (Iceland, Greenland and Faroe Islands)	North-eastern Canada (Newfoundland and Labrador Sea)	Total
Capelin	0.64			1.12	0.02	1.78
Herring	0.83		0.05	0.27	0.01	1.16
Cod fish						3.58
North-east Atlantic cod	0.49[1]			0.25		
Saithe north of 62°N	0.15					
Haddock, saithe				0.42[2]	0.01	
Pollack		1.50	0.40			
North-east Arctic haddock	0.08					
Blue whiting				0.28		
Greenland halibut	0.01			0.04	0.04	0.09
Pacific salmon		0.04	0.02			0.06
Other groundfish		0.20				0.20
Flatfish		0.06	0.01			0.07
Others	0.01	0.04	0.04	0.23		0.32
Total wild fish	**2.21**	**1.84**	**0.52**	**2.61**	**0.08**	**7.26**
Shrimps	0.06			0.13	0.10	0.29
Snow crab		0.01[3]		0.01	0.05	0.07
Total crustaceans	**0.06**	**0.01**		**0.14**	**0.15**	**0.36**
Aquaculture (salmon, trout)	0.09			0.01		0.10

[1] Includes coastal cod.
[2] See endnote 19.
[3] Includes king crab and Tanner crab.

Fisheries

Data on fishing and aquaculture are available for four large Arctic marine ecosystems: The North-east Atlantic (the Barents and the Norwegian Seas), the Central North Atlantic (the waters around Iceland, Faroe Islands and Greenland), the waters of North-eastern Canada (Newfoundland/Labrador area) and the Bering Sea. The areas seem to cover most of the important commercial fisheries in the Arctic.
The major circumpolar species are capelin, Greenland halibut and northern shrimp. In addition, there are species of high commercial importance in specific regions, like Atlantic cod, haddock, Alaskan pollack, Pacific cod and snow crab.

In 2002, total catch of wild fish in the Arctic amounted to 7.26 million tonnes (Table 3.1)[17]. This constitutes around ten per cent of the world catch of fish. Total catch in 2002 was somewhat lower than the average over the period 1970–2000, but variations among species are large, especially related to the fisheries of cod, capelin and herring. As in the past, fisheries policies and their enforcement and effect on exploitation rates are important for the abundance of different fish populations. Fisheries policies will probably be more important for fish stock levels in the future, than the total effect of climate change[18].

In addition to the marine wild fish catch, there is an Arctic fishery of shrimps and snow crab. In 2002, 290 000 tonnes of shrimps and 65 000 tonnes of snow crabs were landed. The Arctic catch of these two species was 5.3 per cent of the global catch of crustaceans. Total Arctic fish farming of salmon and trout was around 100 000 tonnes or 7.7 per cent of the world aquaculture production of these species.

The North-east Atlantic – the Barents and Norwegian Seas

The fisheries in this area take place in areas under Norwegian and Russian jurisdictions as well as in international waters. The resources in the area are exploited mainly with vessels from Norway and Russia, but also from other countries. While the Norwegian fishing industry is located in many communities along the northern coast, the north-west Russian fishing fleet is based in large cities, primarily in Murmansk. In addition to the Murmansk Oblast, Russia's northern fisheries comprise Archangelsk Oblast, the Republic of Karelia and Nenets Autonomous Okrug. There is no significant commercial fishing activity east of these regions until the far eastern fishery basin in the North Pacific, i.e., the Western Bering Sea.

Total harvest in the Barents and Norwegian Seas was around 2.2 million tonnes in 2002. This level is somewhat below the average catch from 1970–2000, mainly due to a decline in the catches of cod and capelin. Aquaculture in the North-east Atlantic is dominated by salmon and trout, and produced 86 000 tonnes in 2001.

The Eastern and Western Bering Sea

The continental shelves of the Eastern and Western Bering Sea offer one of the world's largest and most productive fishing areas. In comparison with other areas of the Arctic, the commercial fisheries of the

North Pacific, including those of the Sea of Okhostk and the Bering Sea, are of relative recent origin. The vast majority of the commercial fisheries started in the 1950s. In the Bering Sea large vessels trawl for groundfish. About 30 per cent of the trawler's total catch is processed at sea and the rest is delivered to processing plants in Russia, Alaska, and other parts of the US.

Total catch in the Bering Sea was around 2.4 million tonnes in 2002, of which 65 per cent was the walleye pollack. The rest of the harvest mainly consisted of Pacific cod and flatfish. Total catch in 2002 matched the average of the last 30 years, mainly due to a relatively stable fishery of pollack.

The Central North Atlantic – the waters around Iceland, Faroe Islands and Greenland

The waters around Iceland and the Faroe Islands are warmer than those around Greenland and are generally ice free. The influence of warm Atlantic water makes the fauna of Iceland and the Faroe Islands particularly rich in species. In contrast, there are only a few commercial fish and invertebrate species in the waters of Greenland.

Total catch in the Central North Atlantic was around 2.6 million tonnes, of which 43 per cent was capelin. Other important species harvested were cod, haddock, saithe[19] and herring. Total catch was not far from the average catch since 1970. However, behind this figure lie increased catches of capelin outside Iceland, and a reduced cod fishery outside Greenland. Total fish farming in 2002 was around 10 000 tonnes of salmon and related species. Total shrimp catch was around 130 000 tonnes, mainly harvested off Greenland. The shrimp harvest has increased over the last decade.

North-eastern Canada (Newfoundland, Labrador Sea)

Fisheries in this region may be divided into those near the coast of Greenland, those near the coast of Canada and those in the deep waters of Baffin Bay and Davis Strait between Greenland and Canada.

The catch of fish in this area is low compared with the other Arctic regions and was around 80 000 tonnes in 2002. The average annual catch from 1970 to 1990 was around 350 000 tonnes. Atlantic cod and species that were not targeted by commercial fishing, declined to very low levels by the early 1990s. Similarly, off Greenland, the shrimp fisheries have increased during the last years and amounted to almost 100 000 tonnes in 2002. Total snow crab catch was around 45 000 tonnes.

Table 3.1 demonstrates that codfish makes up almost 50 per cent of the total fish catch in the Arctic. When we include herring, it amounts to 65 per cent. These species have a higher monetary value than, e.g.,

Figure 3.9. Arctic share of global wood removal. 2002. Per cent

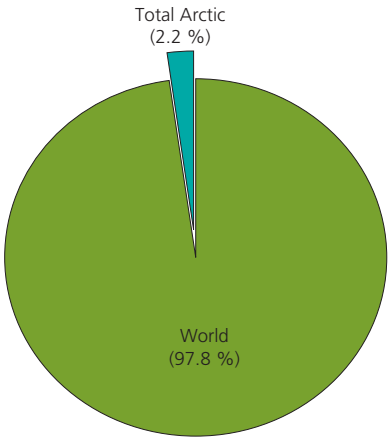
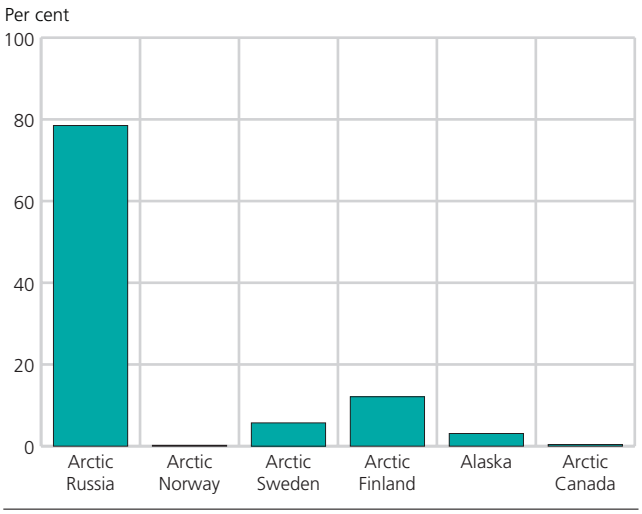


Figure 3.10. Wood removal by region, 2002. Per cent



capelin, anchovy and sardine. However, because capelin is at least as important in the Arctic fisheries (25 per cent) as anchovy and sardines seem to be in the world fisheries[20], it is difficult to draw conclusions about the value share of Arctic fisheries in world fisheries without further investigation.

Forestry

Forests cover 30 per cent of the world's land area and the boreal forests surrounding the northern tip alone cover about 17 per cent of the global land area[21]. The boreal forest is a belt with a limited variety of coniferous species (spruce, pine, larch and fir) and a few broad-leaved species, primarily birch and poplar.

The boreal forests of the Arctic represent the largest natural forests in the world, but most of the boreal forests are uncultivated due to the harsh climate, remoteness and lack of infrastructure. Consequently, only 2.2 per cent of total wood removal, in million cubic metres, takes place in the Arctic, as illustrated in Figure 3.9[22]. Today, most of the Arctic forests are beyond the economic limits for logging and transportation.

Figure 3.11. Arctic share of global wood volume of forests, 2002

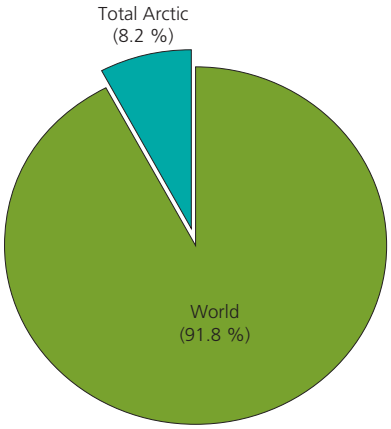
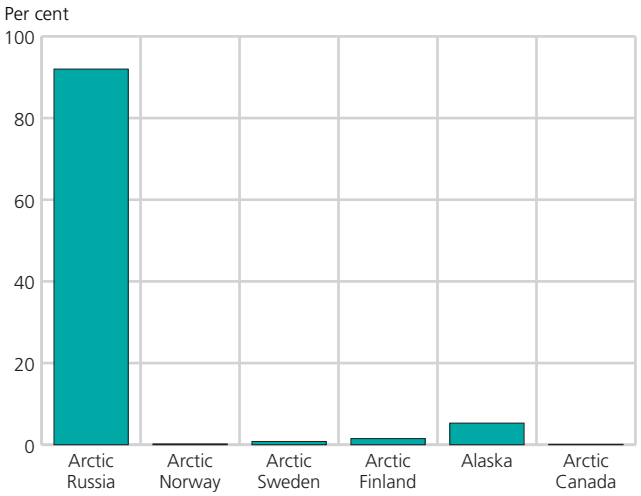


Figure 3.12. Wood volume by region, 2002. Per cent



When it comes to the different regions' contribution to total Arctic wood removal, Figure 3.10 shows that Arctic Russia is clearly the most important. Northern Finland, and to a lesser degree, Northern Sweden and Alaska also contribute to the Arctic production of wood, pulp and paper. The other Arctic areas contribute less than one per cent of the Arctic wood harvest.

Wood removal includes harvesting for several purposes, among them wood fuel, which for a major part is collected by households for their own consumption. The Arctic share of industrial round wood and sawn wood is around 3.4 per cent of the world's production. Clearly, the Arctic is relatively more important in the production of these wood products than in total wood removal. This partly reflects the fact that wood also serves as a major source of fuel in many densely populated parts of the world, e.g., Africa, and that the wood-fuel consumption of the relatively sparsely populated Arctic counts far less in proportion to the total Arctic wood harvest.

With respect to wood volume of forests, around 42 per cent of the earth's resources are found in the countries belonging to the Arctic, mostly in North America and Russia[23]. However, only 20 per cent of the northern forests are in the Arctic area itself. When estimating the Arctic share of the global wood volume of forests, we find the share to be around 8.2 per cent (Figure 3.11) [24]. Hence, the Arctic share of global wood volume is around four times higher than the share of global wood removal.

The Arctic consists not only of forested land, however. Most of the high Arctic consists of vast areas of polar desert and tundra. While the polar desert can be described as open areas of bare ground without any plants, the tundra is characterized by low shrub vegetation.

Figure 3.12 shows how wood volume is distributed among the Arctic nations. Arctic Russia contains over 90 per cent of the wood volume in the Arctic, while somewhat over five per cent is found in Alaska. The other Arctic areas, except Northern Finland, contain less than one per cent of the Arctic wood volume. Again, we see that Russia, with its vast Arctic areas, is very dominant when it comes to holding natural resources.

However, although Arctic Russia has more than 90 per cent of the standing wood volume, it has slightly less than 80 per cent of Arctic wood removal (Figure 3.10) Hence, Russia is clearly more important in terms of wood volume compared with wood removal. This is also true for Alaska, where logging was reduced by 80 per cent during 1992–2003 when two pulp mills closed, owing to a combination of high harvest and production costs and environmental concerns. We see from the figure that Arctic Sweden and Finland, especially, have less wood volume compared with production, thanks to a more benign climate and support from a more developed infrastructure.

Environmental regulations limit the degree of wood harvesting from Arctic forests. In remote Siberian forests and other areas of Russia, production of wood is partly or totally prohibited in order to protect habitats and wildlife. A large proportion of Alaska is managed as a strict nature reserve and as resource land for biodiversity and ecosystem services.

Even if vast areas of the Arctic's forest probably could be more intensively cultivated, the northern forest could also be a significant contributor to carbon sequestration. Certain forest biomass sinks can be used to meet national commitments to reduce the emission of greenhouse gases under the Kyoto protocol. «Carbon cropping» of the Arctic forests could also lead to payments from organizations wishing to sustain or increase carbon storage. If an international, effective system of placing value of transfers of carbon is established, the cultivation of the Arctic forest could lead to increased flow of wealth into the Arctic nations[25].

Russia has already made commitments to the management of carbon stocks, and has obtained substantial carbon emission credits for its participation in the Kyoto Protocol[26].

Concluding remarks

The Arctic population constitutes 0.16 per cent of the world population and the Arctic GDP is 0.44 per cent of the world GDP. Compared with these figures, we find that the Arctic is abundant in many important resources, such as petroleum, several minerals, fish and forest products. The Arctic share of global petroleum production is 16.2 per cent. When total proven reserves and undiscovered *oil* resources are added, we find around 13 per cent of the world reserves in the Arctic. As around ten per cent of the global oil production takes place in the Arctic today, it can be seen that the Arctic has the potential to continue as an important supplier of oil in the future. Around 25 per cent of total proven reserves and undiscovered gas resources are located in the Arctic, matching the Arctic share of global gas production today, which is around 25 per cent. As global gas demand continues to increase in the future, the Arctic has the potential to continue to supply around one-quarter of total demand. The vast majority of the Arctic proven petroleum reserves are found in Russia. Significant undiscovered petroleum resource potential is also estimated to be located in areas that do not have important production histories, such as North-east Greenland.

In addition to oil and gas, the Arctic region contains abundant mineral resources. The magnitude differs between the various minerals, from an Arctic share of 0.3 per cent of global production of titanium to 40 per cent of global production of palladium. Even though Arctic Russia, generally, is the most important region in terms of mineral reserves and extraction, other Arctic areas also have significant amounts of certain minerals.

Total catch of fish in the Arctic in 2002 amounted to around ten per cent of the world catch of wild marine fish. We would need stock figures to outline possible future development of these catches. In addition, the Arctic catch of shrimps and snow crab was 5.3 per cent of the global catch of crustaceans. Total Arctic fish farming of salmon and trout was around 7.7 per cent of the world aquaculture production of these species.

Only 2.2 per cent of total wood removal, in million cubic metres, takes place in the Arctic. Today, most of the Arctic forests are beyond the economic limits to logging and transportation. Even if Russia is clearly the most important in terms of wood removal, Northern Finland, and to a lesser degree, Northern Sweden and Alaska, contribute to the Arctic production of wood, pulp and paper. When estimating the Arctic share of the global volume of forests, we find the share to be around 8.2 per cent. Hence, the Arctic share of global wood volume is around four times that of its share of global wood removal. Around 92 per cent of the Arctic wood volume is found in Arctic Russia.

In this chapter, we have indicated the Arctic resource sectors' contribution to the global economy in physical terms. Future analysis should include an evaluation of resource values. Even if the Arctic has a large share of world production and reserves of various raw materials, it is difficult to assess the future relative importance of Arctic production. In order to say more about possible future developments in Arctic natural resource extraction, we need more information about

Table 3.2. Estimated Arctic share of global production and reserves of fossil energy resources[1]. 2002. Per cent

Mineral extraction	Arctic share of global		
	Production	Proven reserves	Undiscovered reserves[2]
Mineral fuels			
Oil	10.5	5.3	20.5
Gas	25.5	21.7	27.6
Coal	2.1		

[1] Some Arctic shares are estimated and must be considered as approximate figures. Consequently, the findings in this table should be treated with caution.
[2] Based on USGS estimates. See endnote 5.

Table 3.3. Estimated Arctic share of global production of some raw materials[1]. 2002. Per cent

Iron and ferro-alloy minerals	
Iron ore	2.3
Nickel	10.6
Cobalt	11.0
Chromite	4.2
Titanium	0.3
Tungsten	9.2
Non-ferrous minerals	
Bauxite	1.9
Zinc	7.8
Lead	5.6
Copper	3.8
Palladium	40.0
Precious metal ores	
Gold	3.2
Silver	3.6
Platinum	15.0
Industrial minerals	
Diamonds - gem	26.8
Diamonds - industrial	23.3
Phosphate	3.7
Vermiculite	5.8
Fishery	
Wild marine fish	10.1
Crustaceans	5.3
Salmon and trout fish farming	7.7
Forestry	
Wood[2]	2.2

[1] Some Arctic shares are estimated and must be considered as approximate figures. Consequently, the findings in this table should be treated with caution.
[2] The Arctic share of global wood reserves is esimated to 8.2 per cent.

the likely extraction costs. Such information would bring us closer to measuring the resource rent, i.e., the excess value of a raw material beyond the supply costs.

Petroleum dominates the resource extraction industries of the Arctic today. Climate policy may add bio-energy to current fossil fuel-related production. The Arctic forests may serve both bio-energy and carbon sequestration purposes. Hence, the resources of the Arctic also provide services that are compatible with a global redirection towards more sustainable development.

We summarize the discussion in this chapter by referring to tables 3.2 and 3.3.

Notes

[1] Data on production, proven reserves and undiscovered resources are taken from BP (2006): «Statistical review of world energy», Jumppanen, P. (2002): «Global views and challenges on the development of Arctic technology projects», Paper presented at the conference: Technological Challenges for Sustainable Development in the Arctic, Kajaani, Finland, 17–18 June, Burakova, I. (2005): «Russia should get the Arctic ready for global warming», Pravda, 21. April, Ahlbrandt, T. S. (2001): «Future oil and gas resources of the world – unresolved issues», Conference proceedings from the US DOE Natural gas/renewable energy hybrid workshop at National Renewable Energy Laboratory, Morgantown-West Virginia, US, 7-8. August and Ahlbrandt, T. S. (2002): «Future petroleum energy resources of the world», International Geology Review 44 (12), 1092–1104.

[2] See e.g. Aune, F.R., Glomsrød, S., Lindholt, L. and K.E. Rosendahl (2005): Are high oil prices profitable for OPEC in the long run?, Discussion Papers 416, Statistics Norway.

[3] NCS – Norwegian Continental Shelf (2004): «Cold opportunities», NCS, 1, 12–17.

[4] USGS – US Geological Survey (2000): «World petroleum assessment», USGS Report.

[5] See Ahlbrandt, T. S. (2001): «Future oil and gas resources of the world – unresolved issues», Conference proceedings from the US DOE Natural gas/renewable energy hybrid workshop at National Renewable Energy Laboratory, Morgantown-West Virginia, US, 7-8. August and Ahlbrandt, T. S. (2002): «Future petroleum energy resources of the world», International Geology Review 44 (12), 1092–1104.

[6] See e.g. Aune, F.R., Glomsrød, S., Lindholt, L. and K.E. Rosendahl (2005): Are high oil prices profitable for OPEC in the long run?, Discussion Papers 416, Statistics Norway.

[7] NCS – Norwegian Continental Shelf (2004): «Cold opportunities», NCS, 1, 12–17.

[8] IEA – International Energy Agency (2005): «Resources to Reserves», OECD.

[9] IEA – International Energy Agency (2005): «Resources to Reserves», OECD.

[10] (60–30)*0.24/((60–10)*0.76+(60–30)*0.24) = 15.9.

[11] For some of the surveyed minerals in Russia, it is difficult to measure the Arctic share. The most important source for separation between Arctic and non-Arctic extraction is the information given in Levine, R.M. and G.J. Wallace (2000): «The mineral industries of the Commonwealth of Independent States», Levine, R.M., Bendiner, M. and G.J. Wallace (2002): «The mineral industries of the Commonwealth of Independent States» and Levine, R.M., Steblez, W.G., Kuo, C.S., Newman, H.R., Wallace, G.J. and D.R. Wilburn (2002): «The mineral industries of Europe and Central Asia», For all three publications, see http://minerals.usgs.gov/minerals/pubs/country. They describe specific mining areas and locations of mines, but sometimes the production figures are lacking detail. The Arctic shares must therefore be regarded as approximate estimates. Consequently, the findings that follow must be treated with caution.

[12] Sources: Kommersant (2006): Russia's Daily Online, see www.kommersant.com (Regions of Russia), Szumigala, D.J. and R.A. Hughes (2005): «Alaska's mineral industries 2004", Information Circular 51, Division of Geological and Geographical Surveys, Statistics Canada (2004) and 2005): «Provincial and territorial economic accounts», see also www.statcan.ca/English, Statistics Canada (2006): www.statcan.ca/english, Statistics Finland (2006): www.stat.fi, Statistics Faroe Islands (2005): «Faroe Islands in figures», Statistics Greenland (2005): «Greenland in figures», Greenland Home Rule Government, Statistics Norway (2006): www.ssb.no and Statistics Sweden (2006): ww.scb.se.

[13] See Mbendi (2006): www.mbendi.co.za/indy/ming/p0005.htm and Minerals Gallery (2005): www.galleries.com/minerals. The most important source for world production broken down at a country level is Weber, L. and G. Zsak (2005): «World mining data», Bundesministerium für Wirtschaft und Arbeit, Volume 20, Vienna.

[14] Leijonhielm, J. and R. Larsson (2004): «Russian strategic commodities: Energy and metals as security levers», FOI Report 1346, Swedish Defence Research Agency.

[15] Leijonhielm, J. and R. Larsson (2004): «Russian strategic commodities: Energy and metals as security levers», FOI Report 1346, Swedish Defence Research Agency.

[16] Diamonds in Canada (2004): see www.ainc-inac.gc.ca/ps/nap/diamin/dianarr_e.html

[17] Sources: ACIA (2004): «The Arctic climate impact assessment», Cambridge University Press, FAO (2005): «Review of the state of world marine fishery resources», FAO Fisheries Technical Paper 457, ICES – International Council for the Exploration of the Sea (2005): «Report of the Arctic fisheries working group», AFWG: 20, Copenhagen, Statistics Faroe Islands (2005): «Faroe Islands in figures», Statistics Greenland (2005): «Greenland in figures», Greenland Home Rule Government and Statistics Norway (2005): «Fishery Statistics 2002–2003", Official Statistics of Norway D321.

[18] ACIA (2004): «The Arctic climate impact assessment», Cambridge University Press.

[19] Some of the haddock and saithe fishing in table 3.1 may contain other species, see e.g. Statistical Faroe Islands (2005): Faroe Islands in figures.

[20] Statistics Norway (2004): «Natural resources and the environment. Norway», Statistical Analysis 70.

[21] See FAO (2005): «Global forest resource assessment», available at www.fao.org. Sources for wood removal and wood volume of forests are ACIA (2004): «The Arctic climate impact assessment», Cambridge University Press, FAO (2005) «Global forest resource assessment», available at www.fao.org. , Goldsmith (2006): Personal information, Kommersant (2006): Russia's Daily Online, see www.kommersant.com (Regions of Russia), Statistics Canada (2006): www.statcan.ca/english, Statistics Finland (2006): www.stat.fi, Statistics Norway (2006): www.ssb.no and Statistics Sweden (2006): www.scb.se.

[22] Wood removal used for wood fuel, industrial roundwood, sawnwood, wood-based panels, paper pulp, paper and paperboard.

[23] Wood volume refers to total volume over bark of living trees, usually above 10 cm in diameter at breast height. For some countries, the stem volume of all living trees is included. See FAO (2004): «FAOSTAT statistical database», Rome, available at apps.fao.org/faostat/collectionc.

[24] For some Arctic Russian regions, it is difficult to find up-to-date figures for both wood removal and wood volume of forests. See ACIA (2004): «The Arctic climate impact assessment», Cambridge University Press and Kommersant (2006): Russia's Daily Online, see www.kommersant.com (Regions of Russia). The Arctic shares must therefore be regarded as approximate estimates. Consequently, the findings that follow must be treated with caution.

[25] ACIA (2004): «The Arctic climate impact assessment», Cambridge University Press.

[26] Webster, P. (2002): «Climate change: Russia can save Kyoto, if it can do the math», Science, 296, 2129–2130.

Box 3. Notes on Gross Domestic Product and Value Added Comparisons Across Arctic Regions

Gross Domestic Product (GDP) is the total value of final goods and services[1] produced within a territory in a specified time period. It is one of the important measures of the level of economic activity in a region, along with employment and personal income.

GDP is a measure of how much output a region can produce as well as how much income it can generate from that production. In this regard GDP is equivalent to Value Added (VA), defined as the economic contribution to goods and services production at each step in the production process by the factors of production—mostly labor and capital. Since the sum of value added equals both the value of output and the income to factors of production, total income equals total output.

The international standard for measuring GDP is established in the System of National Accounts (SNA93) prepared by representatives of the International Monetary Fund, European Union, Organization for Economic Cooperation and Development, United Nations, and World Bank. The rules and measures for the measurement of national accounts are designed to be flexible, to allow for differences in local statistical needs and conditions.[2] GDP statistics are available for most countries and are commonly used to track and compare economic performance.

GDP is generally measured in the local currency, and so to compare the economic activity or performance between different countries requires that they be converted to a common base, typically using either the currency exchange rate or the purchasing power parity exchange rate. The choice depends on the objective of the comparison. The former compares the international purchasing power of different economies. The latter is a better measure of the domestic purchasing power of the average producer or consumer within the countries. Some implications of this choice with relevance for The Economy of the North are illustrated in Box 1, pages 14-15.

Analysts using GDP as a measure of economic performance for a country need to keep in mind that it has a number of well-known shortcomings including:

1. Non-market transactions (child rearing, homemaker production, etc.) are generally excluded.
2. Economic «bads» are included. More production simply means a higher GDP, regardless of what is produced.
3. The value of leisure and other aspects of the quality of life are excluded.
4. The distribution of income across the population is not measured.
5. The sustainability of production is ignored.

In many countries GDP is also calculated at a regional level, allowing comparisons between regions within a country as well as between regions in different countries. These comparisons need to recognize certain features of regional GDP calculations, particularly when the regions are small and remote.

1. Residency—GDP is a measure of the value of production within a region, regardless of the residence of the labor used in production or the ownership of the capital. A companion measure at the national level, Gross National Product (GNP), measures the value of production by the residence of the owners of the labour and capital used in production, wherever that production takes place, but there is no comparable figure at the regional level, at least in the United States.

This can be a problem when using GDP as a measure of the income of a small and remote regional economy. A significant share of the work force could consist of commuters or seasonal workers who live outside the region. A large share of the capital could be owned by non-residents and the profits from production could leave the region. If these conditions are true then the income accruing to the residents of the regional economy will be less than the value of production.

It is also possible that the opposite would be the case. The state of Alaska controls a large investment fund, the Alaska Permanent Fund, with a portfolio of investments that is entirely outside the state. Each year the Fund generates several billion dollars of income that is not included in Alaska GDP because the production associated with those investments occurs outside the state.

2. Federal Assistance—A remote rural region of a national economy may be dependent upon assistance from the central government to pay for and provide public services, over and above the level that taxes from the region to the central government can provide. In such a case the GDP, which generally includes all public sector spending in the region, will be an overestimate of the productive capacity of the region itself by the amount of the «subsidy». For example, an increase in the subsidy will increase GDP, even though it does not represent a strengthening of the regional economy.

3. Location of Production—When production involves inputs located in different regions it can be difficult to allocate the share of value added attributable to each region. For example oil production on Alaska's North Slope depends on the inputs physically located in Alaska, but also on capital and labor inputs located in the headquarters offices of the oil companies outside the state. Allocating economic rents (the value of output in excess of that required to compensate capital and labor) between regions in this case is arbitrary.

Production may occur in one region and be reported in another. A share of the seafood harvested in the ocean adjacent to Alaska is done by boats headquartered outside the state. The value of their harvest is reported as occurring in other locations rather than in Alaska.

4. Valuing Subsistence Activities—A share of the population in many remote rural regional economies engages in productive activities outside normal economic markets, such as the subsistence activities of indigenous people. The valuation of these subsistence activities can be handled in several different ways in the GDP accounts. They may be excluded altogether as is the case in the United States. If they are included, there may be differences in the types of activities included. For those included activities valuation may be done by comparison of the outputs to similar outputs that have market prices (replacement value), by valuing the outputs at the cost of the inputs, or by some other method of imputing a value to the activity.

5. Price Variation—Small remote regional economies may be dominated by a limited number of primary commodity producing industries. The value added in the production of those commodities can be quite volatile from year to year because of volatility in their market prices. The Alaska GDP is heavily influenced by the importance of oil production, and much of the change in GDP from year to year is a result of the change in the price of oil rather than any change in the physical output of the economy.

This volatility means that comparisons with other regions are sensitive to the year in which the comparison is made. A comparison when the price of oil is high will indicate a larger Alaska economy relative to other locations than would be the case of a comparison when the price of oil is low.

6. Data Collection Difficulties—The small size of regional economies results in less precision in estimates of GDP based on sampling (due to sampling error). Remoteness can also contribute to imprecision due to the challenges of data collection associated with travel, weather, and other variables.

---

[1] Including exports.

[2] Countries may differ in the types of non-market activities they chose to include in GDP. They also may differ in which prices they use to present output figures. Among the alternatives are market prices (including any sales, property, and excise taxes) or factor costs (market prices net of taxes which are not a return to a factor of production).

Village of Uummannaq, Greenland/ Scanpix

4. Arctic economy within the Arctic nations

Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää

Alaska/Photos.com

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes[1] devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and professional labour, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the diversity in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Alaska

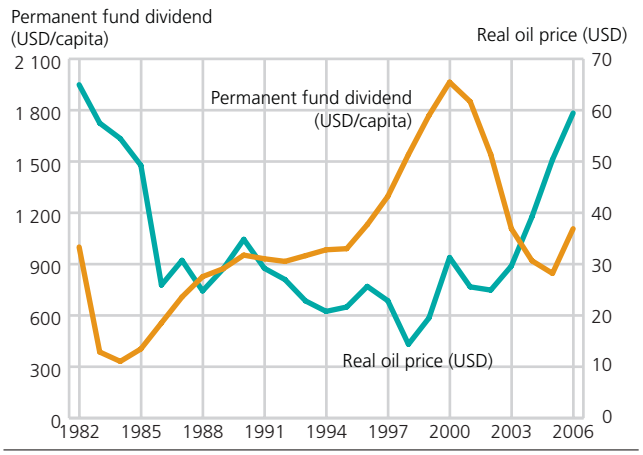
The economy of Alaska has a large contribution from resource-based industries such as petroleum, minerals, seafood, timber and tourism. However, national defense and other government services play an important role in the economy and international airfreight is a rapidly increasing service industry. In 2002 Alaska accounted for 2.9 per cent of the GDP of USA.

Alaska has a small and dispersed population of about 660 000 people. Many goods and services are imported by the region and contribute to a high cost of living and relatively high labor costs. Furthermore, the limited infrastructure in the state as well as its distance from major American and foreign markets have restricted the development of processing and manufacturing industries. Natural resources, primarily oil, are extracted and generally shipped out of the state for processing. However, there is some manufacture of seafood, and to a modest extent, petroleum.

The Alaskan processing and manufacturing industries serve a limited number of international resource based commodity markets that are cyclical in nature and price sensitive. As a high cost producer Alaska tends to be the last into the market and first out when price fluctuates, exposing the economy to boom and bust cycles. Furthermore the importance of US federal spending to Alaska makes the economy vulnerable to political decisions made at the national level. Fluctuations in military spending reflect the conflicting demands of security and federal budget constraints. The boom and bust nature of the Alaskan economy often results in an influx of workers during boom periods and an exodus when the boom ends.

Petroleum extraction and pipeline transportation taken together was the largest single industry in Alaska in 2002, followed by public administration and defense. Oil and gas extraction contributed about 25 per cent to Alaska's GDP. It can roughly be said that the economy of Alaska stands on two pillars – petroleum and the public and private services necessary to sustain the society. Agriculture and forestry play a negligible role, and fishing and fish processing each contribute only about one per cent to GDP. Forestry is even less important than agriculture as the harvest has drastically been reduced following the closure of two pulp mills in the 1990s due to high harvest costs and environmental regulation.

Figure 4.1. Alaska permanent fund dividend. Current USD/capita. Real oil price. USD/barrel. 1982-2005[1]



[1] Source: www.apfc.org/ , http://inflationdata.com/Inflation/Inflation_Rate/Historical_Oil_Prices_Table.asp

Table 4.1. Value added by industry. Alaska. 2002

	Mill. USD	Per cent
Agriculture	26	0.1
Forestry	14	0.1
Fishing	258	0.9
Coal, lignite and peat extraction	0	0.0
Oil and gas extraction	5 343	18.0
Other mining and quarrying	503	1.7
Processing of fish	285	1.0
Other manufacture of food	32	0.1
Manufacture of wood and paper	20	0.1
Manufacture of basic metals	0	0.0
Other manufacturing	259	0.9
Electricity, gas and water supply	346	1.2
Construction	1 442	4.9
Transport via pipelines	2 040	6.9
Public administration and defense	5 861	19.7
Education, health and social work	1 728	5.8
Other services	11 584	39.0
GDP[1]	**29 741**	**100.0**

[1] At basic prices.

With 25 per cent of total income from petroleum extraction and pipeline transportation, the economy is naturally heavily exposed to fluctuations in the market price for oil and gas. The revenue in petroleum production is usually higher than in other economic activities, as the oil and gas prices contain a resource rent. On the other hand, the cost of petroleum production is higher in the Arctic than in other petroleum producing areas[2], hence the resource rent element of revenue is lower than in more accessible petroleum regions. As a consequence, price variability causes more uncertainty in Alaska than in most petroleum producing areas world-wide. This is also the case for mining.

Resource rent is a wealth component rather than income generated by labour and capital. To turn petroleum rent into a sustained source of income the Alaska Permanent Fund was created. The fund receives 25 per cent of royalties on oil production and has a value of about USD 34 billion[3]. The fund has achieved a nominal rate of return of about 10 per cent per year over the last 20 years[4]. A dividend program allocates a share of annual fund revenues to inhabitants of Alaska according to a scheme that smoothes the return over the last 5 years. Each person received a dividend of USD 1 107 in the fiscal year 2006.

Table 4.2. Selected Economic indicators. Alaska. 2002-2004. Mill. USD

	Gross sectoral value	Gross production value		
	2002	2002	2003	2004
Fisheries	258	997	1 100	1 166
Mining	503	1 013	1 001	1 180
Petroleum	7 383	8 196	9 891	12 997
Tourism	675	996	1 021	1 118

Petroleum royalties and taxes from oil production have historically generated large revenues for the state of Alaska to finance the public sector and build infrastructure. Although the growth in the economy has been significant during recent years it has not resulted in much economic diversification. The State government has encouraged diversification through the use of subsidies, but the Alaskan economy still relies heavily on petroleum.

Historically, the U.S. federal government has contributed to the Alaska economy, through direct expenditures and transfers to the state government. Direct expenditures to federal activities are related to management of public lands, services to Alaska natives and military operations. The level of federal government spending in Alaska is quite high both on a per capita basis and as a percentage of federal spending. The military is an important part of the economy; in 2004, about 23 000 military personnel were on active duty in Alaska. Growth in federal spending in Alaska has been strong in recent years facilitated by high oil prices. However, the shut-down in 2006 of the Prudhoe Bay field owing to pipeline repair over several months represents a significant loss of public revenue as 80-90 per cent of tax revenue in Alaska comes from that oil field[5].

Petroleum

The value of petroleum production at wellhead was USD 13 billion in 2004. Crude oil including natural gas liquids accounted for the lion's share of petroleum revenues with 96.5 per cent of total output in value terms. The value of oil and gas production increased 31 per cent from 2003 to 2004. This increase in value was largely a result of increased prices as annual crude oil production remained stable around 390 million barrels. With the exception of refining of crude oil for local consumption, the bulk of crude oil is exported outside the state.

Alaska ranks as the third largest U.S. producer of crude oil (after Texas and Federal Offshore production). The state accounted for 17 per cent of total crude oil production in the U.S. in 2004[6]. The Prudhoe Bay field on Alaska's North Slope has dominated the oil production and is the largest oil field ever discovered in North America. Production from Prudhoe Bay peaked in the late 1980s and went into decline in spite of increasing production from discoveries of smaller fields. However, the Prudhoe Bay oil field alone still provides about 6 per cent of total US production[7].

The value of natural gas production accounted for 3.5 per cent of total petroleum production in 2004, up 38 per cent between 2000 and 2004. As in the case of crude oil the increase in production value came mainly from a considerable increase in price (31 per cent). Some natural gas is processed into LNG (liquefied natural gas) and ammonia-urea for export, and some is consumed within the state. At 15 per cent of the U.S. total, Alaska natural gas production (gross withdrawals) is ranked third after Texas and the Gulf of Mexico. However, 87 per cent of total gas production was re-injected to increase oil field pressure and enhance oil recovery. Approximately 65 per cent of net withdrawal of gas is exported. Exports average about 124 billion cubic feet per year.

With petroleum production dominating the economy, the future reserve situation becomes of huge importance. Alaska has not been explored extensively compared to the rest of the U.S. In terms of proved reserves, Alaska's oil reserves accounted for 20.2 per cent of US reserves and Alaska's gas reserves for 4.4 per cent of US reserves in 2004[8].

Other minerals

The value of mineral production, at market prices, rose from USD 1 080 million in 2000 to USD 1 180 million in 2004, an increase of 9.2 per cent.[9] The major mineral product in terms of value was zinc, which accounted for over 50 per cent of the value of mineral production in 2004. After zinc came gold (at 15.7 per cent) and lead (at 10.2 per cent). In volume terms, zinc production amounted to 680 015 tons, gold production was 454 680 ounces, and lead production was 150 796 tons. Virtually all the output of the mining sector is exported.

Figure 4.2. Mineral production. Alaska. 2004. Mill. USD

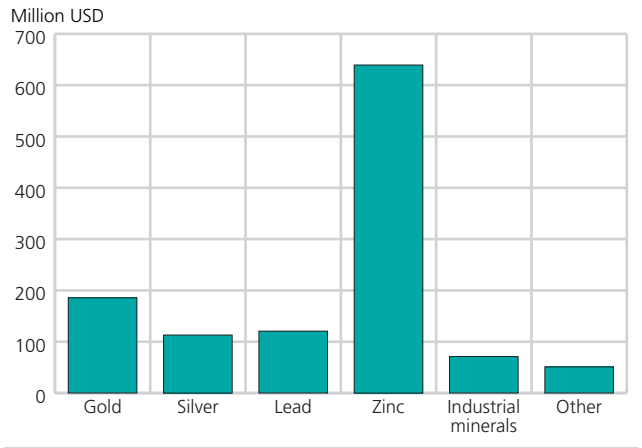


Figure 4.3. Value of fish and seafood landings. Alaska. 2004. Per cent

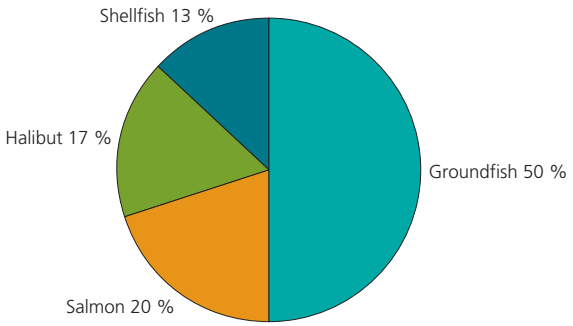


Figure 4.4. Value added by main industry. Alaska. 2002. Per cent of GDP

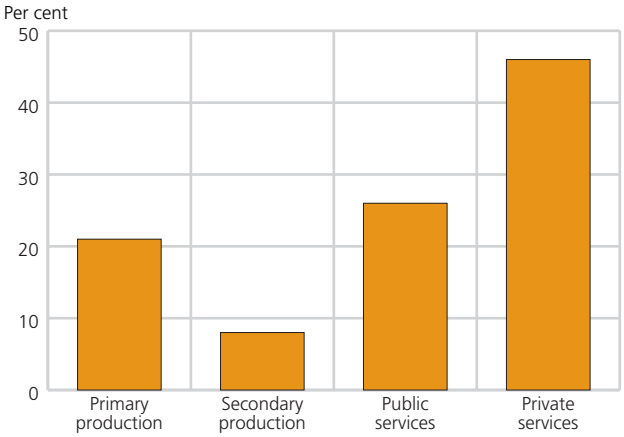
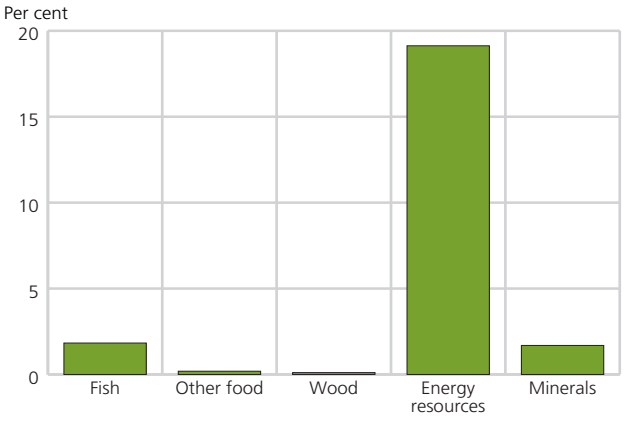


Figure 4.5. Value added of natural resource based industries. Alaska. Per cent of GDP



The mining industry is likely to benefit from growing world demand. However, further development is economically viable only for the largest deposits. This is because of a lack of access to, and power at, remote sites, as well as the high construction and operating costs at these sites.

Other industries

The landed value of fish and seafood landings amounted to USD 1 166 million in 2004, up from USD 942 million in 2000. However, the value of landings fluctuated during that period, as a result of significant variations in both prices and volume. Groundfish accounted for almost half of the total value of landings in 2004 followed by salmon (at 20.2 per cent), halibut (16.7 per cent) and shellfish (at 13.3 per cent).

The value of exports of fish products rose from USD 1 034 million in 2000 to USD 1 335 million in 2002. The Alaska fishing industry is close to full exploitation of its resource base. In recent years Alaskan salmon fisheries have faced significant international competition from farmed salmon in Norway, Chile, U.K., Canada and elsewhere.

Data on the value of the timber harvest and exports are not available, but with the closure of the two pulp mills in the state in the 1990s, the production of timber fell dramatically. In 1992 it was estimated at 1 017 millions board feet, but by 2003 it was down to about 200 millions board feet. This decline was due to a combination of high harvest and production costs and environmental concerns. This low level of production supports a work force of about 900**.**

Alaska attracts tourists both from elsewhere in the U.S. and abroad. Alaska is an attractive tourist destination and is expanding its capacity in terms of tourism infrastructure. The number of tourists visiting Alaska increased steadily over the period from 1.15 million people in 2000 to 1.37 million people in 2004, an increase of 19.2 per cent. The 2004 level was already substantially above the level of 1990 when 716 000 tourists visited Alaska. This suggests that tourism in the Arctic is experiencing a long-term trend in growth. Reflecting the harshness of the climate, almost 90 per cent of tourists in 2004 visited Alaska during the summer.

International air cargo operations continue to expand at the Anchorage International Airport, and also at Fairbanks. The trans-Pacific air cargo market is growing rapidly and Alaska is well positioned to serve not only the trade associated primarily with economic growth in China, but also trade due to the shift in manufacturing growth to countries such as Malaysia and Vietnam. Air transportation is included in the other services industry in Table 4.1.

Economic structure

Secondary industries, which include manufacturing industries, contributed only 8 per cent to GDP of Alaska in 2002. The private sector of the service industry is about twice as large as the public service industry and contributes as much as 46 per cent to GDP. Private services include pipeline transportation, air cargo and tourism among others. From table 4.1 we see that pipeline transportation contributed 6.9 per cent to Alaska's GDP; hence there is a large private service industry beyond petroleum transportation.

Table 4.3. Employees in selected industries. Alaska. 2003

Fishing[1]	16 771
Forestry[2]	860
Mining[2]	1 422
Petroleum[2]	10 153
Tourism	16 647
Federal government[3]	40 906
Air cargo	2 300

[1] Including self-employed harvesters.
[1] Including processing.
[2] Civilian and military.
Source: Institute of Social and Economic Research, MAP Database.

The federal government is the largest employer in terms of salaried work in man-years. Table 4.3 shows number of employees by main industries. Employment in seasonal industries such as tourism is converted to an annual average. Self-employed persons are generally not included exept in fisheries where self-employment typically occurs. It is worth noting that tourism employs 60 per cent more people than the petroleum industry.

To show the role of natural resources in the Alaskan economy, processing of fish and other food is included in the resource-based industries, as is value added generated by petroleum pipelines. Data for tourism are not available; otherwise this industry might well be included among the nature based industries. In total the resource-based industries in Alaska accounted for 30 per cent of GDP in 2002, and oil and gas production and pipeline transportation clearly dominates the resource economy. Hence, Alaska has a narrow economic base, which makes the economy vulnerable to events such as the shut down of the Prudhoe Bay pipeline due to corrosion damage by August 2006. With the oil price at record level, the failure to maintain the pipeline leads to a serious short term interruption of revenues for Alaska since oil taxes accounts for 80-90 per cent of tax income generated within Alaska.[10] This incidence may illustrate that dependency on natural resources and their markets, which are frequently stated in an Arctic context occasionally is less of a problem than the dependency of the economy on proper infrastructure management. Prudhoe Bay is a mature petroleum province, and there is a general concern that short-term financial targeting by corporate management leads to under-investment in mature petroleum provinces.[11]

Pipelines, Alaska/Photos.com

The Canadian North

For purposes of this report, the Canadian North is defined as the three Northern Territories, namely, Northwest Territories, Yukon Territory and Nunavut. The Northern Territories combined accounted for 0.5 per cent of Canadian GDP in 2004. The population of Arctic Canada was 101 900 in 2003, and was fairly evenly distributed among the three territories with about 40 thousand in the Northwest Territories and 30 thousand each in Yukon and Nunavut.

Public administration and defense was the largest single industry in 2002 accounting for 17 per cent of regional GDP. Mining and quarrying (excluding mineral fuels) came second at 13.2 per cent, followed closely by education, health and social work and the construction industry. Next was the oil and gas extraction with 10.3 per cent of total regional GDP. It should be noted that the real price of oil in 2002 was considerably lower than in 2005/2006. More recent data suggest that the dominance of the government in the Territorial economy has declined primarily because of the boost given to the mining sector by the diamond industry. All of the diamonds currently mined in Canada are produced in the Northwest Territories.

Petroleum and mining

For the three Territories combined, the major pillar of economic activity has been mining and oil and gas extraction. In 2004, these industries accounted for 36.4 per cent of total economic activity in the Territories.

Between 2000 and 2004, the income from mining and oil and gas extraction in Arctic Canada more than doubled, growing from CAD 870 million to CAD 2 080 million in real terms. Within the Northwest Territories alone GDP from the mining and oil and gas extraction industry has more than tripled during the last five years, offsetting the continuous decline since 2001 in the two other territories as producing wells and fields come to the end of their lifespan.

Most of the crude oil produced in the Territories is shipped to Ontario while most of the natural gas is shipped to British Columbia. The destination of these products depends on the proximity of pipelines. Oil and gas extraction has declined continually since 2001.

Table 4.4. Value added by industry. Arctic Canada. 2002

	Mill. CAD	Per cent
Agriculture	16	0.3
Forestry	3	0.1
Fishing	2	0.0
Coal, lignite and peat extraction	0	0.00
Oil and gas extraction	504	10.3
Other mining and quarrying	646	13.2
Processing of fish	0	0.0
Other manufacture of food	0	0.0
Manufacture of wood and paper	0	0.0
Manufacture of basic metals	0	0.0
Other manufacturing	26	0.5
Electricity, gas and water supply	81	1.7
Construction	556	11.3
Transport via pipelines	31	0.6
Public administration and defense	838	17.1
Education, health and social work	560	11.4
Other services	1 645	33.5
Regional GDP[1]	**4 908**	**100.0**

[1] At basic prices.

The value of diamond production has more than tripled from CAD 625 million in 2000 to CAD 2 140 million in 2004. The boom in diamonds has more than offset declines in oil and gas extraction in all three territories. The total value of gold production in the Northern Territories also declined from CAD 162 million in 2000 to CAD 99 million in 2004. The volume of gold produced fell even more sharply during this period, decreasing from 12 185 kilograms in 2000 to 5 756 kilograms in 2004, less than half its 2000 level.

Diamonds in Northwest Territories have been the major contributor to growth in income from mining. In fact, the diamonds in Northwest Territories have made Canada a major player in the international diamond market. Not only is Canada rich in diamonds as a result of the diamonds being mined in Northwest Territories, these diamonds are also high in quality. While most of the diamonds are shipped out of the Northwest Territories for processing, there are a few companies, which are processing diamonds in Northwest Territories. However, most of the diamonds from the Northwest Territories are exported outside Canada as rough or un-worked diamonds.

The boom in the diamond industry is having a positive impact on other sectors in the economy of Arctic Canada, including exploration, which is being carried out to some extent in Nunavut as well as in Northwest Territories. The growth in the diamond industry has also stimulated non-residential construction, wholesale trade and transportation. The diamond mining industry has been the largest contributor to capital expenditure in the mining and oil and gas extraction sector of the Northwest Territories. It is expensive to construct and maintain a diamond mine in

Table 4.5. Basic indicators. Arctic Canada. 2004

	Northwest Territories	Yucon	Nunavut
Population	42 206	30 554	29 140
Share of GDP in all three Northern Territories (per cent)	65.1	19.8	15.1
Transfers[1] as share of public revenues	74.9	82.2	91.3

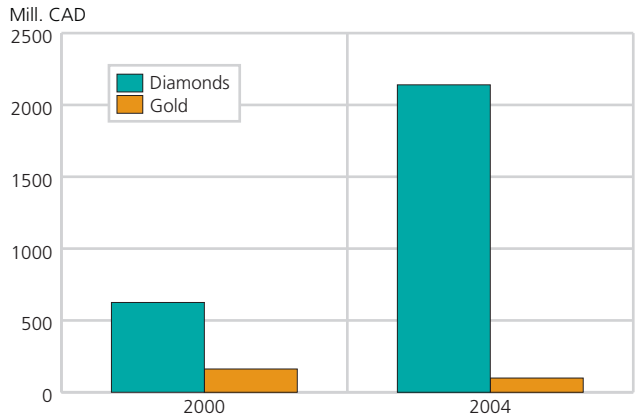
[1] From other than territorial government.
Source: Statistics Canada.

the Northwest Territories. A number of factors contribute to high construction and maintenance costs including *a harsh, yet fragile, environment characterized by long winters and short summers. Transportation involves 'ice' roads, and environmental commitments must ensure that, among other things, companies remain sensitive to caribou migration patterns.*[12]

In 2004, public administration was the second largest sector in the economy of the Northern Territories. In all three Territories, the territorial government is larger than the federal government sector and considerably larger than the local, regional and municipal sector. Transfers from the Canadian federal government are a substantial source of funding for the territorial governments. In fiscal year 2004/2005, transfers from other than the territorial government accounted for 82.9 per cent of total public revenues in the three Territories. For the individual Territories the share of revenues accounted for by other government transfers ranged from a low of 74.9 per cent in Northwest Territories to a high of 91.3 per cent in Nunavut with Yukon Territory in the middle at 82.2 per cent.

While the Territorial governments are largely funded by federal government transfers, it should be noted that the federal government is benefiting from the boom in diamond mining through royalties and increased business and personal income taxes generated by the sector. Defense spending in the Arctic is expected to increase, taking the form of a build up of Canada's military presence in Arctic waters, including the construction and launch of three armed ice breaking ships as well as underwater surveillance. In addition, a new port is planned for Iqaluit in Nunavut to house the additional military personnel and ships.

Figure 4.6. Precious minerals. Production value. Arctic Canada. 2000-2004. Mill. CAD



Source: Statistics Canada.

Figure 4.7. Value added by main industry. Arctic Canada. 2002. Per cent

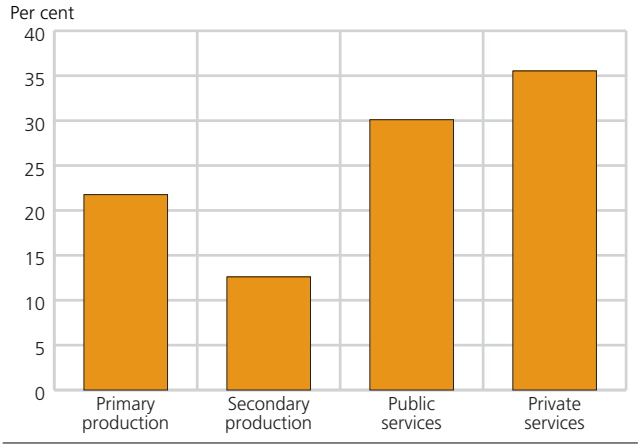
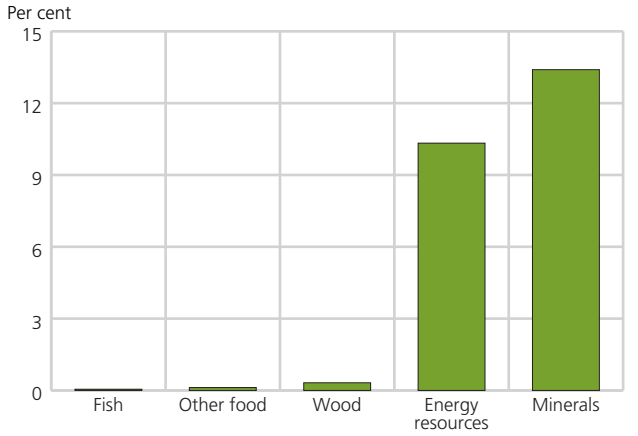


Figure 4.8. Value added in natural resource based industries. Arctic Canada. 2002. Per cent of regional GDP



For the Territories as a whole, the third largest industry in terms of gross production value is the financial industry, which includes finance and insurance, real estate and renting and leasing and management of companies and enterprises. The financial industry showed steady growth throughout the 2000-2004 period, increasing from current CAD 600 million in 2000 to CAD 720 million in 2004.

The fourth largest sector is construction, which like the natural resource revenues of the territorial economy is highly cyclical. Construction in the Territories peaked at CAD 640 million in 2001. After showing declines in 2002 and 2003, construction in the Territories grew 15 per cent from CAD 420 in 2003 to CAD 480 million in 2004.

Figure 4.9. Petroleum and mining in Arctic Canada. 1997-2002. Mill. CAD

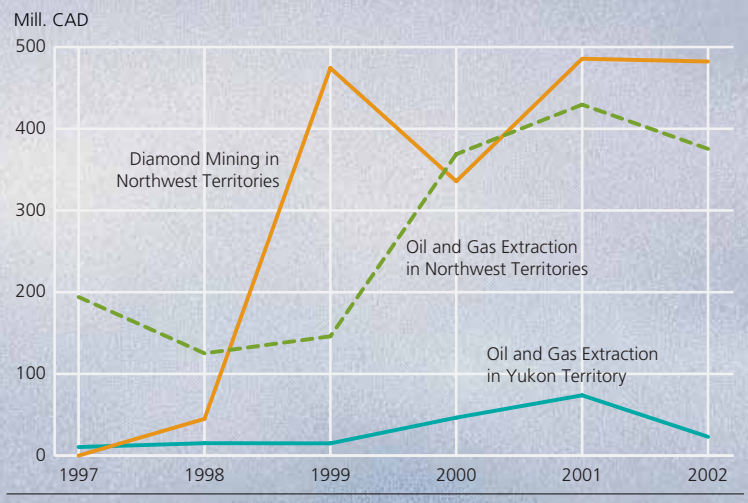


Figure 4.10. Value added in selected industries. Arctic Canada. 1997-2002. Mill. CAD

Canada/Photos.com


Vestmanna, Faroe Islands/Photos.com

Faroe Islands

The Faroe Islands have enjoyed rapid economic growth over the last decade largely as a result of increased fish landings and high export prices. The rate of unemployment has been reduced from 15 per cent in 1995 to around 2 per cent in recent years. More than 90 per cent of the value of exports is based on fish and fish processing, making the Faroe Islands particularly sensitive to mismanagement of fish stocks or negative impacts on marine life from global warming. The population of the Faroe Islands numbers nearly 50 000 people. Annual transfers from Denmark have been around 15 per cent of GDP[13]. Economic growth in recent years has resulted in increased budget surpluses for the Faroe Home Rule Government, enabling the Faroe Islands to reduce its large debt. Oil finds near the Faroe area might open the door to a more diversified and balanced economy.

Fishing generates 21.5 per cent of total income and is the largest single industry in the Faroe Islands, followed by education, health and social work. Other services accounts for about a third of total income. Fish processing is now limited after a serious crisis in the 1990s due to declining fish landings and overcapacity. More recently, manufacture of fishing gear and other fishing related equipment has emerged as an industry. Faroe Islands have a tradition in shipbuilding and ship repair is one of the major small manufacturing industries. Small manufacturing industries generate about 6 per cent of total income.

Table 4.6. Value added by industry. Faroe Islands. 2002

	Mill. DKK	Per cent
Agriculture	57	0.7
Forestry	0	0.0
Fishing	1 758	21.5
Coal, lignite and peat extraction	0	0.0
Oil and gas extraction	0	0.0
Other mining and quarrying	497	6.1
Processing of fish	107	1.3
Other manufacture of food	0	0.0
Manufacture of wood and paper	0	0.0
Manufacture of basic metals	0	0.0
Other manufacturing	488	6.0
Electricity, gas and water supply	186	2.3
Construction	471	5.8
Transport via pipelines	0	0.0
Public administration and defense	449	5.5
Education, health and social work	1 351	16.5
Other services	2 820	34.5
GDP	**8 184**	**100.0**

Table 4.7. Employees by industry. Faroe Islands. 2005

Fishing	2 463
Other primary industries	300
Fish processing	2 202
Other manufacturing	3 470
Private and public services	6 690
Total	**24 541**

Source: Statistics Faroe Islands.

After a serious fish resource crisis, transferable quotas were used in the 1990s to manage the harvest capacity. However, the quota system was abandoned after a short period as the market for quotas was too limited. Later a system of limiting fishing days has been introduced.

About 6 per cent of income in the Faroe Islands comes from mining. Overall the natural resource based industries contributed 32 per cent to GDP in 2002. Oil has been discovered close to the Faroese area, raising hope for Faroese reserves[14]. On the northern part of the island Sudoy there are coal layers that have been exploited earlier, however there is currently no commercial production.

Figure 4.11. Value added by main industry. Faroe Islands. 2002. Per cent

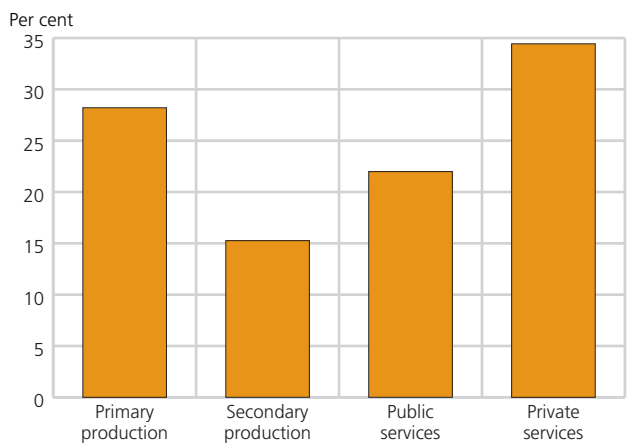
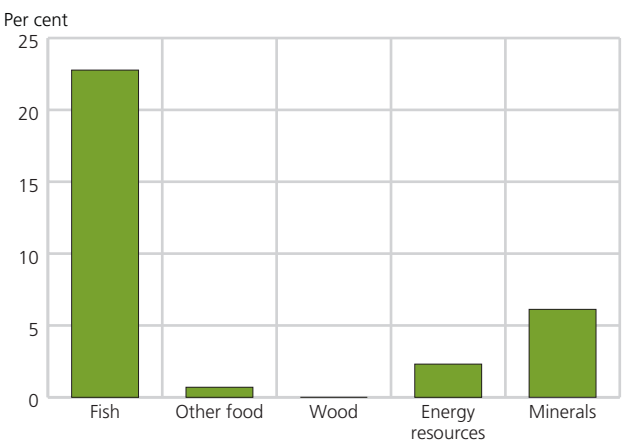


Figure 4.12. Value added of natural resource based industries. Faroe Islands. 2002



Arctic Finland

Arctic Finland consists of the two provinces Lapland and Oulu covering almost a half of the surface area of Finland. The province of Oulu is furthermore divided into Kainuu and North Ostrobothnia. The population of 645 000 amounts to about 10 per cent of the total population and the regional GDP about 11 per cent of national GDP.

Within Arctic Finland, North Ostrobothnia is the largest region in terms of population and economy. Lapland covers, however, almost two thirds of the land area of Arctic Finland.

The regional GDP per capita of Northern Finland is 14 per cent lower than that of the whole country. In Kainuu the per capita GDP was almost 32 per cent lower than the average for Finland. However, the disposable income of households is distributed markedly more equally, hence the per capita disposable income in the Arctic Finland is only 10 per cent lower than the average of the whole country and the differences between the sub-regions of Arctic Finland are negligible.

A characteristic of the industrial structure is that the share of both secondary industries and private services are rather high, about 36 per cent of the regional GDP. The share of primary production is 7 per cent,

Table 4.8. Land area, population, regional GDP and household disposable income (HDI) in Arctic Finland and in the whole country. 2003

	Land area	Population	Regional GDP	HDI
	Km²	Persons	Mill. EUR	Mill. EUR
Lapland	92 856	187 347	3 722	2 369
North Ostrobothnia	35 233	370 953	8 302	4 703
Kainuu	21 506	86 972	1 446	1 094
Arctic Finland	149 595	645 272	13 469	8 166
Finland	304 112	5 213 014	126 585	74 028

Table 4.9. Value added by industry. Arctic Finland. 2002

	Mill. Euro	Per cent
Agriculture	242	1.9
Forestry	482	3.7
Fishing	13	0.1
Coal, lignite and peat extraction	42	0.3
Oil and gas extraction	0	0.0
Other mining and quarrying	35	0.3
Processing of fish	0	0.0
Other manufacture of food	110	0.9
Manufacture of wood and paper	840	6.5
Manufacture of basic metals	698	5.4
Other manufacturing	1 925	14.8
Electricity, gas and water supply	317	2.4
Construction	766	5.9
Transport via pipelines	0	0.0
Public administration and defense	707	5.5
Education, health and social work	2 061	15.9
Other services	4 737	36.5
Regional GDP[1]	**12 975**	**100.0**

[1] At basic prices.

which is low in an Arctic context. Public services contribute about 22 per cent to regional GDP.

The largest manufacturing industry is electronic industry, which contributed about 39 per cent of the value added and 24 per cent of the employment of the manufacturing industry in Northern Finland. The electronics industry is a knowledge based industry which in Arctic Finland is mostly situated at the

Figure 4.13. Regional GDP and household disposable income per capita in Arctic Finland and in the whole country. 2003

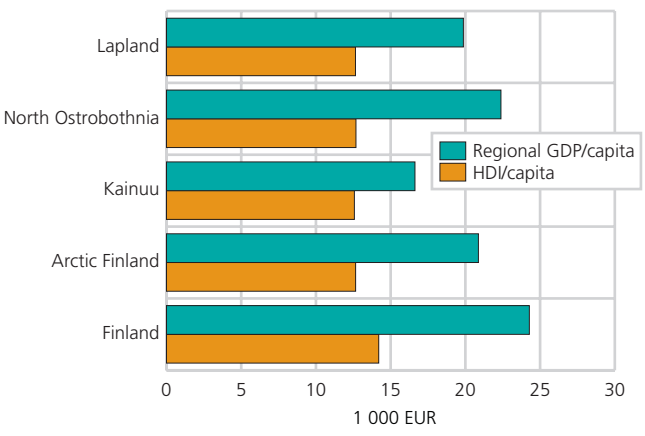


Figure 4.14. Value added by main industry. Arctic Finland. 2002. Per cent of GDP

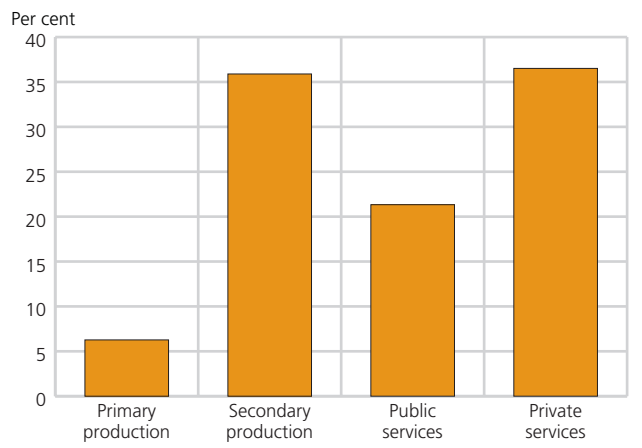


Figure 4.15. Value added in selected industries. Arctic Finland. Mill. EUR at 2000-prices

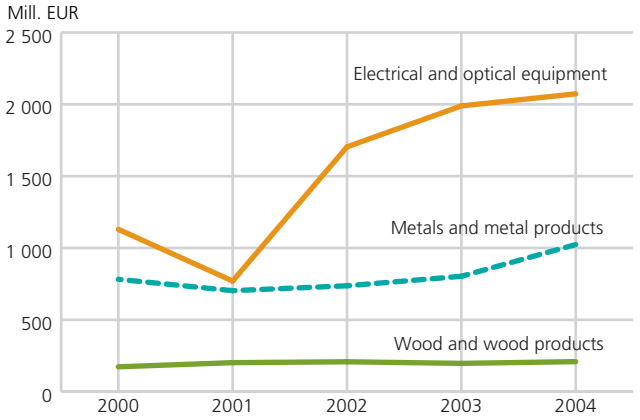
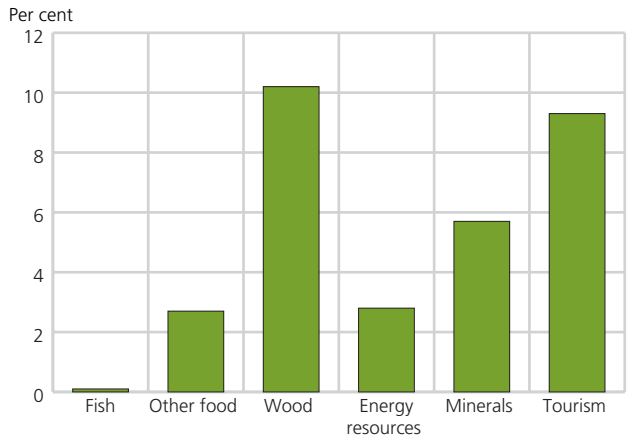


Figure 4.16. Value added of natural resource based industries. Arctic Finland. 2002. Per cent of regional GDP



vicinity of Oulu, the main city of North Ostrobothnia. Mobile telecommunication is the core technology area of the electronics industry even though the product diversity is widening. The electronics industry in the region is an important spill-over of the University of Oulu and its large engineering faculty.

The most important natural resources in Finland are forests, metal minerals, energy resources and nature itself as a source of recreational services. Most of the natural resources extracted in Northern Finland are also processed there. Moreover the processing industry of Northern Finland imports some natural resources from other Arctic regions such as raw wood and iron ore from North-West Russia and iron ore from Northern Sweden.

The forest sector – forestry and forest industries – comprises about 10 per cent of the regional GDP. The forest industry uses more raw wood than the yearly loggings provide and thus on the average 1.5 million m^3 of logs and pulpwood are imported from North-West Russia.

Winter, Finland/Photos.com

The value added of mining is small in Arctic Finland. However, the chromite mine in Lapland has been the base of the third largest stainless steel plant in the world, Outokumpu Chrome near the city of Tornio. The carbon steel processing plant at the city of Raahe in North Ostrobothnia was first founded on the domestic iron ore resources of the Northern Finland but nowadays uses ore imported from Northern Sweden and Kostamus in Northwest Russia.

The energy resources consist of wood, peat and hydro power. Most of the larger cities in Arctic Finland have combined heat and power plants using peat as their main fuel. Wood is used as energy resource mainly in combined heat and power plants in the forest industry, but the share of wood in communal heat and power plants is growing. Hydro power is the third most important energy source. Due to the large presence of processing industries, the electricity consumption amounts to about 80 per cent of the electricity generated in the region.

Tourism is based on the recreational services supplied by the nature. According to the regional tourism accounts of Finland[15], the value added of the tourism industry in Arctic Finland amounted to mill. EUR 1 200 in 2002, almost 10 per cent of the regional GDP or one quarter of the value added of private services. Especially the winter tourism in Lapland and Kainuu are important economic activities.

The natural resources extracted in Arctic Finland are thus processed in the region and some additional natural resources are supplied by the northern regions of neighbouring countries. The resource based industries including tourism contributed over 30 per cent to the regional GDP of Arctic Finland in 2002.

Greenland

Greenland has a population of 57 000 people. A substantial share of the economy is owned and managed by the Greenland Home Rule Authorities.

Fishing is the largest industry in Greenland, followed by education, health and social work. Within the fishing industry, shrimp is the most important species. The Home Rule owned Royal Greenland is the world's largest supplier of cold-water shrimps. In fisheries there are individual quotas in combination with other Home Rule regulations. In shrimp fisheries the quotas are transferable. The cod fisheries are now of minor economic value due to decline of the resource base. Sheep husbandry has gained significance in recent years due in part to a warming climate and extended growth season. Increasingly, grass production has replaced imported fodder and created a profitable industry. The sheep industry mainly supplies the domestic market. There is no private ownership of land in Greenland, and the Home Rule Authorities allocates user rights to animal herders[16].

Currently there is no oil and gas extraction in Greenland, but according to US Geological Surveys 2000, Greenland has considerable expected reserves, which are not yet discovered mainly off East Greenland (see chapter 3 in this report). Three licensing rounds were opened for ocean areas west of Greenland in 1992, 2002 and 2003. In recent years new seismic data off the west coast have been obtained, and the results are promising, according to the Ministry for Housing, Infrastructure and Minerals and Petroleum[17]. In July 2006 another licensing round for offshore West Greenland (Disko West) was opened. The environmentally sensitive inner Disko Bay is not included in the licensing round. Environmental investigations have been carried out to assess the possible impact on the marine environment in the licensing area. However, environmental interest groups question the sustainability of future petroleum activity in the area.

Potential for hydro power production offers an opportunity for export oriented processing industries.

There has recently been a marked increase in the exploration of minerals other than mineral fuels, primarily for gold, nickel and diamonds, and lately also molybdenum. A production license for gold was granted in 2003; in 2004 export of gold started up at Mill. DKK 130, already at about 10 per cent the level of total shrimp exports.

There has been an increase in Greenland's role in resource management in recent years and Greenland Home Rule Authorities and Denmark are currently negotiating their role in non-renewable resource extraction in Greenland.

Table 4.10. Value added by industry[1]. Greenland. 2002

	Mill. DKK	Per cent
Agriculture	66	0.7
Forestry	0	0.0
Fishing	1 695	17.8
Coal, lignite and peat extraction	0	0.0
Oil and gas extraction	0	0.0
Other mining and quarrying	580	6.1
Processing of fish	480	5.0
Other manufacture of food	0	0.0
Manufacture of wood and paper	0	0.0
Manufacture of basic metals	0	0.0
Other manufacturing	569	6.0
Electricity, gas and water supply	217	2.3
Construction	549	5.8
Transport via pipelines	0	0.0
Public administration and defense	524	5.5
Education, health and social work	1 575	16.5
Other services	3 289	34.5
GDP[2]	**9 544**	**100.0**

[1] Estimates by ECONOR: Data on value added by industry are under preparation by Statistics Greenland.
[2] At basic prices.

Table 4.11. Fishing and whaling. Greenland. 2003

Total catch (in 1 000 tonnes)	238
Whaling (in number)	
- small	3 607
- large	203

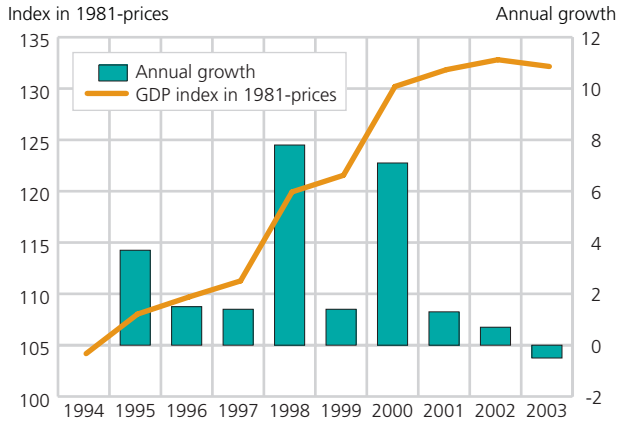
Source: FAO, Greeland Statistical Yearbook 2005.

Table 4.12. Employment in selected industries. Greenland. 2003

	Number of persons	Per cent
Animal husbandry, fishing and hunting	1 900	6.9
Fish manufacturing	2 193	8.0
Retail trade	2 917	10.6
Public Administration	11 969	43.5
Total	**27 494**	**100.0**

Source: Greenland Statistical Yearbook 2005.

Figure 4.17. GDP index and growth rate. Greenland. 1994-2003



Source: Greenland Statistical Yearbook 2005.

Figure 4.18. Value added by main industry. Greenland. 2002. Per cent of GDP

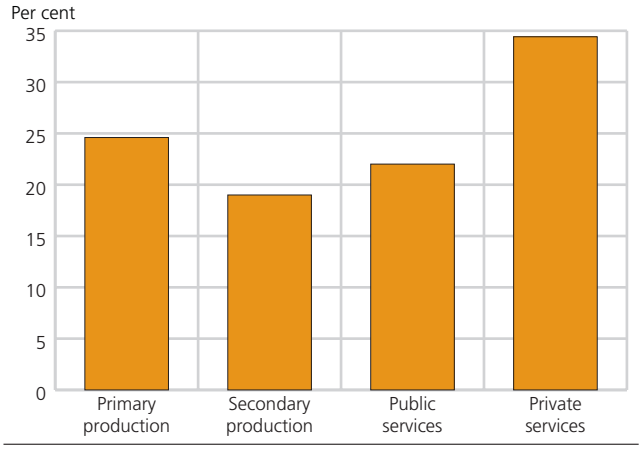
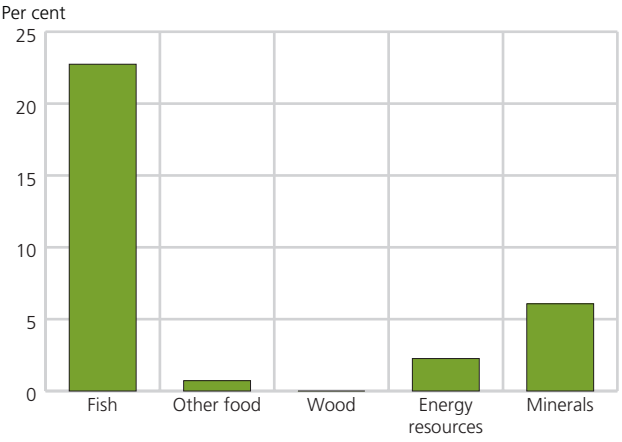


Figure 4.19. Value added in natural resource based industries. Greenland. 2002. Per cent of GDP



In the years 1994-2001 Greenland experienced annual economic growth at about 3.5 per cent on average. After 2001 the growth of GDP[18] has slowed and even turned into a 0.5 per cent decline in GDP from 2002 to 2003. The export value of shrimps declined from 2002 to 2004, mainly due to a reduction in the price of shrimps. The export of shrimps alone accounts for about 50 per cent of total export value.

In terms of employment, government is by far the largest employer in Greenland. The government sector accounted for 43.5 per cent of employment in 2003, down from 46.7 per cent in 2000. The second largest sector in terms of employment was retail trade (10.6 per cent) followed by fish processing (mainly shrimps) with 8.0 per cent of total employment.

Fishing accounts for about 90 per cent of all exports from the country. In 2003, total exports of goods amounted to DKK 2 285 million. This compares with total imports of DKK 3 031 for the same year. Notice that data for external trade do not include services. The largest category of imports was goods for household consumption, which accounted for over a third of the total value of imports in 2003. Most goods including food for household consumption are imported. Imports of consumer goods increased from DKK 874 million in 2000 to DKK 1 269 million in 2003, an increase of 45.2 per cent. In addition to marketed consumer goods, there is significant consumption of fish and meat harvested by the households themselves (see chapter 5 in this report).

Fishing dominates the resource based industries in Greenland. The tourism industry, which is a resource based industry is not included due to a lack of data. Tourism has increased and the industry is considered to have potential for further growth.

Greenland/Photos.com

Iceland

Iceland is endowed with a mild and humid climate dus to the influence of the the North Atlantic Current. The country has a population of slightly above 300 000 people of which 115 000 lives in the capital of Reykjavik.

The Iceland economy is clearly focused on fishing, which accounted for 8.4 per cent of GDP in 2002. A system of individual fishing quotas was introduced as early as in 1984. Fishing together with fish processing (3 per cent) is the still a pillar of the Iceland economy. However, income from manufacturing other than fish processing accounts for as much as 10.3 per cent of GDP. The mining industry is small, but the country is rich in hydropower and geothermal potential. Manufacture of primary metals is encouraged as a vehicle to export the energy surplus. The value of production in the metal industry increased by 63 per cent from 1998 to 2005. The tourism sector has expanded as a result of growth in eco-tourism and whale-watching. The completion of Iceland's circle road has made it easier to approach the Vatnajökull by car[19] and has contributed to the growth in tourism.

The Iceland economy has grown rapidly in recent decades, and growth in GDP amounted to 8.2 per cent in 2004 and 5.6 per cent in 2005. Import volumes increased drastically after 2002, responding to high investment in the energy and the aluminium industries. The accompanying imbalances in the economy illustrate the difficulty of implementing large-scale projects in a small economy. The dynamics of the Iceland economy have established a secondary industry of 25 per cent of GDP in 2002, whereas primary production from extractive industries only accounted for 10 per cent of GDP. Besides fishing there is some agriculture amounting to 1.6 per cent of GDP. To determine the degree of nature based production, we have to add the energy sector and processing of raw materials to the pure extractive industries. In total, 20 per cent of GDP can be said to be based on Iceland's own resources and nature. The wood and paper industry is included in this estimate. Iceland has carried out substantial treeplanting programs, particularly over the last 50 years. There is also a government program for CO_2 sequestration in forests.[20] Tourism is a growing industry that would have raised the indicator of natural resource dependency even higher if data were available. Its share in total employment increased from 3.3 per cent in 1992 to 4.4 per cent in 2004.

Table 4.13. Value added by industry. Iceland. 2002

	Mill. ISK	Per cent
Agriculture	10 666	1.6
Forestry	117	0.0
Fishing	54 401	8.4
Coal, lignite and peat extraction	0	0.0
Oil and gas extraction	0	0.0
Other mining and quarrying	823	0.1
Processing of fish	19 627	3.0
Other manufacture of food	13 699	2.1
Manufacture of wood and paper	3 200	0.5
Manufacture of basic metals	10 153	1.6
Other manufacturing	39 941	6.1
Electricity, gas and water supply	26 262	4.0
Construction	52 482	8.1
Transport via pipelines	0	0.0
Public administration and defense	42 781	6.6
Education, health and social work	103 121	15.8
Other services	274 402	42.1
GDP[1]	**651 675**	**100.0**

[1] At basic prices.

Table 4.14. Economic indicators. Iceland. 2002-2005

	Current prices ISK billion	Annual growth rates, volume		
	2002	2003	2004	2005
Private consumption	445.6	5.9	7.2	11.9
Government consumption	202.1	1.6	2.9	3.2
Gross (Investments)	139.3	16.2	29.1	34.8
Exports of goods and services	305.6	1.6	8.4	3.5
Imports of goods and services	292.9	10.8	14.4	28.4
GDP at market prices	799.6	3.0	8.2	5.6

Source: OECD.

Figure 4.20. Value added by main industry. Iceland. 2002. Per cent of GDP

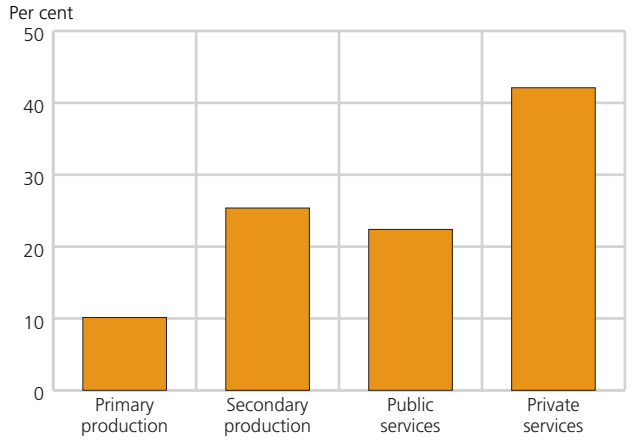
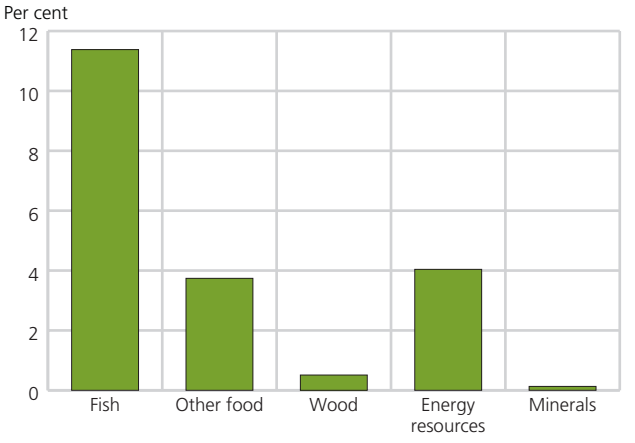


Figure 4.21. Value added in natural resource based industries. Iceland. 2002. Per cent of GDP



Arctic Norway

Arctic Circle, Norway/Photos.com

For purposes of this report, Arctic Norway includes Finnmark, Troms, Nordland, the Svalbard Archipelago and Jan Mayen.

Education, health and social work is the largest industry in Arctic Norway, followed by public administration and defense. Electricity, gas and water supply and construction are also of clear significance. The fishing industry, which is considered a core element of the economy of Northern Norway, contributed only 3.7 per cent to regional GDP in 2002. Fishing activity in Northern Norway may have been underestimated in the statistics as fish is harvested and landed up north by fishing companies with headquarters in the southern part of Norway. As a consequence part of the income from fishing in northern waters may be registered as income in the South of Norway.

The coal production registered in Arctic Norway is located on Svalbard. There was no oil and gas production in Arctic Norway in 2002. Currently the gas field Snøhvit is being developed north of Hammerfest, the northernmost city in the world. The natural gas will be liquefied (LNG) and exported by sea as the warm Norwegian Current keeps the southern part of the Barents Sea ice-free, even in winter.

The favorable climate has contributed to the economic importance of marine fisheries in Arctic Norway.

Svalbard. Photo: Odd Rune Andersen

Table 4.15. Value added by industry. Arctic Norway. 2002

	Mill. NOK	Per cent
Agriculture	756	0.9
Forestry	193	0.2
Fishing	3 264	3.7
Coal, lignite and peat extraction	258	0.3
Oil and gas extraction	1	0.0
Other mining and quarrying	422	0.5
Processing of fish	1 129	1.3
Other manufacture of food	1 241	1.4
Manufacture of wood and paper	325	0.4
Manufacture of basic metals	469	0.5
Other manufacturing	3 281	3.7
Electricity, gas and water supply	4 795	5.4
Construction	4 647	5.3
Transport via pipelines	0	0.0
Public administration and defense	8 165	9.2
Education, health and social work	20 896	23.6
Other services	38 704	43.7
Regional GDP[1]	**88 546**	**100.0**

[1] At basic prices.

Table 4.16. Employment by industry. Arctic Norway. 2002

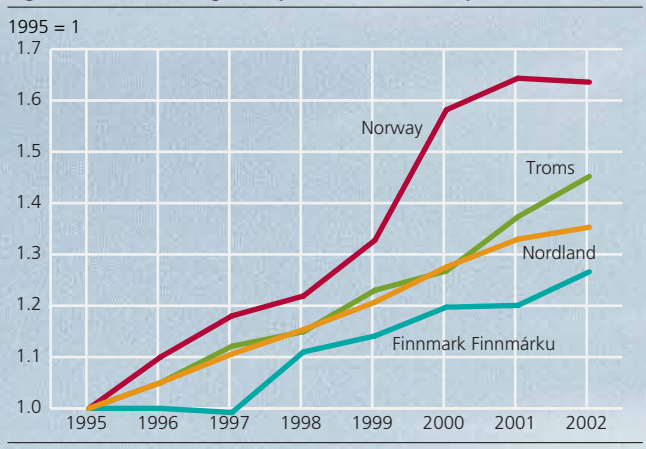
	Number of employees	Per cent
Total	**212 769**	**100.0**
Fishing	7 461	3.5
of which: wild	6 252	2.9
Agriculture, forestry	5 729	2.7
Food processing	7 394	3.5
Mining	927	0.4
Petroleum & gas	12	0.0
Hydroelectric power	1 703	0.8
Tourism	15 253	7.2
Sub total nature based activities	**38 479**	**18.1**
Manufacturing	11 106	5.2
Services, non-government, excl. tourism	64 893	30.5
General government	98 291	46.2

Source: Statistics Norway.

Almost half of all the fishermen in Norway are employed in the Arctic region of the country. In addition, the Arctic region accounts for 37 per cent of Norway's total value of production and 39 per cent of the gross value added in fishing. For mining, 22 per cent of national employment is in the Arctic, with similar shares for output and value added. For hydroelectric power, about 12 per cent of national employment (and output) is in the Arctic.

Tourism, hydropower production and fishing are the dominant activities among the nature- based industries of Arctic Norway (figure 4.24). Hydroelectric power production is very capital intensive. Tourism, fishing and food processing are the largest employers after the government sector and non-government services. The government sector alone accounted for 46.2 per cent and the non-government services (excluding tourism) for 30.5 per cent of the region's total employment in 2002. In terms of income, the ranking is reversed with non-government services accounting for 43.7 per cent of gross value added, followed by

Figure 4.22. Gross regional product in current prices



Source: Statistics Norway.

Figure 4.23. Value added by main industry. Arctic Norway. 2002. Per cent of regional GDP

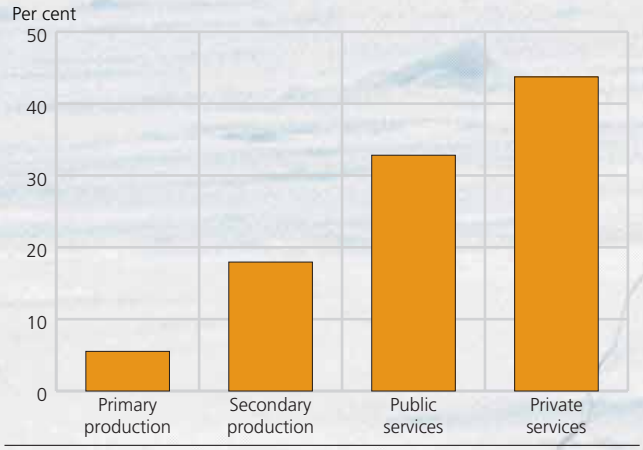
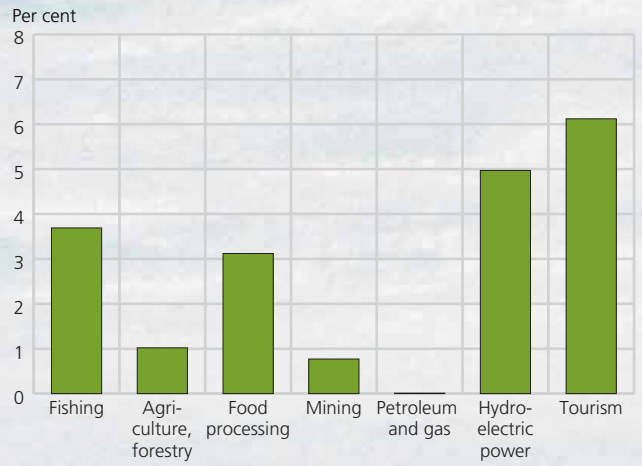


Figure 4.24. Value added in natural resource based industries. Arctic Norway. 2002. Per cent of GDP



general government services, which accounted for 32.8 per cent of total value added.

Roughly 20 per cent of the regional economy can be characterized as nature based activities. The nature-based industries accounted for 18.7 per cent of employment. Hence the nature-based sector is the third largest sector in the economy of Arctic Norway and, when the petroleum industry is not included, has a higher share of employment and production in the Arctic than in the rest of Norway.

Tourism is the largest industry among the nature-based industries in Arctic Norway both in terms of employment and value added. Tourism had double the level of employment and generated 60 per cent higher income than the fishing industry in 2002. The cruise traffic to Svalbard has increased and the main tourist attractions in Svalbard are the Arctic wildlife, particularly the polar bears, as well as the vegetation and scenery. The development of the tourism industry may suffer if climate change and ice cover reductions drastically reduces the hunting ground of the polar bear. However, as discussed in chapter 6, there might also be positive effects of global warming that may facilitate tourism in the Arctic, in particular a prolonged tourist season.

Arctic Russia

Arctic Russia is by far the largest among the Arctic regions, both in terms of land area and population. According to our definition it covers the regions of the Republics of Karelia, Komi, the oblasts of Arkhangelsk, Murmansk, the Autonomus Okrugs Khanty-Mansi and Yamalo-Nenets, Taymir, Evenks, Sakha, Chukotka, Magadan, Koryakia. In 2003, Northern Russia had a population of 7.1 million people down from 7.9 million in 1995.

The basic structure of the Russian economy was developed during the Soviet era with economic planning as a core instrument. As a consequence of planned public industry development, resource extraction and processing have to a large extent been organized in combinates that are vertically integrated and produce multiple outputs. The extractive industries that are pre-dominant in Arctic Russia have this historic origin, and economic statistics have been compiled in formats associated with that institutional framework. Therefore the data for Arctic Russia are not readily comparable with data for other Arctic regions. For instance, fishing is integrated with the food industry and the fuel industry may include refining and chemical products. The data on Russia in this report are provided by the Federal State Statistical Service of Russia. To present data on income and production by industry at about the same aggregation level as for other Arctic regions, some additional compilations have been made for this report using regional statistics on output and employment from the Russian Federal State Statistical Service. However, it is not possible to produce fully compatible tables. Consequently Table 4.17 refers to slightly different industry categories than the corresponding tables for the other arctic regions.

The fuel industry was the largest single industry in the Russian Arctic in 2002. This industry, which includes oil and gas extraction, contributed 36 per cent to regional GDP. Transportation of petroleum via pipelines accounted for an additional 7.3 per cent of GDP. The level of activity reported in the chemical industry and ferrous metallurgy is minor, whereas non-ferrous metallurgy represents 4 per cent of regional GDP. Education, health and social security accounted for 8.7 per cent of regional GDP, while other services contributed 11.4 per cent. The share of private and public services is low compared to other Arctic regions. However, the low share may partly reflect the provision of social welfare services within other industries as was practiced extensively before the economic reforms.

Arctic Russia's share of the population of the whole Russian Federation declined to 4.1 per cent in 2003, down from 4.4 per cent in 1995. The GDP per capita is higher in Arctic Russia than in the Russian nation as a whole.

Table 4.17. GDP[1] by industry. Arctic Russia. 2002

	Mill. Rubles	Per cent
Agriculture	12 345	1.0
Forestry	7 258	0.6
Food Industry	13 618	1.0
Forest Industry	29 526	2.3
Fuel Industry	475 040	36.4
Chemical Industry	5 622	0.4
Ferrous Metallurgy	4 856	0.4
Non-Ferrous metallurgy	52 190	4.0
Other Industries	30 633	2.4
Electric power industry	57 711	4.4
Construction	173 671	13.3
Transport via pipelines	95 575	7.3
Trade	84 274	6.5
Education, health and social security	113 261	8.7
Other services	148 088	11.4
Regional GDP	**1 303 668**	**100.0**

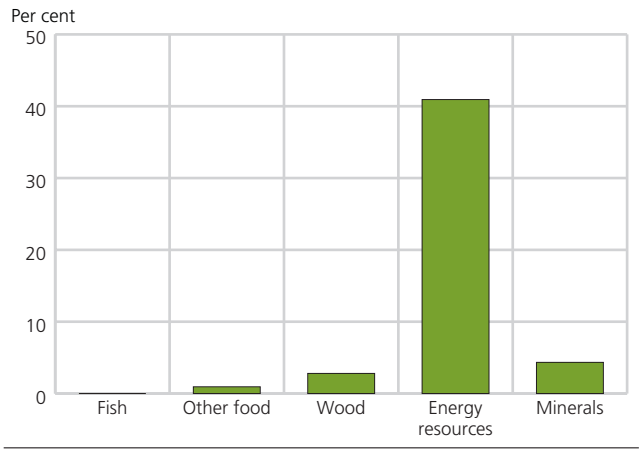
[1] Public administration and defence not included. In other Arctic regions public administration amounts to 12 per cent of GDP on average.

Table 4.18. Employment in selected industries. Arctic Russia. 2003

	1 000 persons	Per cent
Agriculture and forestry	159	4.1
Manufacturing	907	23.7
Construction	370	9.7
Transport and communication	443	11.6
Trade, catering	518	13.5
Education	388	10.1
Public health and social services	285	7.5
Other services	352	9.2
Other industries	406	10.6
Total Arctic region	**3 828**	**100.0**

Source: Federal Statistical Office of Russia.

Figure 4.25. Value added in natural resource based industries. Arctic Russia. 2002. Per cent of regional GDP



However, it is important to distinguish between Khanty-Mansi and Yamalo-Nenets and the other Arctic regions of Russia. In Khanty-Mansi and Yamalo-Nenets gross product per capita is considerably higher than in other parts of Russian Arctic (figure 2.3, pg

Figure 4.26. Russian oil production and consumption 1990-2004. Million tons

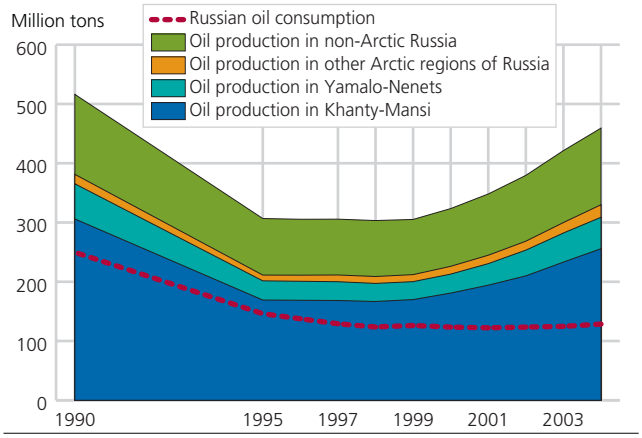
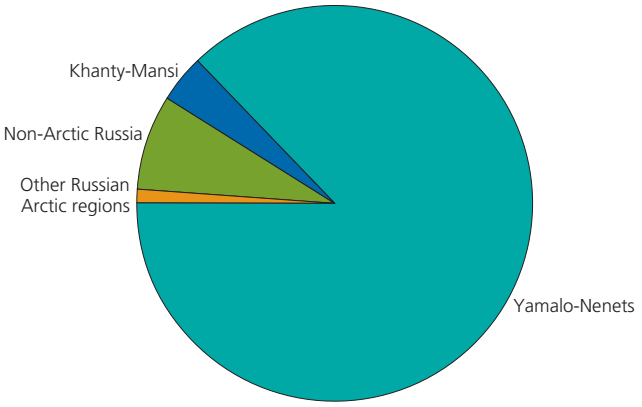


Figure 4.27. Regional distribution of Russian gas production in 2004



21). In these other parts of the Arctic regions gross product per capita is only slightly higher than the Russian average.

Figure 4.26 and 4.27 provides the reason for these significant differences: Approximately 55 per cent of Russian oil production takes place in Khanty-Mansi and more than 85 per cent of Russian natural gas production takes place in Yamalo-Nenets. Probably more than 50 per cent of total gas production in Europe and Northern parts of Asia is taking place in Yamalo-Nenets. The oil production in Khanty-Mansi is also substantial in a global perspective. The oil production in this area equals approximately 50 per cent of the oil production in Saudi Arabia. While the oil production in Russian Arctic has been increasing during the last decade, the gas production has been relatively stable.

In the years after 1990 the oil production in Khanty-Mansi dropped significantly. This drop was to a large extent caused by a parallel drop in domestic demand. The increased production in Khanty-Mansi during the recent years has, on the other hand, mainly been driven by increased export, cf. Figure 4.26.

With respect to coal production, only a small share of the Russian production is taking place in the Arctic region, cf. Figure 4.28.

Figure 4.29 provides an overview of the employment by sector. It shows that agriculture has a significantly smaller share of the workforce in the Arctic regions than in the rest of Russia. The employment share is especially small in Khanty-Mansi and Yamalo-Nenets. The remarkably large share of employment within the construction industry in these two regions is among other things probably related to petroleum production and transport.

Figure 4.28. Russian coal production. Million tons. 1990-2004

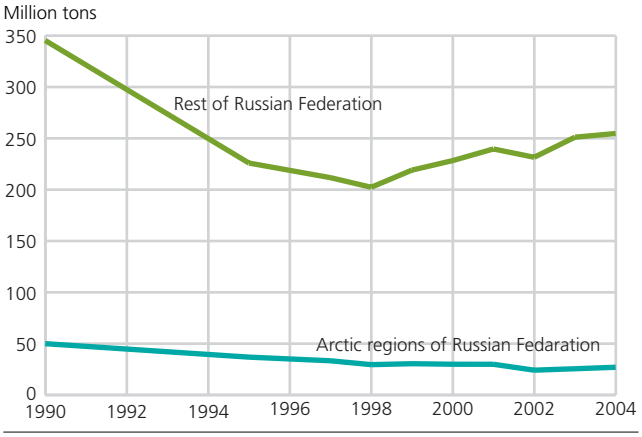
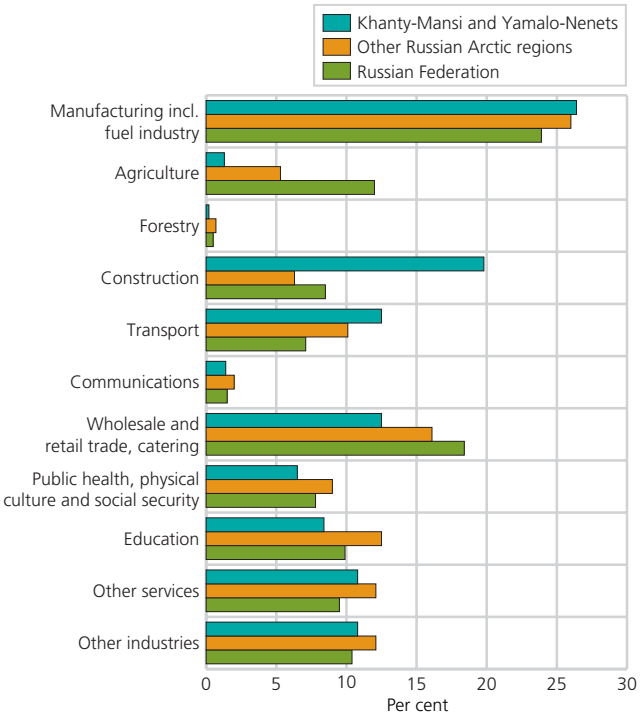


Figure 4.29. Number of employed in Russian Arctic by sectors in 2003. Shares of regional employment. Per cent



Russian trawler in the Barents sea.
© Helge Sunde / Samfoto

Arctic Sweden

Arctic Sweden covers the two northern counties, Västerbotten and Norrbotten. Together they account for slightly less than 5 per cent of total GDP in Sweden. Together they have a population of 523 000 people, or 5.8 per cent of the total Swedish population.

Table 4.19 shows GDP by industry for Northern Sweden for 2002. In 2002, the largest industries besides public and private services were other manufacturing (i.e. manufacturing excluding fish, food processing, manufacture of wood and paper, coal and oil, chemicals and basic metals).

The manufacturing sector accounted for 14.8 per cent of regional GDP in 2002. Within private services real estate, renting and business service companies is the largest single activity with about 14 per cent of regional GDP. Health and social work alone contributed slightly above 10 per cent. The largest resource sector is forestry followed by mining and quarrying.

Table 4.19. Value added by industry. Arctic Sweden. 2002

	Mill. SEK	Per cent
Agriculture	706	0.6
Forestry	3 371	2.9
Fishing	0	0.0
Coal, lignite and peat extraction	0	0.0
Oil and gas extraction	0	0.0
Other mining and quarrying	2 887	2.5
Processing of fish	0	0.0
Other manufacture of food	0	0.0
Manufacture of wood and paper	0	0.0
Manufacture of basic metals	0	0.0
Other manufacturing	17 234	14.8
Electricity, gas and water supply	6 497	5.6
Construction	5 490	4.7
Transport via pipelines	0	0.0
Public administration and defense	6 727	5.8
Education, health and social work	20 836	17.9
Other services	52 386	45.1
Regional GDP[1]	**116 134**	**100.0**

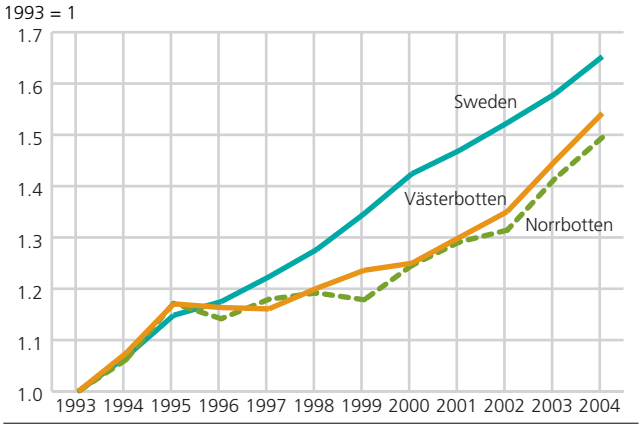
[1] At basic prices.

Table 4.20. Net disposable income per capita. Arctic Sweden. 1 000 SEK

	2001	2002	2003
Västerbotten	114	120	124
Norrbotten	117	123	126
Arctic Sweden	116	122	125
Sweden	132	138	142

Source: Statistics Sweden.

Figure 4.30. Regional GDP in current prices



Source: Statistics Sweden.

Figure 4.31. Value added by main industry. Arctic Sweden. 2002. Per cent of regional GDP

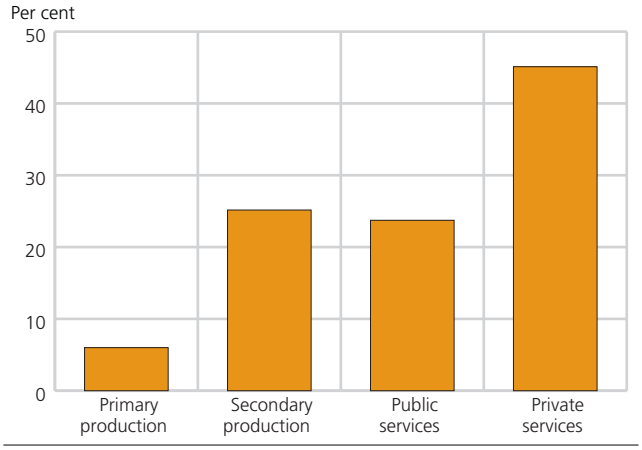
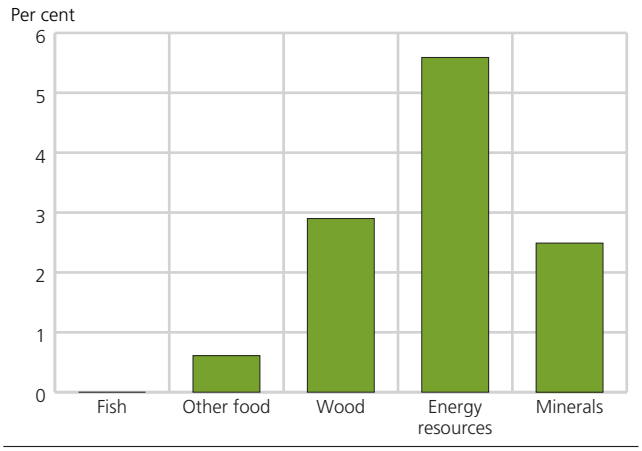


Figure 4.32. Value added in natural resource based industries. Arctic Sweden. 2002. Per cent of regional GDP



Concluding remarks

Although this chapter has primarily focused on the individual Arctic regions, the format of the core data is uniform and prepared for providing a brief overview of the whole circumpolar region. When looking at the overall picture, Iceland and Northern Fennoscandia have fairly low shares of extractive industries (5-10 per cent of GDP) and the highest shares of secondary industries. Finland and Iceland clearly take the lead in having the highest share of secondary industries, i.e. non-extractive production of goods. The mineral based American Arctic and fishing based Faroe Islands and Greenland are the most involved in extractive industries among Arctic regions other than Arctic Russia. The share in GDP of private services varies among the regions, but there are no outliers with significant deviations from the general level. Arctic Norway is special in having the highest share of public services on top of a relatively large private service industry. A corresponding picture is seen for Alaska.

However, the share of income from extractive industry does not tell the full story about regional dependence on the nature. The structure of the whole area looks far more diverse when we look at the proportion of the whole economy accounted for by the resource base. Russia by far surpasses the other regions in terms of nature based elements in the economy and it is the energy industry (oil and gas mainly) that is overwhelmingly large and boosts the share to almost 50 per cent of GDP. Greenland and the Faroe Islands have fish processing industries that add to their already high contribution to the economy from the fisheries.

Figure 4.33. Value added by main industry in Arctic regions (except Russia). 2002. Per cent of regional GDP

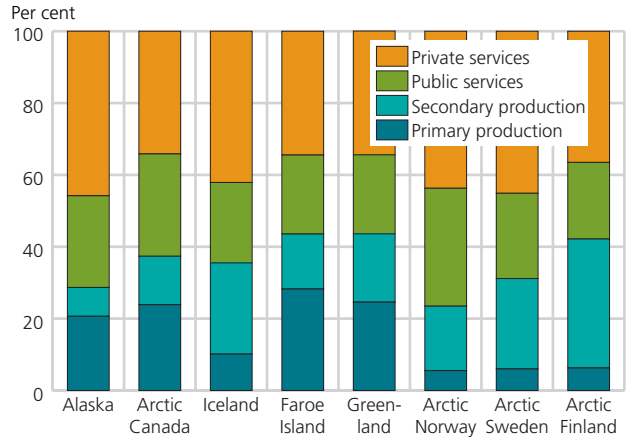
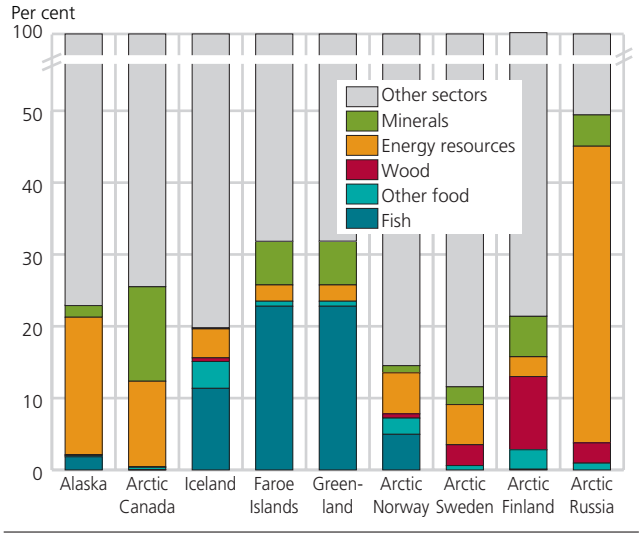


Figure 4.34. Value added. Natural resource based and other industries by Arctic regions. 2002. Per cent of regional GDP



Notes

1 Landes, D.S. (1998): The Wealth and Poverty of Nations. WW Norton & Company. New York.
2 IEA, 2005.
3 September 2006.
4 www.apfc.org
5 The Economist, August 12th, 2006.
6 DOE-EIA 2006.
7 IEA 2006: Monthly Oil Market Report, 11 August 2006.
8 www.eia.doe.gov
9 The source of mineral production data for Alaska is «Alaska's Mineral Industry 2004: A Summary» by D.J.Szumigala and R. A. Hughes, Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources, March 2005.
10 The Economist August 12h 2006.
11 Petroleum Intelligence Weekly, August 14, 2006.
12 Statistics Canada, Analysis in Brief, Diamonds: Adding lustre to the Canadian economy.
13 CIA World Factbook.
14 CIA World Factbook.
15 Konttinen, J-P. 2005. Matkailun satelliittitilinpito ja aluetaloudelliset vaikutukset [Tourism Satellite Account and Regional Economic Effects]. Ministry of Trade and Industry, MTI Financed studies 4/2005.
16 AHDR (Arctic Human Development Report) 2004. Akureyri: Stefansson Arctic Institute.
17 Greenland Government 2006.
18 GDP in 1981-prices.
19 AHDR (Arctic Human Development Report) 2004. Akureyri: Stefansson Arctic Institute.
20 ACIA (Arctic Climate Impact Assessment) 2005.

Arctic/Photos.com

5. Interdependency of subsistence and market economies in the Arctic

Birger Poppel[1]

Ilulisssat, Greenland. Photo: Birger Poppel.

In his address to the Inuit Circumpolar Conference in 1998, Finn Lynge focused on a topic «which has so far received all too little attention and which – to the mind of a growing number of people – is essential in securing a place for hunting cultures in the world of tomorrow. And that is the issue of economic quantification of subsistence values. … What evades a monetary assessment has no interest for the statisticians. For governments' economic planners, what cannot be counted in money doesn't exist»[2]. On several occasions, the Arctic Council[3] has focused on subsistence activities as part of the lifestyle of the indigenous peoples of the Arctic, and on how subsistence is conditioned by environmental impacts. These concerns are reflected in research contributions developed under the auspices of the Arctic Council, such as the Arctic Monitoring and Assessment Program, the Arctic Human Development Report, the Arctic Climate Impact Assessment Program and a number of other projects[4]. The Arctic Human Development Report stated that: «Customary harvesting practices are not only culturally but also economically important locally, although their role varies by region, ethnic group, urban or rural setting, and generation. This harvesting is important for its contribution to food production and consumption.» Although the importance of the subsistence economy in the Arctic is now becoming more widely recognized, sufficient data are not yet available to give a comprehensive picture of the subsistence activities of economic significance to individuals, households and communities in the Arctic. One of the purposes in launching the Survey of Living Conditions in the Arctic (SLiCA) was to help to fill this gap.

This chapter, which includes some preliminary results from the SLiCA project, aims to contribute to the picture of how subsistence activities and the cash economy are mutually dependent on each other for providing consumption possibilities in the Arctic today, and at the same time are part of a lifestyle that represents continuity, sharing and connection to nature. As we show in this chapter, the proportion of food obtained by subsistence activities is quite large for many Arctic communities. Moreover, subsistence activities are embedded in a unique cultural and social context that conditions their value. Quantification of subsistence activities in economic terms cannot capture the cultural values, but may provide an important input for understanding the economy and living conditions in the Arctic. Hopefully, the information provided in this report and by follow-up activities, e.g., future SLiCA reports, will give statisticians, policy-makers and the public a better basis for understanding the significance of the economy of subsistence activities outside the market sphere. Thus, this information will give a more comprehensive picture of consumption possibilities and well-being of the people in the Arctic.

Subsistence and subsistence activities

Subsistence is a highly disputed theoretical concept within the social sciences and the humanities. The discussion among Arctic social scientists has been focusing on how far into the transition, from wildlife harvest and principles of sharing, to a globalized world governed by the market economy, it is still meaningful to employ the concept of subsistence. To reflect the changing socio-economic conditions of the hunting, herding and fishing societies, a variety of subsistence concepts has been introduced, all stressing the importance of traditional subsistence activities in a mode of production now mixed with the cash economy[5]. One approach suggests defining subsistence as «the concept of meeting basic human needs or requirements by expending the amount of labour and capital required to obtain enough food for personal survival (and the survival of one's family)», and highlights that «subsistence hunting is not only what one lives on; rather it is also what one lives by, because it sustains the life of a culture»[6]. In the present

day setting of many northern indigenous communities, the two sectors often coexist. Another approach points out «the combination of subsistence and commercial wage activities provides the economic basis for the way of life so highly valued in rural communities»[7].

From an economic viewpoint, it is often emphasized that traditional hunting and fishing activities, taking place at a distance from modern infrastructure and market opportunities, can represent a «barrier» for broader participation in the market and thus limit access to what is provided from the market economy: not only wage income, but also access to credit, subsidies and market-related transfer payments. However, this aspect has only been emphasized in very few empirical studies of the subsistence economy of the Arctic, and should be included in future research.

In a 1992 statement from the Inuit Circumpolar Conference[8], subsistence is defined as «a highly complex notion that includes vital economic, social, cultural and spiritual dimensions. The harvesting of renewable resources provides Inuit with food, nutrition, clothing, fuel, harvesting equipment and income. Subsistence means much more than mere survival or minimum living standards. … It enriches and sustains Inuit communities in a manner that promotes cohesiveness, pride and sharing. It also provides an essential link to, and communication with, the natural world of which Inuit are an integral part».

The concept of subsistence has had a prominent position in various discussions of indigenous people's rights in international legislation, conventions and declarations. For example, the International Whaling Commission recognized that aboriginal subsistence whaling is different from commercial whaling, and since 1985 the Commission has set catch limits for stocks with special allowances for aboriginal subsistence whaling. The United Nations Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights, both from 1966, have the following statement of principle: «All peoples may, for their own ends, freely dispose of their natural wealth and resources without prejudice to any obligations arising out of international economic cooperation, based upon the principle of mutual benefit, and international law. In no case may a people be deprived of its own means of subsistence.» This statement of principle introduces in international law the concept of subsistence and thereby states a right for all, including the indigenous peoples of the Arctic.

Rights to land represent a crucial condition for subsistence activities. An example is the Alaska Native Claims Settlement Act (ANCSA), passed in 1971. Through ANCSA, the indigenous peoples of Alaska

Photo: Jack Kruse. Barrow

received designated land and money in exchange for giving up land, which then became public. The indigenous groups also gave up rights to subsistence harvest on public land. In 1980, the United States Congress passed the Alaska National Interest Lands Conservation Act (ANILCA), attempting to return the subsistence rights to the indigenous peoples according to criteria of traditional and direct dependence upon wildlife harvest as the mainstay of livelihood, and local residency[9].

Land rights are not the only preconditions for subsistence activities in the Arctic. A crucial question today is: To what extent will climate change and other environmental impacts limit the possibilities for subsistence activities in the Arctic? Changes in winds, ocean currents and precipitation may have adverse impacts on fish, birds and mammals, core elements for sustaining life in the Arctic region. Melting ice may diminish the habitat of animals and hunting opportunities. Environmental toxins, with a high degree of accumulation in northern regions, are found in Arctic animals at increasingly high levels, threatening subsistence food production. The World Conservation Strategy Caring for the Earth from 1985 summarizes the perspectives of the indigenous peoples: «Their cultures, economies and identities are inextricably tied to their traditional lands and resources. Hunting, fishing, trapping, gathering, herding or cultivation continue to be carried out for subsistence – food and materials – as well as for income. They provide communities with a sense of continuity with the past and unity with the natural world, reinforcing ethics of sharing and of stewardship of the land.» It is often assumed that indigenous peoples have only two options for their future: to return to their ancient ways of life, or to become assimilated into the dominant society. They should however, also have a third option, to modify their lifestyles, combining the old and the new in ways that maintain and enhance their identity while allowing their economy to evolve[10].

Measurement issues

In order to measure the importance of subsistence activities, the following aspects are essential[11]:

- economic aspects – income, production and consumption, including the value of the harvest and of the «factors of production», e.g., hunting equipment.
- integrative aspects – the integration of market and subsistence.
- nutritional aspects – including food security, the nutritional value of the diet, and environmental toxins in food
- social aspects – expressing the social order and kinship.
- cultural aspects – including the sharing of food.
- identity aspects – including identity markers, such as language, food, relations to the land, hunting skills and traditions.

In order to quantify the value of Arctic subsistence activities in regional and national economies, the following activities must be examined: hunting, whaling, fishing, herding, animal husbandry, gathering and trapping. To illustrate how the household in the mixed subsistence and cash economy works as a micro-enterprise, a household production model was developed for use in SLiCA study[12]. The model illustrates how Arctic households organize productive activities and allocate the factors of production (land, labour, capital) in order to optimize income flows from both the market (public and private sectors) and subsistence spheres of the economy. The model captures both monetary and non-monetary production and consumption within the household. However, the model does not capture the potential barriers to market participation, such as lack of employment or credit[13]. Household income and expenditure are quantified in terms of:

- cash income (wages from public and private sector, sale of commodities from harvest or household production);
- transfers (pensions, social assistance);
- in-kind income from household subsistence production and gifts from mutual aid/sharing;
- household consumption;
- reinvestment/depreciation of the household capital.

Sources of data on subsistence are diverse and include case studies of small communities, administrative registers of regional wildlife management, and regional and national statistical data on licences, quotas, catches of different species, and sales to processing plants. Other sources include harvest monitoring, government studies, species-specific studies, socio-economic impact assessments, claims statements, food security/nutrition studies, combined register and survey data, community profiles and comparative circumpolar studies. Some regions of the Arctic are rich in administrative data from public registers, e.g., Russia up to the collapse of the Soviet Union[14], and Greenland, where very detailed wildlife harvest records has been registered for more than 200 years.

Since the late 1950s, the Canadian Government has carried out a number of Area Economic Surveys, yielding data on local resources, game-catch statistics and land-use maps. In Canada, harvest surveys are usually required in association with land claims documentation and implementation. In Alaska, harvest studies are usually conducted in association with management of subsistence rights. In 1978, the Subsistence Division of the Alaskan Department of Fish and Game began studies that, like the Canadian studies, intended to establish baseline studies of subsistence resource use. Reports have since been published on wild resource harvest and use, seasonality of fishing, hunting, and gathering, methods of harvesting and processing, harvest levels, sharing and trading of subsistence foods, cultural and economic values associated with subsistence, trends in resource use patterns, and resource issues that need resolution [15].

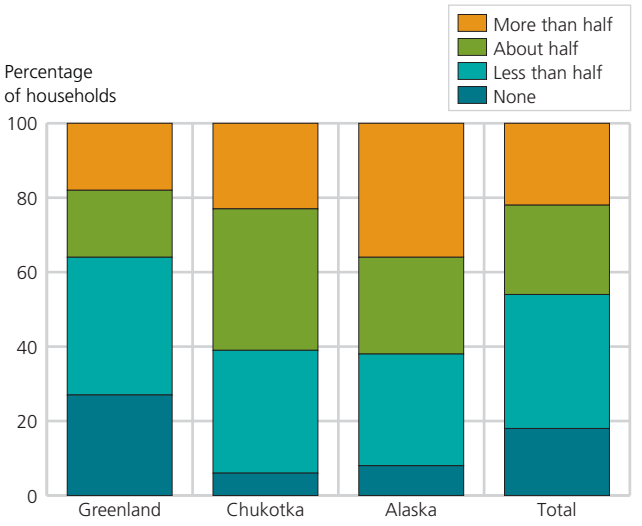
The role of mixed cash and subsistence economies in the Arctic

Realizing that the traditional social indicators and ways of measuring living conditions and individual well-being did not adequately reflect the welfare priorities of the indigenous peoples of the Arctic[16], Statistics Greenland in collaboration and partnership with individual researchers, research institutions and indigenous peoples' organizations initiated the Survey of Living Conditions in the Arctic, SLiCA. The core questionnaire (www.arcticlivingconditions.org) applied by SLiCA offers opportunities to examine and grasp some of the the economic, and social, cultural and nutritional significance of subsistence activities. A broad variety of questions have been asked about individual and household activities and behaviour. The importance of a mixed cash and subsistence economy for living conditions in the Arctic is one of five international research topics suggested by the indigenous people's representatives participating in SLiCA.

Preliminary findings of the Survey of Living Conditions in the Arctic, SLiCA

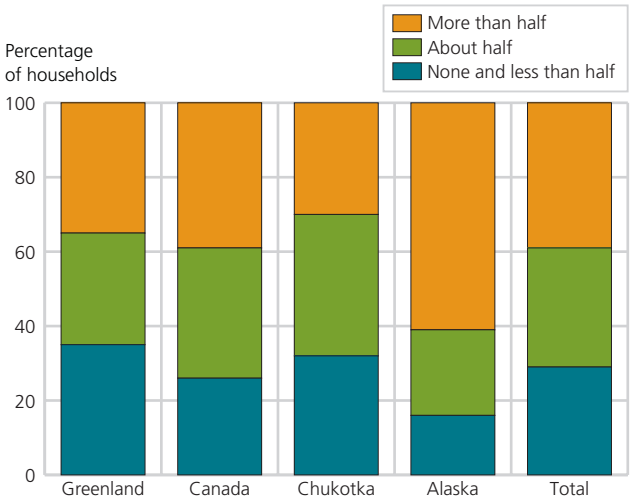
Below, some preliminary findings from SLiCA are presented based on more than 7 000 personal interviews with native adults (aged 15 and above) in Greenland, Canada, Chukotka in Russia, and Alaska[17]. Further analyses will be carried out in forthcoming SLiCA reports. In addition to Inuit, the native populations include Evan, Chuvan and Yukagir people living in Chukotka. Since 97 per cent of the population represented is Inuit, we take the liberty to refer to the population in the survey as Inuit adults living in Inuit settlements of the Arctic.

Figure 5.1. Proportion of meat and fish consumption harvested by households. Regional Surveys 2001-2006



Source: SLiCA.

Figure 5.2. Traditional food in household consumption of meat and fish. Regional Surveys 2001-2006

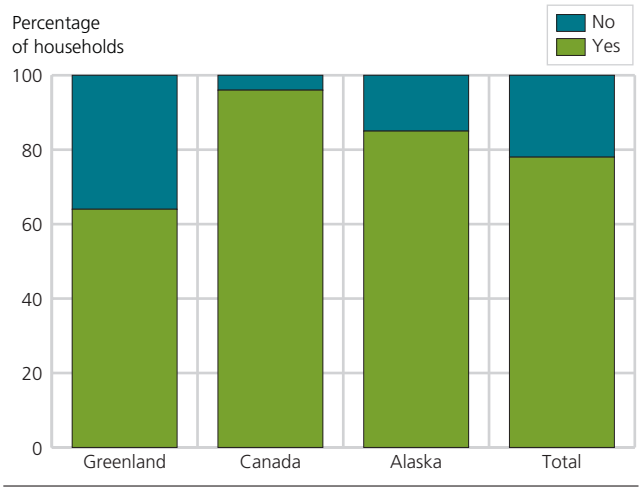


Source: SLiCA.

Meat and fish harvested and eaten by households

One of the SLiCA questions dealt with the proportion of meat and fish consumed by the household that was harvested by the household. The response as depicted in Figure 5.1 supports the hypothesis that subsistence harvesting is still important among the Inuit of the Arctic. In total, five out of ten households report that they harvested about half or more than half of all the meat and fish the family ate. Six out of ten Inuit households in Chukotka and Alaska report that they harvested about half or more than half of their meat and fish consumption, whereas less that ten per cent did not harvest at all. For Greenland, the harvest activity is smaller than Chukotka and Alaska as slightly less than 40 per cent of the Greenland households report that they fish, hunt and gather about a half or more of the traditional food supply of the household.

Figure 5.3. Traditional food shared with other households. Regional Surveys 2001-2006



Source: SLiCA.

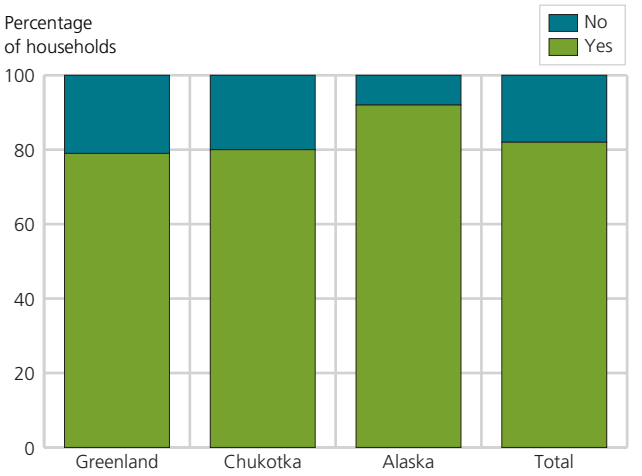
Traditional food in the diet

To get an overall impression of the significance of traditional food (the concept covers several regional words like e.g. nikipaq, kalaalimernit and country food) in the diet of the respondents, everyone in the survey was asked about the proportion of «traditional food» meat and fish, eaten by the household. In the literature traditional food is usually characterised by type of food and type of preparation: locally or regionally harvested, primarily meat from marine or land mammals, fish or wild fowl, but can also include berries, mushrooms or herbs[18]. Regarding preparation, food has generally been considered traditional if it was eaten raw or transformed by natural processes (frozen, dried or fermented) or, if prepared, cooked or smoked. The term traditional food was not defined to the respondents which probably means that the term, not least when it comes to the type of preparation, covers a large variety. The proportion of meat and fish that is traditional in all regions comes from different activities and sources:

- the households' own subsistence activities;
- gifts from family or other households;
- sharing due to local traditions and principles;
- food exchange;
- buying food directly from hunters/fishermen, at the local markets, at co-ops or at supermarkets, e.g., Greenland.

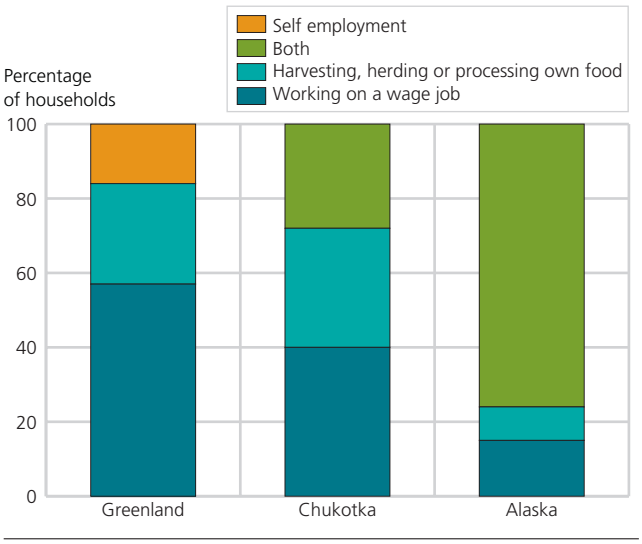
Figure 5.2 shows that traditional food accounts for a substantial part of the food supply of the household everywhere in the Arctic. Two of every three Inuit households report that half or more of their household's food consumption is made up by traditional food. Among the Arctic Inuit, traditional food seems to account for the largest part of the households' diet

Figure 5.4. Traditional food received from other households. Regional Surveys 2001-2006



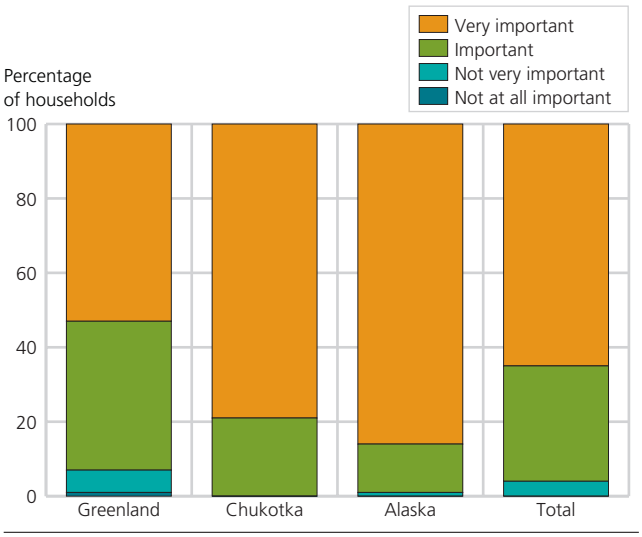
Source: SLiCA.

Figure 5.5. Preferred lifestyle. Regional Surveys 2001-2006



Source: SLiCA.

Figure 5.6. Importance of subsistence activities: hunting/ fishing, gathering, preserving traditional food. Regional Surveys 2001-2006



Source: SLiCA.

in Alaska, whereas the proportion of traditional food consumed by Inuit households of Greenland, Canada and Chukotka is somewhat smaller. It should be noted that the percentage of households that do not consume traditional food at all is below one per cent.

Some questions in the SLiCA questionnaire focus on sharing and exchange of traditional food. The findings are presented below (note that only Greenland and Alaska are represented in both figures). Figure 5.3 shows that in Greenland, Canada and Alaska, the sharing of traditional food is still an important and enduring tradition. In Canada, 96 per cent of Inuit households in the Arctic share traditional food with other households. The corresponding figures for Alaska and Greenland are 85 per cent and 64 per cent, respectively.

The same pattern appears when traditional food received from other households is compared for Greenland, Chukotka and Alaska in Figure 5.4. On average, 80 per cent of the households report that they received traditional food from others. Alaska ranks highest with 92 per cent, while 80 per cent of the households in Chukotka and 79 per cent in Greenland received food from others.

In all the communities, sharing food is perceived as an important part of social relations, with different types of social and cultural motivation. The food sharing can be seen as a form of «social security», providing food for those who lack food; it can strengthen social relations through the demand for «reciprocity»; and it can be a form of «conspicuous consumption», showing the relative wealth of those with abundant food supply. In Greenland and Chukotka, buying traditional food is quite common. Seven out of ten Greenland Inuit households buy traditional food in a 12-month period. In Chukotka, more than five out of ten indigenous households buy traditional food.

Well-being and quality of life

To get a better understanding of the role of subsistence activities in the lives of the Inuit, a number of questions were asked about satisfaction with different aspects of the respondents' lives, traditional Inuit values, and the importance of different activities for maintaining an Inuit identity. The economic development over the last 50 years has meant that most inhabitants of the Arctic, including the Arctic indigenous peoples, take part in market activities as full-time or part-time wage earners, as self-employed people and as consumers. Thus, the SLiCA questionnaire includes questions on the respondents' satisfaction with the degree of market participation, and which lifestyle they would prefer: wage employment or harvesting, herding and processing their own food, or a

combination of market and subsistence activities. The Alaska and Greenland answers to the question concerning satisfaction with a combination of market and subsistence activities are very similar. More than 80 per cent of Inuit adults in Greenland and Alaska are either somewhat satisfied or very satisfied with the combination of production activities that they pursue. The corresponding figure in Chukotka is 60 per cent. Comparable Canadian data are not available.

Figure 5.5 shows preferred lifestyle. In Chukotka and Alaska respondents were asked about their preferred lifestyle, being able to choose between wage employment, harvest, herding and food processing or a combination of both wage employment and subsistence activities. More than 75 per cent of the Alaska Inupiat prefer a combination of harvesting, herding or processing and a wage job, whereas only 15 per cent prefer wage employment and one out of ten subsistence activities as the sole activity. In Chukotka a little more than one out of four indigenous persons would prefer a combination of activities, whereas 40 per cent prefer wage employment and 32 per cent choose harvest, herding and food processing activities as their preferred lifestyle. In Greenland the question was asked differently including the possibility of choosing self employment. Almost 60 per cent of the Greenlandic Inuit prefer wage jobs, a little more than one out of four prefer harvest, herding and food processing activities and one out of seven choose self employment as preferred lifestyle. Though all respondents in Greenland were asked about preferences for a combination of the different activities, the responses were distinctly distributed between the response alternatives, not indicating combinations of alternatives, as in Alaska and Chukotka. The reasons for these marked differences are to be further analysed, but e.g. the criteria to get professional hunters' status and taxation policies in Greenland might be considered obstacles to preferring a combination of production activities.

Photo: Birger Poppel.

Table 5.1. Hunters and harvested animals. Canada. Annual average 1996-2001

Species	Number of animals harvested	Number of hunters
Caribou	25 000	3 000
Ringed seal	25 000	2 700
Ptarmigan	14 000	1 500
Eider duck	6 000	950
Arctic char	200 000	3 200
Mussels	25 000	71

Source: NWHS.

To some extent, different preferences across the regions may reflect what the respondents perceive as possible and available options. It might therefore also reflect the fact that employment opportunities and the conditions for subsistence activities differ between the regions.

Traditional values

All respondents were asked a number of questions on traditional values and urged to indicate how important they found different activities and customs for maintaining their Inuit identity. Figure 5.6 shows the respondents' evaluation of three subsistence activities in which they engage: hunting and fishing, harvesting of wild berries and plants (gathering), and preserving traditional food.

Figure 5.6 shows that almost all Inuit adults consider hunting/fishing, gathering and traditional food preserving activities important to their Inuit identity. To conclude, the preliminary findings reported in these figures show that subsistence activities among the Inuits in the Arctic are highly important as contributions to the diet, to consumption possibilities and to cultural identity. The fact that it is difficult to distinguish between the motivations for different aspects of subsistence activities reflects the intertwined nature of economy and culture in the Arctic.

Subsistence activities in Canada

In Canada, only the Northwest Territories seem to have a continuous record of native harvests, starting in 1975 with the James Bay and Northern Quebec Agreement. In 1982, aboriginal rights were placed under the protection of the Canadian Constitution as charter rights. A recent study[19] reports from surveys that «compare Inuvialuit use of the Beaufort Sea and its resources in the 1960s and the 1990s», and shows that, «contrary to many predictions in the 1960s, subsistence harvesting persists as a significant economic as well as cultural preoccupation in the lives of Inuvialuit today».

The Nunavut Land Claims Agreement (NLCA) from 1993 required that: «A Nunavut

Wildlife Harvest Study (NWHS) shall be undertaken in, and cover, each of the three regions of the Nunavut Settlement area». The purpose of the NWHS was to establish current harvest levels, to contribute to the sound management of wildlife resources, document the levels and patterns of Inuit use of wildlife resources for the purpose of determining the basic needs level, and analyse biological, ecological and harvest data pertinent to management of wildlife in the Nunavut Settlement Area. The basic needs level was defined as the amount of harvest that is currently taken for domestic and cultural purposes.

As a result, the NWHS was conducted over 1996–2001. It was the largest wildlife harvest survey ever undertaken in Canada. A total of 6 017 hunters were surveyed. The mean annual response rate was 82 per cent. This comprehensive study contained detailed information on 86 wildlife species within the following categories: big game, fur bearers, small game, marine mammals, waterfowls, other birds, eggs, feathers, fish and shellfish. Data were presented on harvest estimates, reported hunter responses, calculated recall periods between harvest and interview, and number of hunters harvesting each species.

The NWHS estimated neither the nutritional nor the money value of the catch to individuals, households, communities or regions. However, replacement value for the four main food species in Nunavut can be estimated from the NWHS data and from the Nunavut Wildlife Management Board. Replacement value is defined as the amount of money one would have to pay to purchase the harvested amount of meat and fish from a store. The replacement value of food harvested by Nunavut Inuit has been estimated at between 30 and 35 million CDD per year[20].

In 2006, the first results from the combined «2001 Aboriginal Peoples Survey and Survey of Living Conditions in the Arctic» were published[21]. More than 4 700 Inuit adults (15 years of age and over) were asked about their harvest activities (hunting, fishing, trapping and gathering), and their perceptions of the future for harvesting. A summary of the results published in the report concerning harvest and country food shows that seven in ten Inuit adults in the Canadian Arctic harvested traditional food in the year before the survey. The average within the regions varied from roughly eight out of ten Inuit adults in Nunavik (81 per cent) and Labrador (76 per cent) to less than six out of ten in the Inuvialuit region (55 per cent). On average, more men (80 per cent) harvested than women (63 per cent) and the tendency that men were more likely to harvest was reflected in all age groups. Middle-aged men and women (45–54 years of age) were most likely to harvest and nine out of ten men, compared with seven out of ten women, were most likely to prepare for the harvest.

The respondents were asked about their perceptions of the future for harvesting, and 49 per cent thought that harvesting would remain the same over the next five years, whereas 21 per cent thought the activities would increase. The main reason stated for increasing activity was that more household members would take part in harvesting. Of the respondents, 13 per cent were of the opinion that harvesting activities would decrease and, of those, one-third referred to fewer resources to harvest or fish and game becoming scarcer. In almost four out of ten Inuit households, country food made up more than half of the fish and meat eaten. In another third of the Inuit households, about half of the fish and meat eaten was country food. Most households (almost 80 per cent) in Nunavik answered that at least half of the fish and meat eaten was country food. In Labrador, the percentage was 66, whereas 45 per cent of the Inuit children in the Canadian Arctic had wild meat five days or more a week and 20 per cent fish or seafood. The diet of the children varied over the Arctic. In Labrador, the fewest Inuit children ate wild meat and fish. In Nunavik, in the Nunavut and Inuvialuit regions, between 45 and 50 per cent of the children ate wild meat at least five days a week and between 14 per cent in the Inuvialuit region and 30 per cent in Nunavut had fish or seafood five days or more. Finally, the study confirmed that the tradition of sharing country food is still alive, as nine out of ten households reported sharing with family and/or community members.

Barrow. Bowhead in lead. Photo: Jack Kruse

Subsistence activities in Greenland

Archaeological studies of settlements along the coasts of Greenland document that, not only did the different groups of Inuit migrating to Greenland live from hunting and fishing, but there has also been a diversified exploitation of wildlife. The excavations at Qeqertasussuk in the vicinity of Qasigiannguit in Disco Bay contain a particularly extensive example, with relics from 45 different species (mammals, fowl, fish, mussels and snails) as well as tackle – including some made of whalebone and baleen, contributing to the picture of a diversified use of living resources.[22] For more than 250 years, hunting for food and clothing and maintaining social relationships and cultural tra-

ditions has coexisted with hunting for trade. Income from this trading is, to some extent, a condition for continued hunting, by providing necessary cash income to buy hunting gear and boats[23].

The political and economic changes in the period after the Second World War led to profound changes in the traditional Greenland fishing and hunting culture, and hence in the traditional social structures. The transition to a monetary economy, the educational mobility and increased urbanization have meant that the norm, value and prestige systems in Greenland society today are no longer so closely linked to subsistence production in extended families in small closed communities[24]. Social values have increasingly become linked to wage earning in a more globalized and open society. In 1945, it was estimated that 66 per cent of the labour force in a population of 21 412 individuals were involved in hunting and fishing. In 1996, this proportion had decreased to approximately 25 per cent. This figure also includes people working in the modern fishing industry. However, community studies from the 1970s and more recent studies of local Greenlandic communities and settlements confirm that the introduction of wage labour in the Greenlandic society has by no means brought hunting and fishing for personal consumption, for sharing, or for local sale, to an end. Two studies[25] conducted from 2003 to 2006 contribute data to the understanding of the subsistence economy and the way it is mixed with the cash economy in contemporary Greenland.

In 1994, Statistics Greenland conducted a living conditions survey including the importance of subsistence activities to the Greenlanders. This was measured as the participation in (subsistence) hunting and fishing activities and as the contribution to the food supply of the various households. According to the survey, 67 per cent of those with wage labour as their main income source were engaged in small-scale fishing and/or hunting (the corresponding figure for the inhabitants of towns[26] was 28 per cent). In total, 80 per cent of the households in the settlements hunt sea or land mammals and/or fish for the consumption of the household (or the sledge dogs) as a necessary supplement to their wage incomes[27]. These figures show the importance to the Greenlandic Inuit of having access to hunting and fishing activities and a significant difference between ways of life in towns and settlements.

Socio-economic analysis of the Greenland hunters

A socio-economic analysis of the Greenland hunters was conducted in 2003–2005, surveying their catches by species, expenses on hunting and fishing equipment, and attitudes to professional hunting[28]. The study combined register data and personal survey data. In the period surveyed (1987–2002), a total number of 36 931 people (27 711 men and 9 220 women) were engaged in fishing and hunting activities. From

Photo: Birger Poppel.

1993 to 2002, the number of people with a professional/full-time hunter's licence was reduced from 6 560 to 3 083, whereas the number of people with a leisure-time hunter's licence increased from 6 554 to 8 398. The average age of professional hunters increased due to the lower recruitment of young hunters. The average size of the hunters' households was equal to that of other households except in the settlements where there were more large and single-person households. There are, on average, more professional/full-time hunter's licences in households in the settlements than in the towns. Whereas the profession of hunting tended to continue from one generation to the next, it now seems that being a professional hunter ranks low among the youth and is given low priority in recommendations from parents. If the decrease in the number of professional hunters continues, the profession will be extinct within a generation. A recruitment of a minimum of 40 new hunters annually would mean that the current number of hunters could be maintained.

The *formal economy* includes all economic transactions that are officially recorded and represent potential tax objects, whereas the *informal economy* includes all other economic activities. Estimating the total value of informal supply leads to an estimate between 80 and 180 million DKK at purchaser prices, at the local market. The proportion of the total value coming from the catches of professional hunters is 80–90 per cent, whereas the contribution by leisure-time hunters amounts to 10–20 per cent. The value of

Table 5.2. Contribution of professional hunters to the informal economy in Greenland. Annual average 1993-2002. Million DKK

Type of activity	Total value
Own consumption	46
Gifts	24
Private sale	10
Sale to restaurants	6
Sale to institutions	6
Sale at market	38
Total	**130**

Source: Rasmussen (2005).

Table 5.3. Value of informal production by professional and leisure-time hunters in Greenland. 2004. Million DKK

Activity	Total value
Professionals	130
Leisure-time hunters	52
Total	**182**

Source: Rasmussen (2005).

Table 5.4. Variable costs for professional hunters and fishermen in Greenland. 2004. Million DKK

Equipment	Towns	Settlements	Total
Boats	34	32	66
Snowmobiles	2	2	4
Dog sledges	10	11	21
Other types	33	29	62
Total	**79**	**74**	**153**

Source: Rasmussen (2005).

the catches that are not sold to production plants or used to feed sledge dogs is estimated to be roughly 130 million DKK. This number can be broken down into the following categories as shown in Table 5.2. A little more than half of the informal transactions come from activities within the towns and the rest comes from activities in the settlements. A third of the value comes from hunting marine and terrestrial mammals and fowl, and two-thirds comes from fish and fish products. The total value of the catches of leisure-time hunters is estimated at 52 million DKK (see Table 5.3). Hence, the total value of informal production is 182 million DKK.

To estimate the contribution of informal production to the Greenlandic GDP, it is necessary to estimate and subtract the variable costs of production. Table 5.4 shows that variable costs for professional hunters amount to 153 million DKK, however, this number comprises both the formal (market) and informal (subsistence) activities of the professional hunters.

In order to calculate the contribution to GDP of informal subsistence activities, the costs need to be allocated between formal and informal activities. It is estimated that informal activities represent 40 per cent of the costs, or 61 million DKK for the professional hunters. The costs for leisure-time hunters are unknown. Assume that these costs are zero. Then the value

Table 5.5. Investments by professional and leisure-time hunters in Greenland. 2004. Million DKK

Type of equipment	Towns	Settlements	Total
Boats	73	89	162
Snowmobiles	3	3	6
Dog sledges	4	5	9
Other types	47	41	88
Total	**127**	**138**	**265**

Source: Rasmussen (2005).

Table 5.6. Total estimated sales value and value of informal economic activities by professional and leisure-time hunters in Greenland. Annual average 1993-2002. Million DKK

	Professional hunters	Leisure-time hunters	Total
Sale	196	10	206
Informal value	130	52	182

Source: Rasmussen (2005).

minus costs, 121 million DKK, for hunting activities within the informal economy contributed roughly to 1.3 per cent of the total Greenlandic GDP of 9 040 million DKK, in 2001. Although the value of the subsistence activities might seem negligible when measured as a fraction of GDP, the subsistence activities contribute substantially to household consumption and well-being. More focus on consumption data on a circumpolar basis is needed to document the contribution of subsistence to household consumption and well-being.

The survey shows that cash income and subsistence are of vital importance for the hunters and fishermen. There are major regional differences in hunters' cash incomes. On average, the cash income of hunters in North and East Greenland is about 65 000 DKK, and in other regions of Greenland about 130 000 DKK. The hunter's contribution to total household income amounts to between 40 per cent for hunters in North and East Greenland and 25 per cent for hunters in the rest of Greenland. A large number of hunters are single or members of low-income households, for which the products from hunting and fishing for the household's diet are of great significance. When the total value of professional hunting activities, 130 million DKK, is divided by the number of hunters, we find that each hunter contributes to the household with hunting and fishing products plus cash from private sales worth 42 000 DKK.

Table 5.5 shows that investments (including vessels, outboard motors, snow mobiles, dog sledges, rifles, shotguns, fishing nets and other equipment) were estimated at 265 million DKK.

Table 5.6 shows that the total informal production is almost as large as total sales value for hunting activities.

Chukotka race. Photo: Jack Kruse

Reindeer husbandry

Reindeer and caribou represent principle subsistence resources for many indigenous people of the rural regions of the Arctic[29]. Their value as nutritional and economic resource is closely connected to their value in maintaining culture and identity. The sustainability of reindeer and caribou herding and hunting relates to ecology, socio-economic conditions and the transmission of cultural tradition from one generation to the next, as well as political processes at a regional, national and international level. The following brief presentations of reindeer husbandry in Norway, Sweden and Russia give an introduction to the topic and present some findings from two recent reports on reindeer herding and hunting[30].

Reindeer husbandry in Norway[31]

Reindeer husbandry in Norway is organized within six official grazing areas. Each grazing area is divided into districts containing several production units with a licence that determines each individual herder's grazing rights. The «1978 Reindeer Husbandry Act» introduced the production unit to restrict individual access to the industry and to avoid overgrazing. The oldest and original indigenous organization in reindeer husbandry is the *siida*. A siida is a herding partnership based on bilateral kin relations and has existed as a cultural institution for hundreds of years. The siida is at the same time an extended family and an organization of the labour force. Family members may be members of different siidas during winter and summer. When the herd is grazing on winter pasture, a family unit may belong to one siida and, while the herd is grazing on summer pasture, they may be members of another siida. This flexible organization of the herd and their owners is determined by the grazing conditions of the herds, and depends on family patterns derived from interfamily relationships.

Each reindeer has an individual owner. All deer owned by a nuclear family constitute one or several licensed production units. In this extended family, they make a siida that now and traditionally, in legal terms, has an assigned grazing area at its disposal. The six herding districts in Norway consist of almost 600 production units. Although there are only approximately 600 licensed production units in Norway, as many as 2 200 family members are, in one way or the other, involved in daily or periodical reindeer herding activities. Reindeer husbandry is, thus, a family business that requires the efforts of several siida members.

The concept of value entirely focused on economics only explains, to a limited extent, the values in a herding world. Throughout the Arctic region in the areas where herding is taking place, hunting and herding were the original basis for human existence in these remote landscapes. From time immemorial, different indigenous groups hunted the migrating reindeer herds and, from the mid 1600s, started keeping them in herds. This fact must be considered when the economy of the herding business is to be accounted for. There are no alternatives to careful handling of the pastures in sustaining reindeer herding and the culture and livelihood it gives rise to. A myopic understanding of improving the economy immediately brings reindeer herding into conflict with issues affecting the sustainability of the herders' way of life. If, for example, the number of reindeer is increased for the purpose of improving income in the short-run, this strategy will result in overgrazed pastures that in the longer run will badly affect the economy of the siida, as has happened in Norway, Sweden, and Finland[32].

Photo: Jens-Ivar Nergård

Originally, the herding business was a way of living rather than a way of earning money. To a large extent, reindeer herding works as an informal subsistence economy. Each siida or production unit should be concerned with a whole range of issues affecting the business. The herding activity cannot be separated from the responsibility the herding world must take for the Saami traditions, as a whole. For a long time, especially from the 1850s to 1970, when the Norwegian authorities pursued a rather harsh policy

Photo: Jens-Ivar Nergård

Photo: Jens-Ivar Nergård

towards the Saami, the herding siidas were the stronghold of the Saami language and Saami tradition. Herding has always been seen, by the outsider, as the leading Saami activity. When the Saami identity revitalized in the 1980s, reindeer herding had a leading effect on the process, politically and symbolically.

Reindeer herding has gained knowledge from experience through generations.[33] Even though the siida members have ownership of the herd in legal terms, they are, at the same time, taking care of it on behalf of the next generation. Being responsible for its own grazing land means that each siida needs sophisticated knowledge and skills to handle the herd within its particular landscape. To this responsibility belongs the knowledge of experience gained through generations of handling the herd in the particular areas the siida has at its disposal. This knowledge is referred to, by the outsider, as indigenous or traditional knowledge and is sometimes seen as less valuable and reliable than modern scientific knowledge. Traditional knowledge is sometimes handled within a spiritual frame of reference.[34] One reason this knowledge is seen as somewhat obscure from an outsider's point of view is its attachment to the traditional narratives, having a strong cultural and religious flavour. The experience of previous generations is, using a Malinowskian term, called *sacralizen* and communicated with narratives about the landscape handed down from one generation to the next[35]. Together with the sophisticated knowledge of an actual landscape, this experience works as a leading principle for harvesting of nature and natural resources – also seen as a protection against overloading grazing land with herds that are too large. In order to keep the herds in the best possible condition, the grazing areas must likewise, be kept in the best condition. This is perhaps the most important source of the values that have guided the traditional herding economy for hundreds of years to the present day. This is also the most important source of conflict with the Norwegian authorities over strategies to improve the economy of Norwegian reindeer husbandry, avoid overgrazing, and promote sustainable development.

The composition of animal categories within a reindeer herd is an important issue to address. Reindeer are considered herd animals, which mean that they prefer to graze and move together. The female reindeer graze in large groups, while the male reindeer sometimes stray in search of more remote pasture areas. However, the female reindeer tend to follow the movements of the males, resulting in the relocation of several smaller groups consisting of male reindeer, female reindeer and calves. When the animals scatter, the herd grazes in several different places, which tends to secure the quality of the pastures.

A herd with fewer male reindeer tends to graze in a more concentrated area, often with damaging effects on the pastures. When grazing exceeds the carrying capacity, the land is overgrazed. A policy that aims to improve the pastures and regain carrying capacity must include traditional herders' knowledge of herd structure, herd composition and balanced grazing. Overgrazing is, thus, not just the result of increased animal numbers, but also a consequence of compositional and structural change within the herd.

The average production unit within a siida is partly commercial and partly based on subsistence production, where women, especially, contribute largely to the economy. Women quite rarely feature as owners of the siida production units (less than 10 per cent), but they take part in herding activities in their spare time away from their work in the home village of the herding family. They are active members of the herding unit when the calves are marked during the summer season and during the slaughtering season in late September. They are responsible for preserving the skins and preparing them as raw material for *doudji*, i.e. craft. In many families, this craft contributes to the economy in terms of products for sale during the tourist season and as production of suitable clothes, such as footwear (skaller, komager), coats (pesker),

etc. Women also receive income from paid employment in the village. Women are the important teachers of Saami knowledge and tradition to their children. This teaching always takes a practical form. Hence, women are largely the carriers of the cultural capital of the siida and herding family. An overall goal of the siida, and the nuclear family, is the maintenance of Saami tradition, Saami language and Saami customs. This maintenance entails a wide range of activities taking non-economic forms. The very maintenance of Saami tradition, of herding knowledge, understanding nature, and sharing natural resources is the basis of the herding economy.

Reindeer husbandry in Sweden[36]
Reindeer are herded over an area of approximately 160 000 square kilometres, or about 34 per cent of the area of Sweden. The topography includes a varying landscape where forest, tundra and high mountains are all important pastures. The reindeer industry is divided into two main groups: forest and mountain reindeer husbandry. The first group stays in the forest during both summer and winter, while the second group uses the forest only as winter pasture and the rest of the year is spent in the mountain regions on both sides of the Norwegian–Swedish border.

The Swedish Reindeer Herding Act 1971 regulates all reindeer herding activity in Sweden. As with the Norwegian case, the Act secures reindeer herding as an exclusive right for the Saami people of Sweden, and is of profound importance. Sweden, like Norway, has one exception to this rule: a limited reindeer herding area below Lappmarksgränsen (the Saami territory border) in the Kalix and Torne river valleys in Norrbotten. This area is called the «Concession area» and the reindeer owners are a mixture of Saami concession holders and local farmers.

Reindeer herding is closely connected to membership in a Saami Village. The designated pasture areas for reindeer husbandry are within the borders of the Saami Village. There are 51 Saami villages in Sweden. The northernmost Saami village is located in the county of Norrbotten and the southernmost is situated in the county of Jämtland. According to the Swedish Reindeer Herding Act, a Saami village is defined as an organization that manages reindeer herding in a designated geographical area. A Saami village is an economic unit, and rights concerning hunting, fishing and use of the forest are connected to membership in a Saami village, and it presumes active participation of its members in reindeer herding. The reindeer industry in Sweden, including concession areas, involves approximately 950 private family business units distributed over the 51 Saami villages. A management unit can be defined as an economic enterprise managed by a responsible reindeer herder and his/her household/family.

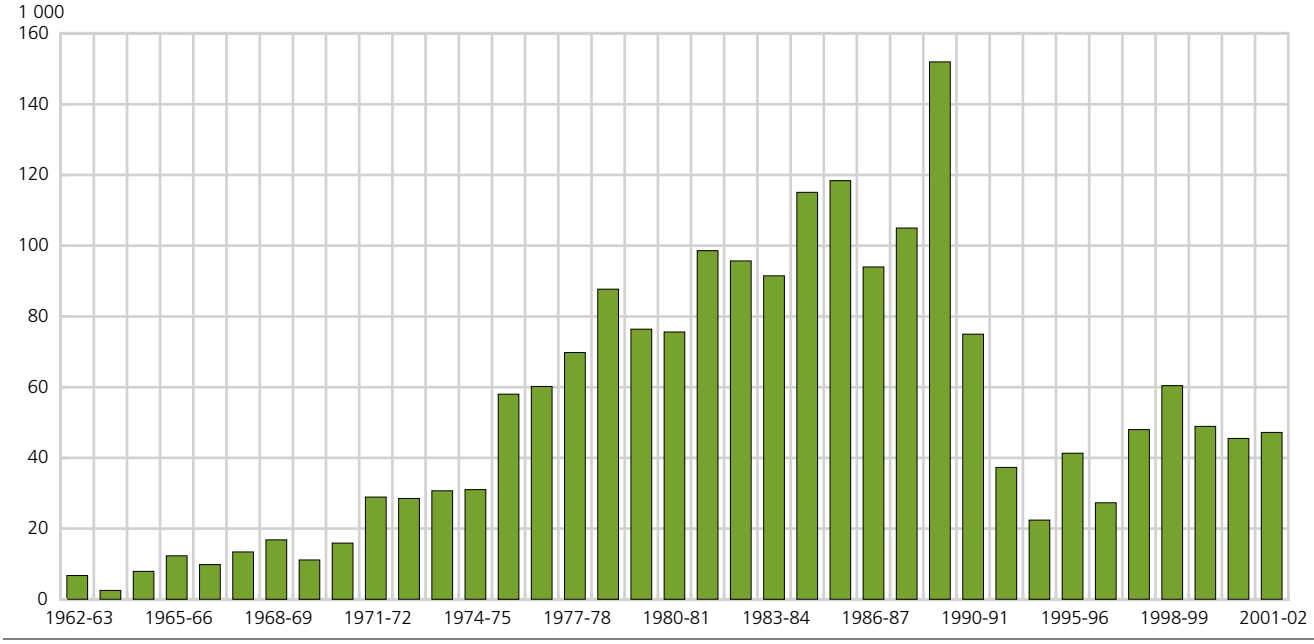
One difference between the economic structure of the Swedish reindeer industry and that of other Fennoscandinavian countries is the right to hunt moose, in addition to fishing and berry picking. Fishing is generally no longer an important source of income, except for areas such as Jokkmokk. However, the right to hunt moose is assigned to members of the Saami villages and generates a substantial income for many of the reindeer owners.

The price of reindeer meat is relatively low today, while the industrial costs are fairly high. The generally low income from reindeer husbandry often means that a supplementary income is required. Often it is the women who provide the family with income from sources other than herding. This, in turn, leads to a reindeer industry dominated by men, although men often have to work part-time as well, outside the industry. A reindeer owner could have income from different sources, but reindeer meat, compensation for loss of reindeer and income from sale of skins, antlers, hunting and fishing are important. For an average reindeer owner, the income from meat is 43 per cent, compensation for loss of reindeer is up to 20 per cent, and the additional earning (hunting, fishing) amounts to 26 per cent. In addition, the average income from wages received from the Saami village amounts to 11 per cent. The situation with loss of pastures connected to infrastructure development is a major threat to the reindeer industry in Sweden. A joint effort between national authorities and the reindeer industry is needed to secure the remaining grazing areas.

Reindeer husbandry in Russia
Reindeer herding and hunting is the economic and cultural basis of many northern indigenous peoples in Russia[37]. The sharp decline in harvesting of wild reindeer in the early 1990s, see Figure 5.7, coincided with an increase in family-owned reindeer, see Figure 5.8, in line with a move towards more private ownership, following the breakdown of the Soviet Union. As illustrated in Figure 5.7, major changes in the harvest of wild reindeer took place during the 1970s and 1980s, with a sharp decline in harvest level at the beginning of the 1990s.

The reindeer husbandry areas of Russia can be divided into three zones, which differ concerning the state of the industry, trends in change and perspective on future development. The North-western zone includes tundra and forest tundra from the western borders of the Russian Federation to the Yenisei River. This is the territory of Saami, Nenets, and Komi-izhemtsy reindeer husbandry. Although this region is under intensive exploration for gas and petroleum, reindeer husbandry here is comparatively stable. The number of reindeer in this area has remained constant or been slightly reduced during the last decade. Conditions

Figure 5.7. Harvesting of wild reindeer in Russia. 1 000



Source: Ulvevadet and Klokov (2004), Figure 3.8, p. 85.

for reindeer husbandry are comparatively favourable because of market conditions.

The North-eastern zone includes areas of tundra, forest tundra and the northern mountainous taiga to the east of the Yenisei River. Meat-productive reindeer husbandry is the occupation of the Evens, Chukchi and Koriaks. The number of reindeer in this region is reduced, resulting in increasing poverty of the indigenous population. To stabilize the situation and stop the decline in the number of reindeer, financial support for reindeer herders' families from regional budgets is granted, but there is no clear effect. The future of the industry is uncertain. Reindeer husbandry here seems to develop only with other branches of the traditional economy (hunting wild reindeer, fur animals, sea mammals, fishing) as part of a common economic undertaking.

The Siberian Taiga zone includes all reindeer husbandry regions of the Siberian taiga (except northern mountainous areas). Here, many indigenous people are engaged in reindeer husbandry. In the European part of the territory, taiga reindeer husbandry has disappeared. In the Siberian taiga, it has rapidly diminished; the area has been divided into separate isolated lots with a few hundred reindeer in each. The populations of domesticated and wild reindeer in Russia are now nearly equal in number, see Figure 5.8. According to official data from 1999 there were 1 232 000 wild reindeer in Russia. About half of the stock of domesticated reindeer is owned by reindeer herder families and about half by collective and state reindeer enterprises.

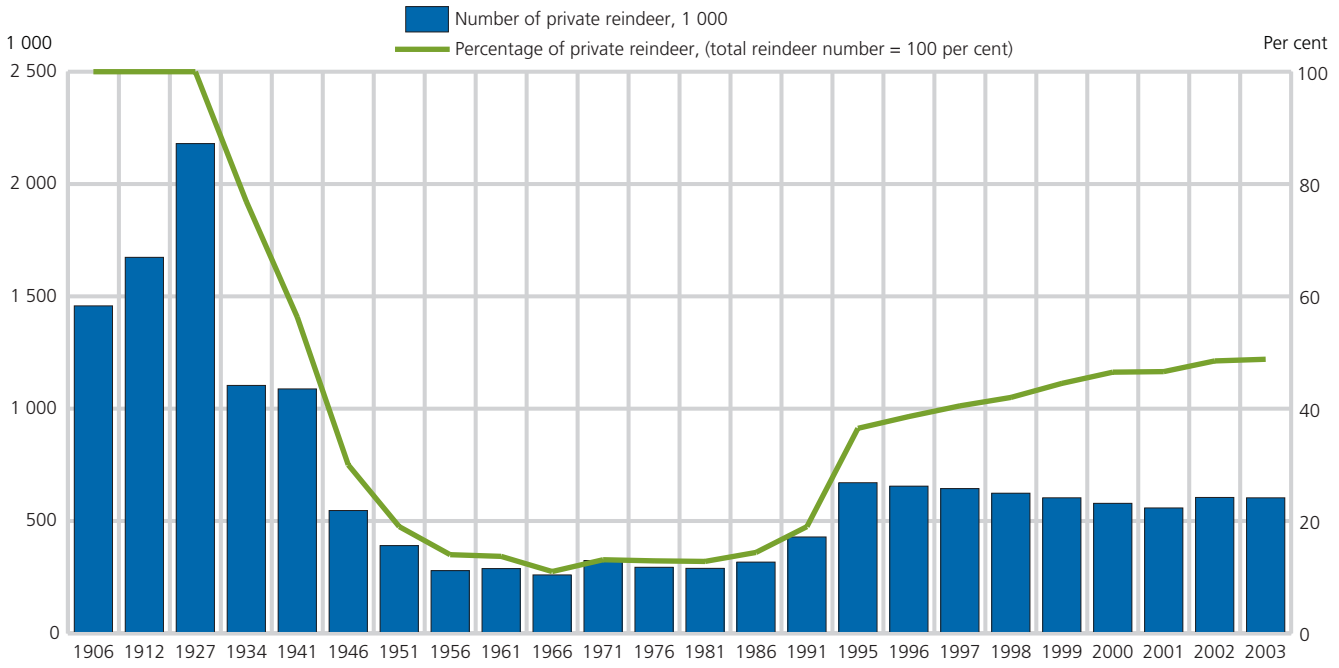
In contrast to other countries, Russia does not have any legislation that determines the legal status of reindeer husbandry. The reindeer economy is regulated by by-laws and is implied in other laws. Thus, it is subjected to management and legislation for land use, agriculture, the rights of indigenous peoples, legislation on ecology and use of mineral resources. Recent legislation has set the rules for compensation-inflicted damages on the landowners, lessors and users of the land. This has been very important for all reindeer enterprises affected by industrial companies in the areas of extraction of oil, gas and other mineral resources.

The Russian Ministry of Agriculture manages the reindeer economy at a federal level. The Department of Agriculture within each Regional Administration is responsible for reindeer management at the regional level. Traditional family-based reindeer husbandry has been subject to major changes in external conditions. In the Soviet period, most reindeer husbandry was organized as collective farms or state enterprises and the herders and their families worked in «brigades». After the reforms in the 1990s, a partial return to the family-based reindeer economy took place.

As is the situation of reindeer husbandry elsewhere in the Arctic, the basic unit in Russia is also the family. The family is the main contributor to the transfer of herding skills and habits, mother-tongue languages, traditional and cultural values and worldviews. There are four ways of operating the family-based reindeer economy:

- the traditional organization of family nomadism (there are 3 000–4 000 nomadic families, mostly Nenets);
- the semi-traditional way of organizing the husbandry (typically found in the brigades of the collective

Figure 5.8. Number of family-owned (private) reindeer in Russia



Source: Ulvevadet and Klokov (2004): 64, Figure 3.2, p. 64.

reindeer enterprises. Women are partly restrained from living in the tundra);

- the neo-traditional type of organization where the herder families are integrated into the market economy;
- disintegrated family husbandry: the husband working in a herding brigade while the wife lives permanently in a settlement where she might have a paid job.

To conclude, «In general we find that most of the reindeer economy in Russia is based on subsistence. Despite the fact that most reindeer owners between 1970 and 1980 received relatively high salaries from their reindeer enterprises and were also considered to be prosperous among other indigenous people, many of them fell into poverty after the transition to a market economy.»[38] The following income sources are important to family-based reindeer husbandry in Russia: salaries from reindeer enterprises, pensions and welfare payments, sale of reindeer meat, skin and fish, sale of clothes and shoes made out of reindeer skin and sale of private reindeer. Nomadic reindeer husbandry is practically impossible without extra work including hunting, fishing and gathering: «If average incomes are below the level of 500–600 USD a year, the indigenous population is compelled to return from reindeer husbandry to other forms of economic activity, such as subsistence fishing and hunting near villages.»[39]

Subsistence and climate change

Climate change can substantially influence the conditions for subsistence in the Arctic. The different signs of climate change, e.g., longer sea ice-free seasons, soil erosion; melting glaciers creating torrents in place of streams, and still more unpredictable weather, have been of growing concern to both indigenous peoples and other Arctic residents. One of the key conclusions of the Arctic Climate Impact Assessment (ACIA) was that numbers of marine species dependent on sea ice, including polar bears, ice-living seals, walrus and some marine birds are very likely to decline, with some species facing extinction. Moreover, environmental toxins, with a high degree of accumulation in northern regions, are found in Arctic animals at increasingly high levels.

To summarize, «For the indigenous population, and particularly for those people who depend on hunting, herding, and fishing for a living, climate change is likely to be a matter of cultural survival, however. Their uniqueness as people with cultures based on harvesting marine mammals, hunting, herding caribou and reindeer or fishing, is at risk because climate change is likely to deprive them of access to their traditional food resources … Today, the indigenous peoples live in greatly circumscribed social and economic situations and their hunting and herding activities are determined to a large extent by resource management regimes and local, regional, and global economic market situations that reduce their ability to adapt and cope with climate variability and change. While they experience stress from other sources that threaten their lifestyles and cultures, climate change magnifies these threats.»[40]

Concluding remarks

This brief introduction into the complex reality of subsistence and subsistence activities as a means to

maintaining a cultural identity and livelihood among Arctic indigenous peoples, points to the following conclusions.

- Hunting, herding, fishing and gathering activities continue to be of major significance to the indigenous peoples of the Arctic in providing food, social relationships and cultural identity.
- Subsistence activities and the cash economy jointly provide the consumption possibilities, and the subsistence activities are an integrated part of a lifestyle that embodies the importance of continuity, sharing and connection to nature.
- Sufficient and comparative data on the subsistence economy and its importance for household consumption and well-being are not yet available on a circumpolar basis.
- Gaps in knowledge on the value of harvesting, consumption of wildlife, costs of harvesting and the economic significance to the households of the Arctic imply a lack of recognition of activities that are crucial to indigenous peoples and a lack of recognition of the indigenous people's contribution to the total production and consumption in society.
- In international and some national legislation, subsistence is not considered part of, nor linked, to the modern cash economy. Rather, subsistence activities are seen as existing separately from market-oriented activities.
- More relevant statistics are needed to evaluate the development of central economic indicators of importance to the indigenous population groups – and hence to evaluate development according to international conventions, as, for example, agreed upon in the International Labour Organization (ILO) Convention No 169: The Indigenous and Tribal Populations Convention from 1989.[41]
- Continued documentation is needed on the location, participation levels and costs of subsistence harvesting activities. Circumpolar, standardized, comparative and reliable data on subsistence production and consumption are required. Proven and up-to-date methods to generalize about cost levels and the relationship of inputs to outputs in the subsistence activities and environmental impact assessment are also required. Dialogue between the different end-users and stakeholders: indigenous representatives and other Arctic residents, data producers at local, regional and national level – including statistical institutions, other stakeholders and policy-makers at regional, national and international levels, must take place.
- Further research is needed into the link between the subsistence sector and the market sector, and the potential consequences for households and communities of diminishing foundations for local subsistence activities. Subsistence activities, in a similar way as unpaid household work in «satellite accounts», i.e., supplementary accounts to the national accounts[42], should be measured in order to ensure that the value of subsistence activities is taken into account. Research should also be undertaken into economic development that facilitates the continuation of subsistence activities and a subsistence mode of production mixed with market activities. The effect of climate change on the subsistence way of living also requires more research.
- To further document the significance of subsistence activities within the subsistence-based mixed economies of the Arctic, to develop analyses and recommendations and to contribute to the follow up on the above-mentioned recommendations, a working group within the ECONOR project should be created.

Notes

1 Birger Poppel is formerly Head of Statistics Greenland, is Senior Researcher at Ilisimatusarfik, University of Greenland and Project Chief, Survey of Living Conditions in the Arctic/SLiCA, www.arcticlivingconditions.org. The sections in this chapter on reindeer husbandry in Norway and Sweden are written by Jens-Ivar Nergård and Johnny-Leo Jernsletten, respectively, both at University of Tromsø, Norway. The author is grateful to Iulie Aslaksen, Yvon Csonka, Jens Dahl, Rune Fjellheim, Solveig Glomsrød, Jack Hicks, Jack Kruse, Finn Lynge, Peter Nielsen, Carl Christian Olsen (Puju) and Rasmus Ole Rasmussen for helpful comments.

2 Lynge, F. (1998): *Subsistence Value and Ethics*. Address to the General Assembly of the Inuit Circumpolar Council. Nuuk.

3 The Arctic Council members are the eight Arctic countries: Canada, Denmark/Greenland/The Faroe Islands, Finland, Iceland, Norway, Russia, Sweden, USA, and organizations of the Indigenous Peoples of the Arctic: Aleut International Association, Arctic Athabascan Council, Gwich'in Council International, Inuit Circumpolar Conference, Russian Association of Indigenous Peoples of the North, and Saami Council.

4 AMAP (1998): *Arctic Monitoring and Assessment Program*, Arctic Council. 1998. AHDR (2004): *Arctic Human Development Report*. Arctic Council. 2004. ACIA (2005): *Arctic Climate Impact Assessment Program*. Arctic Council. 2005.

5 Among others the following terms have been used: mixed cash/subsistence or subsistence-based economies, see Hovelsrud-Broda, G. (1997): *The Seal: Integration of an East Greenlandic Economy*. A Dissertation Presented to the Faculty of Graduate School of Arts and Sciences, Brandeis University, Dept. of Anthropology; mixed subsistence-market systems / mixed subsistence-cash economies, see Wolfe, R.J. (1998): Subsistence Economies in Rural Alaska. *Cultural Survival Quarterly* 22:3. Alaska Department of Fish and Game. Division of Subsistence. Juneau, Alaska; mixed subsistence-based economies in which the harvesting of country food for primarily domestic consumption plays a significant role in their economies and cultures, see Usher, P. J. (2003): Environment, race and nation reconsidered: reflections on Aboriginal land claims in Canada. Wiley Lecture. *The Canadian Geographer/Le Géography canadien* 47:4, 365–382.

6 Kassam, K.-A. (2004): Hunting, Subsistence. In: Mark Nuttall: *Encyclopedia of the Arctic*, Routledge, New York.

7 Wolfe, R.J. and R.J. Walker (1987): Subsistence economies in Alaska: Productivity, geography, and development impacts. *Arctic Anthropology* 24:56–81.

8 Inuit Circumpolar Council 1992: *Principles and Elements for a Comprehensive Arctic Policy*. Centre for Northern Studies and Research. Montreal, Quebec. Inuit Circumpolar Council is an

NGO representing approximately 150 000 Inuit living in the Arctic regions of Alaska, Canada, Greenland and Chukotka, Russia (http://www.inuit.org/).

9 Huntington, H.P. (1992): *Wildlife Management and Subsistence Hunting in Alaska*. Seattle: University Press. ANILCA, *Alaska National Interests Land Conservation Act*. 1980. Pub. L. No 96-497, 94 Stat. 2371. ANCSA, *Alaska Native Claims Settlement Act*. 1971. Pub. L. No 92203, 85 Stat. 688.

10 Beazley, M. (1993): *Caring for the Earth: A Strategy for Survival*. Published in association with IUCN, UNEP and WWF.

11 See e.g. Kruse, J. (1991): Alaska Inupiat Subsistence and Wage Employment Patterns: Understanding individual Choice. *Human Organization*, 50(4):317–326, Rasmussen, R.O. (2000): Formal economy, renewable resources and structural change in West Greenland. *Èconomie contemporaire. Present-day economy. Études/Inuit/Studies* 24(1):41–78, Dahl, J. (1989): The Integrative and Cultural Role of Hunting and Subsistence in Greenland, *Etudes Inuit Studies* 13(1):23–42, Hertz, O. (1995): *Økologi og Levevilkår i Arktis: Uummannarmiut*. Christian Ejlers' Forlag. Mellemfolkeligt Samvirke, Krupnik, I. (1993): *Arctic Adaptations: Native Whalers and Reindeer Herders of Northern Eurasia*. Dartmouth College, University Press of New England, Hanover and London, Hovelsrud-Broda, G. (1997), see note 5, Duhaime, G. et al. (2002): Food Consumption Patterns and Socioeconomic Factors among the Inuit of Nunavik. *Ecology of Food and Nutrition*, 41, 91–118, Duhaime, G. and N. Bernard (2006): *Arctic Food Security*. (To be published 2006/07), Nuttall, M. (1992): *Arctic Homelands: Kinship Community and Development in Northwest Greenland.* University of Toronto Press, Huntington, H.P. (1992), see note 9, Wolfe, R.J. (1998), see note 5, Wenzel, G. et al. (2000): *The Social Economy of Sharing: Resource Allocation and Modern Hunter-Gatherers*. Senri Ethnological Studies. National Museum of Ethnology, Osaka, Lynge, F. (1998), see note 2, Gumbay (2003): *Making a Living: Place and the Commoditisation of Country Foods in a Nunavik Community*. A thesis submitted to the Department of Geography, Queen's University, Kingston, Ontario, Canada. Moreover, household activities like cooking, cleaning, childcare, etc. are included in SLiCA, but not analyzed in this chapter. Despite the fact that these activities are crucial to family well-being everywhere in the world, they are usually not accounted for in economic valuation. For a discussion and analysis of unvalued housework see e.g. Waring, M. (1988): *If Women Counted.* Macmillan, London.

12 Usher, P.J., G. Duhaime and E. Searles. (2003): The Household as an Economic Unit in Arctic Aboriginal Communities, and its Measurement by Means of a Comprehensive Survey, *Social Indicators Research*. 61: 175-203. Kluwer Academic Publishers.

13 Kruse, J. (1991): Alaska Inupiat Subsistence and Wage Employment Patterns: Understanding individual Choice. *Human Organization*, 50(4):317–326.

14 Krupnik, I. (1993): *Arctic Adaptations: Native Whalers and Reindeer Herders of Northern Eurasia.* Dartmouth College,University Press of New England, Hanover and London.

15 www.subsistence.adfg.state.ak.us.

16 Andersen, T. and B. Poppel (2002): Living Conditions in the Arctic. In: Michael R. Hagerty, Vogel, J. and Møller,V. ed.: *Assessing Quality of Life and Living Conditions to Guide National Policy. The State of the Art.* Social Indicators Research Series, Vol. 11. Kluwer Academic Publishers. Reprinted from: Social Indicator Research 58, Nos. 1-3 (June 2002): 91-216, 2002, Andersen, T. (2006): *Living Conditions Research in the Arctic. How to measure Living Conditions and Individual Well-being among Inuit and Sami in the Arctic.* To be published 2006/07.

17 The development of the analytical concepts, the database and the SPSS syntax is chiefly the result of the joint efforts of Jack Kruse, Program Director and Marg Kruse, Research Assistant.

18 Petersen, R. (1985): The Use of Certain Symbols in Connection with Greenlandic Identity. In: Brøsted et al. (eds). *The Quest for Nationhood of Indigenous Peoples*. Bergen: Universitetsforlaget, Roepstorff, A. (1997): Den symbolske betydning af Kalaalimernit [The Symbolic Significance of Kalaalimernit]. *Kalaalimerniit. Inussuk – Arktisk Forskningsjournal* 1, 1997.

19 Usher, P.J. (2002): Inuvialuit Use of the Beaufort Sea and its Resources, 1960–2000. *Arctic* 55 (Supplement 1):18-28.

20 Hicks, J. and G. White (2000): Nunavut: Inuit self determination through a land claim and Public government. In: Dahl, J., J. Hicks and P. Jull. (eds.) *Nunavut - Inuit Regain Control of their Lands and their Lives*. IWGIA doc. N. 102.

21 Statistics Canada (2006): Harvesting and community well-being among Inuit in the Arctic: Preliminary findings from the 2001 Aboriginal Peoples Survey – Survey of Living Conditions in the Arctic. Ottawa.

22 Bjarne Grønnow og Morten Meldgaard i Naturens Verden 1988: 11–12.

23 Marquardt, O. and R.A. Caulfield (1996): Development of West Greenlandic Markets for Country Foods since the 18th Century. *Arctic*, 49(2):107–119.

24 Hertz, O. (1995): *Økologi og Levevilkår i Arktis*: Uummannarmiut. Christian Ejlers' Forlag. Mellemfolkeligt Samvirke.

25 Rasmussen, R.O. (2005): *Socioøkonomisk analyse af fangererhvervet i Grønland [Socio-economic analysis of the Greenland hunters]*. Prepared under contract to the Greenland Home Rule Government, Department of Fisheries and Hunting, Poppel, B. (2006): *Levevilkår i Grønland 2004-06 [Living Conditions in Greenland 2004-06]* forthcoming.

26 There is no official distinction between the concepts of «towns» and «settlements» in Greenland. In practice, however, the «capitals» of the 18 municipalities are classified as towns, while other inhabited places are classified as settlements. The number of persons living in different towns ranges from 550 to 14 000, whereas the population in the settlements varies from 25 to 500 persons.

27 Andersen, T. (1995): *Living Conditions in Greenlandic Settlements.* Statistics Greenland. Nuuk.

28 Rasmussen (2005), R.O.: *Socioøkonomisk analyse af fangererhvervet i Grønland [Socio-economic analysis of the Greenland hunters]*. Prepared under contract to the Greenland Home Rule Government, Department of Fisheries and Hunting. 2005.

29 Fishing is also important to many Saami communities but is not dealt with in the chapter.

30 Jernsletten, J.-L. and K. Klokov (2002): *Sustainable Reindeer Husbandry*. Centre for Saami Studies, University of Tromsø, Ulvevadet, B. and K. Klokov (2004): *Family-Based Reindeer Herding and Hunting Economies, and the Status and Management of Wild Reindeer/Caribou Populations*. Centre for Saami Studies, University of Tromsø.

31 The section on reindeer husbandry in Norway is written by Jens-Ivar Nergård, Faculty of Social Sciences, University of Tromsø, Norway.

32 Moen, J. and O. Danell (2003): Reindeer in the Swedish Mountains: An Assessment of Grazing Impacts. *Ambio*, 32, 397–402.

33 Nergård, J.-I. (2006): *Den levende erfaring (The living experience)*, Cappelen Akademisk Forlag, Oslo.

34 The sacred landscape, in Jones and Schanke: Landscape, Law and Cusomary Rights. *Diedud* nr. 3, 2004 (Sami Institutha).

35 Malinowski, B. (1954): *Magic, Science and Religion*. Garden City, NY: Doubleday.

36 The section on reindeer husbandry in Sweden is written by Johnny-Leo L. Jernsletten, Centre for Saami Studies, University of Tromsø, Norway.

37 This section relies on two reports by Ulvevadet and Klokov (2004) and Jernsletten and Klokov (2002), see note 30.

38 Ulvevadet and Klokov (2004), see note 30.

39 Jernsletten and Klokov (2002), see note 30.

40 Weller, G. (2005): Summary and Synthesis of the ACIA. In: *Arctic Climate Impact Assessment, ACIA Science Report*. Chapter 18: 990–1020. Cambridge University Press.

41 ILO (1989): *ILO Convention No 169: The Indigenous and Tribal Populations Convention.*

42 United Nations (1993): *System of National Accounts 1993*.

6. Climate change in the Arctic: A discussion of the impact on economic activity

Gunnar S. Eskeland and Line Sunniva Flottorp

The Arctic has vast reservoirs of natural resources serving the world market, and extraction of these on a massive scale largely underpins all other economic activity. Also, and only in part related to this, government's civilian and military presence is important, both in terms of service provision and income generation in the Arctic. Finally, subsistence activity continues to be important to a large number of households and small communities. In this chapter we discuss the impact of climate change in the Arctic region, and in particular how it relates to the economy.

Polar fox/Photos.com

Our discussion is predominantly in qualitative terms. This relates to the nature of present knowledge of climate change and its impact on the Arctic, but also to our present understanding of the structure of regional and local economies. The knowledge of climate change in the Arctic in both qualitative and quantitative terms is thoroughly described in the 2005 report from the Arctic Climate Impact Assessment (ACIA), which is an important source for this chapter, together with the 2001 report from the Intergovernmental Panel on Climate Change (IPCC).

Expected climate trends in the Arctic

The ACIA report concludes that increased atmospheric concentrations of greenhouse gases (GHGs) are likely to have larger and more rapid effects on the climate in the Arctic than in any other region, and the report found that average temperatures in the Arctic have risen at almost twice the rate of the rest of the world. In addition, ACIA warns that the consequences associated with these changes will be serious and felt far beyond the Arctic region.

To a great extent, the expected climate-induced changes in the Arctic are associated with warmer temperatures, degrading permafrost as well as changes in precipitation and extension of snow and ice. One such expected change is more winter rains, leading to faster melting of snow and ice, and possibly flooding in some areas. Table 6.1 briefly lists the expected changes, uncertainty and regional variation, as well as impacts on natural systems.[1]

Another expected outcome of climate change is increased exposure to extreme weather events. When one part of the Arctic gets warmer, the temperature increase can change the strength and direction of wind and water currents, which can result in a decrease in temperature in other parts of the Arctic. The observation that climate impacts may be neither linear nor smooth seems to be particularly appropriate for the Arctic.

In the Arctic, the sea ice cover is an important climatic factor. It affects surface reflection of solar radiation, cloud cover, humidity, exchanges of heat and moisture at the ocean surface, and ocean currents. Over the last 30 years Arctic sea ice has become thinner and its extent has been reduced by approximately 8 per cent [2]. The expected impacts resulting from reduced sea ice include increased air temperatures and decreased salinity of the ocean's upper layers, as well as coastal erosion.

Climate change in the Arctic will happen over time. Most changes are expected to be gradual, and as the climate changes, the people and economies will adapt. To give a general idea of time perspectives, ACIA has studied possible scenarios to 2070–2090. Thus, it is expected that the impacts of climate change as described in ACIA and in this chapter will

Table 6.1. Expected climate change and impacts in the Arctic

Climate change indicator	Expected change	Average over period	Uncertainty and regional variation	Physically projected changes	Impacts in natural systems
Changes in temperature (2071–2090)	↑	3.7°C in the Arctic 1.9°C globally	3°C Scandinavia and East Greenland 2°C Iceland 5°C Canadian Archipelago and Russian Arctic	-melting glaciers -reduction in extent and thickness of sea ice -thawing permafrost -rising sea levels	-the Arctic climate is warming with temperatures during the winter increasing more rapidly than in the summer
Changes in precipitation (2071–2090)	↑	12.3% in the Arctic 2.5% globally	5-10% in the Atlantic sector 35% locally in the high Arctic Autumn and winter greatest increase	-increase in water availability for soil infiltration and runoff -increase in fresh water supplied to the Arctic Ocean, which will increase the stratification of the Arctic Ocean, facilitate formation of sea ice, and enhance freshwater export from the Arctic ocean to the North Atlantic -likely degradation of coastal permafrost in some areas	-increase in plant growth in regions that are presently moisture-limited -Increase in river discharge is likely to increase nutrient and sediment fluxes to the Arctic Ocean with corresponding effects on marine ecosystems -Higher flood rates in rivers cause accelerated flood events -wetland ecosystems are likely to expand
Changes in sea ice (2000–2100)	↓	-17.2% I Northern Hemisphere	Regional differences are small Both winter and summer sea-ice retreat projected to be greatest in European Arctic, Chukotka, Alaska and Western Canada	-increase in atmospheric humidity, cloudiness and precipitation -higher ocean temperatures and salinity -biogenic aerosol fluxes likely to increase -possibly stronger low-pressure systems which increase sea levels and storm-surge height, as well as wave generation	-expected phytoplankton blooms and marine food web changes -distributions of fish stocks will be affected -marine mammals that depend on sea ice must find new habitats -whale migration routes are likely to change
Changes in snow cover (2071-2090)	↓	9 to18% retreat in snow cover	Seasonal retreat in snow extent -3.8% Winter -4.9% Spring -1.1% Summer -3.3% Autumn	-surface energy budget (soil temp and permafrost) and the surface moisture budget (runoff, evaporation) will be affected -earlier pulse of river discharge to the Arctic Ocean and coastal seas -less snow, and shorter snow season, will influence the distribution of vegetation	-accumulation component of ice sheets and glaciers decreases -the ground thermal regime will be influenced, thus warming the soil and thawing permafrost -the growth of seasonal high-latitude vegetation will be affected, as snow insulates underlying vegetation and other biota

happen before 2090. To what extent and when the climate effects will become visible depend on how the Arctic adapts to climate change.

Climate change in the Arctic might make some economic activities in the region more profitable and others less profitable or non-viable. As an example of the former, higher ocean temperatures may increase fish growth (at least up to a certain point), and thus increases the amount that can be sustainably harvested. In the case where higher temperature increases fish growth, harvesting costs for fish in the Arctic are reduced, and both profits and the supply of fish is increased. Generally, such cost reductions will lead to overall improvements in welfare in the Arctic and in the non-Arctic, but distributional impacts may be such as to be negative for some. As we will show in the following, nature based activities in the arctic are sensitive to climate change, but there is great uncertainty as to which will be impacted negatively and which positively. What is clear is that change will be challenging, as both real assets, people and institutions are based on conditions that will be changing.

A sectoral perspective on climate sensitivity

Climate-induced changes in the Arctic will affect nature and society. Our focus here is on selected nature-based activities, reflecting a combination of their importance in the Arctic region and their sensitivity to changes in climatic conditions. The main nature-based activities in the Arctic are fisheries, agriculture, livestock, forestry, hydroelectric power and other renewable energy sources, fossil fuels, mineral extraction, tourism and transportation infrastructure. These activities are dependent on the environment and can have a relatively large impact on it. Table A-1 in the appendix gives a detailed overview of the main activities in these sectors across the Arctic regions.

The tertiary sector (service sector) is by far the dominant sector in the Arctic: see Chapter 1. It accounts for more than 50 per cent of all economic activity. Public administration, in general, accounts for approximately 20 to 30 per cent of all economic activity. In addition, the development of other service industries, such as trade, transportation and real estate, accounts for a large share of the Arctic tertiary sector. We include a tentative discussion of whether and how the government sector itself is likely to change as a result of climate change in the region. However, our main focus is on the direct potential impacts of climate change on nature-based activities. Their importance may go beyond their quantitative share of the formal economy, since they provide the basis for life in many Arctic communities. As an example, fishing may be more important to a fishing village than its share of employment would indicate, since subsistence fishing provides food and sustains a way of living.

Figure 6.1. Possible changes in selected Arctic fish species' location in the Norwegian and Barents Seas resulting from an increase in ocean temperature of 1 to 2°C

Source: ACIA (2004).

Marine fisheries

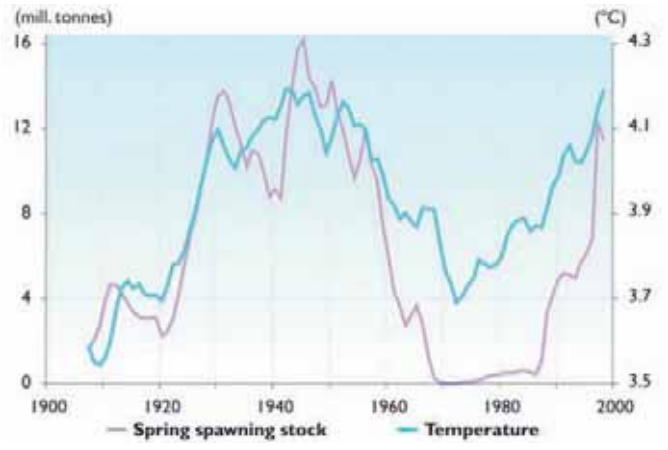
Arctic marine fishing is an important food source for the Arctic nations, and in scale and income terms the catch is also an important export commodity and constitutes a large share of the economy of the Arctic region. The total fish catch in the Arctic constitutes approximately 10.1 per cent of the world catch of fish. Climate changes are expected to impact on marine fishing in several ways across the Arctic. Warmer sea temperature is expected to increase stock productivity for many species. It is also likely that shifts in the ecosystems will lead to changes in fish migration routes. As an example, cold-water species are expected to migrate further north, or their stocks will decline. Examples of changes that cause reductions in fish stocks are changes that either improve conditions for competing species or changes in ocean currents that degrade favourable nutrient conditions.

Moderate warming is likely to improve the conditions for cod and herring, as higher temperatures and reduced ice cover could possibly increase the productivity of their prey and provide a more extensive habitat. Nevertheless, many species are expected to migrate further north or decline in stock, as described in Figure 6.1. One consequence of this can be increasing harvesting costs, perhaps making some fishing activities (and communities) non-viable.

An additional effect of climate change is the introduction of new species in Arctic waters. Changes in ocean currents, nutrient availability, salinity, and the temperature of ocean waters can be expected to influence the distribution of larval and juvenile organisms, the growth rates of individuals, and the population structure of different fish species[3]. An example provided by IPCC is that during a warm phase between the 1920s and the 1960s, Norwegian herring fed in Icelandic waters, but disappeared when the water temperature cooled by 1°C (see Figure 6.2). Overfishing was the primary cause of the collapse of the population, although climatic cooling was probably a contributing factor.

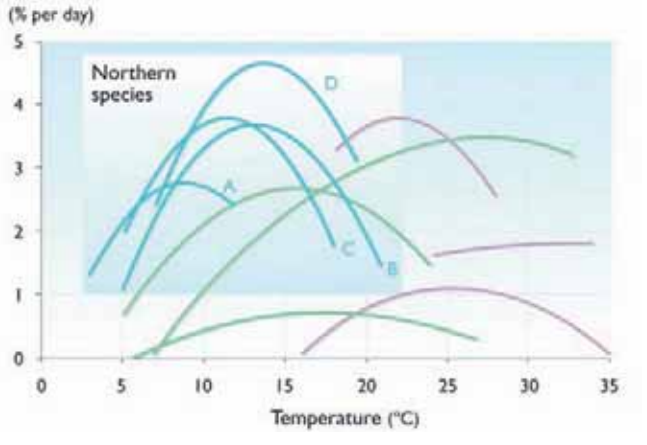
Considering the economic impacts of these changes, the fishing industry in the Arctic will probably experience changes in stocks that can be positive or negative. The general picture can be visualized as in figure 6.3 which displays growth rates for freshwater species in the arctic. It can be seen that fish species all have their ideal temperature, above and below which they display lower growth. Northern species in blue (A: Arctic char, B: Lake cisco, C: Lake trout, and D: Brook trout) have their peak conditions at lower temperature ranges and also display more peaked curves, so their ability to adapt to climate change might be very limited.[4] The unlabelled growth curves are for various lower latitude species.

Figure 6.2. Norwegian herring spawning stock and ocean temperature



©2004, ACIA

Figure 6.3. Growth rate as a function of temperature for Arctic fish species



©2004, ACIA

For marine species, additional questions relate to migration, so that harvesting sites may change considerably. For each, it is uncertain whether higher or lower yields will result, and a similar uncertainty exists about harvesting costs.

Cod and herring are very important commercial marine species in the atlantic arctic region, and both of these are generally assumed to benefit from increased plankton growth associated with higher temperature and less sea ice[5]. For cod, the longer time series display migration further north and east as well as higher weight in warmer periods during the last century. But the uncertainty about fisheries related to climate change is high, not only because more than temperature changes is involved. An important illustration of this is that a healthy fish stock depends on closing its life cycle geographically, a question that depends on a coincidence between where ocean currents carry larvae, nutrient availability, and other factors. There is thus little reason to rely on the basic logic that higher temperatures improve living conditions: as important is the fact that change challenges an observed state, and thus introduces unpredictability.

The great complexity of changes in ocean currents, temperature and nutrient availability makes predictions about how fisheries will be affected by climate changes in the Arctic uncertain. An expected increase in ocean temperature alone could improve growth conditions in northern waters; nevertheless there is a great possibility that an increase in ocean temperature will be accompanied by changes in other factors, such as available nutrients. Similarly, since migratory patterns as well as competition between species might change, it is likely that positive effects on fishing in some areas will occur together with negative ones in the same or other areas. It is possible that the overall effect[6] on fishing will be negative, even if there is assumed tendency towards improved growth conditions in Arctic waters.

Fish farming

Considering fish farming, expected impact of climate change is that warmer water will increase fish growth rates and expand areas suitable for cultivation. However, if the sea temperature changes too much and the temperature exceeds the temperature tolerance of the farmed species, increased incidences of fish diseases and algal blooms are expected.

Agriculture, livestock and forestry

The boreal forest[7] covers about 17 per cent of the global land area.[8] However, a large part of the boreal forests is not commercially harvested to any significant extent. This is because of harsh climatic conditions increasing the costs, and the scale of transportation costs to markets. Hence, only 2.2 per cent of the world's wood removal in million cubic meters takes place in the Arctic.

Climate change is expected to cause vegetation shifts, which are likely to create taller, denser vegetation and new wetland development as permafrost areas are thawing. Forests are likely to expand, and the total number of species present is projected to increase. Further, forest fires are a major climate-related disturbance in the boreal forest[9]. Forest fire is strongly controlled by both temporal and spatial patterns of weather and climate, and effects are therefore not easily predictable.

The boreal forest is affected by, and also contributes to climate change, through its influence on the carbon cycle. Figure 6.4 illustrates changes in the Arctic carbon cycle as the climate warms. Beginning at the left of the figure, the boreal forest absorbs CO_2 from the atmosphere via photosynthesis and vegetation growth. This absorption is expected to increase, although forest fires and insect damage will increase in some areas, releasing more carbon to the atmosphere. Increasing amounts of carbon will also move from the tundra to ponds, lakes, rivers, and the continental shelves in the form of carbon dissolved in water (dissolved organic carbon, dissolved inorganic carbon, and particulate organic carbon).

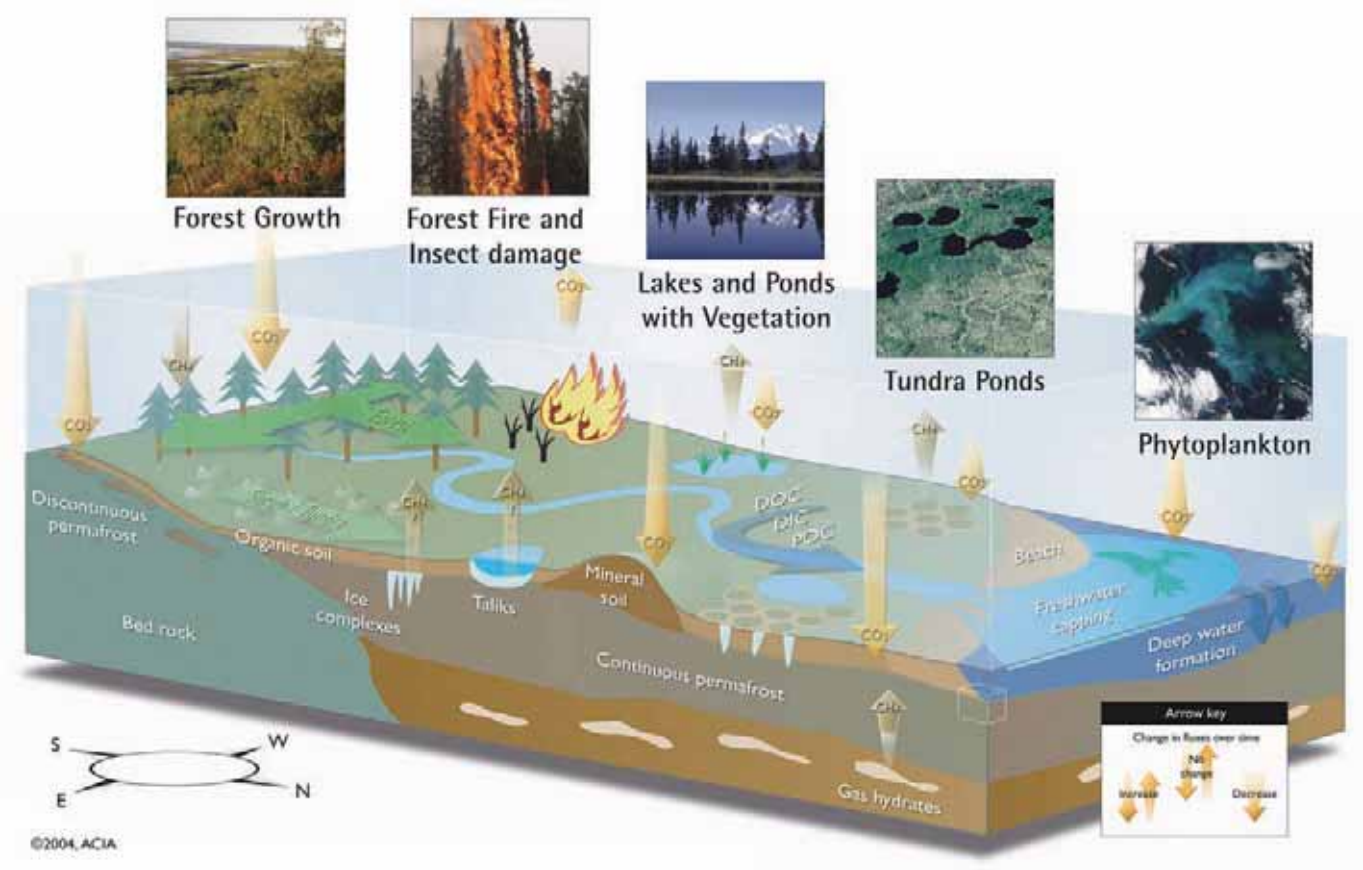
In addition, climatic warming is likely to alter animal husbandry. Concerns include the presence of deep snow with an ice surface that stops animals from obtaining forage, regional overgrazing, and establishment of southern weedy species under a warmer climate[10]. In northern areas of Norway, Sweden, Finland and the Kola region of Russia, indigenous people pursue reindeer husbandry on the basis of ancient rights. However, since these rights are exercised across four nations and legal systems, jurisdictional complexity counteracts adaptation of the herding system in response to climate change.

Agriculture in polar lands is limited by the harsh climate, contributing only 1-2 per cent of regional GDP. Agriculture in the Arctic regions mostly produces forage crops and climate-adapted vegetables and grains in addition to livestock and reindeer herding. Temperature increases are likely to move the grain production boundary northward. Climate changes that increase growing-season length and daily maximum temperatures, while maintaining or slightly decreasing the persistence of growing-season clouds and rainfall, are likely to be favourable to agricultural production in the Arctic region. In brief, agricultural opportunities are likely to expand because of a warmer climate, but are likely to remain of minor importance to the Arctic economy.

Hydroelectric power and electricity production

Many of the countries in the European Arctic rely on hydropower for electricity generation: see Table A.1 in the appendix. Climate change could affect the re-

Figure 6.4. Changes in the cycling of carbon in the Arctic as the climate warms



newable electricity sector in several ways. Precipitation changes will influence inflow, storage and production, with the possibility that existing dimensions of dams and the distribution network are poorly suited for new precipitation patterns. The thawing permafrost may affect hydropower production facilities negatively, but increased precipitation is likely to increase hydropower yields, in particular as adaptation and new construction takes the changed conditions into account.

Wind power and tidal power development are potentially important energy sources for some of the Arctic regions. Both onshore and offshore wind energy may become more important. More wind can result in higher effectiveness and economic potential of wind power, but this again depends on weather patterns. Ice combined with wind could represent a risk for the electricity cables.

For other parts of the Arctic regions, the dominant sources of electricity production are the conventional combustion of fossil fuels and nuclear power. In the discussion in this chapter, it is assumed that these production facilities will not be influenced by climate change. However, any production facilities as well as their logistics could be potentially impacted by changes such as thawing permafrost.

Fresh water

The Arctic landscape is dominated by ice and freshwater systems. As fresh water supplies decrease in the rest of the world, Arctic lakes, rivers and ice reservoirs may become increasingly important as possible fresh water supplies. As an example, there have already been proposals to tap some of these resources. The European Environmental Agency notes in a 2005 report that Russian newspapers have recently referred to plans, originally dating from the early 1970s, to divert the river Ob and other northbound rivers towards water-starved regions in the south. If such plans were implemented, the impacts and consequences could be major. A diminishing flow of fresh water into the Arctic Ocean will affect ice formation off the Siberian coast. The consequences for marine productivity, and possibly also ocean currents and climate, are unknown but potentially dramatic[11]. It is unclear how such interventions would relate to international conventions

Petroleum and mineral extraction

Most of the regions in the Arctic have both onshore and offshore production and exploration of a variety of non-renewables: see Table A.1 in the appendix. The Arctic holds a great share of the world's oil, coal and gas reserves. As shown in chapter 3, the arctic presently produces about 10 percent of the world's oil and a quarter of its gas, and for these critical com-

modities the region's role is estimated to be greater in he future.

For oil and gas, climate change will challenge the petroleum sector in many ways. Offshore oil exploration and production is likely to benefit from less extensive and thinner sea ice, although equipment will likely be costlier as it will be required to withstand increased wave forces and ice movement. Onshore, the impact of climate change is likely to lead to increased costs, but offshore the consequences are uncertain and will probably vary.

The Arctic regions are categorized by extreme weather conditions. The increase in temperature and melting sea ice will open new sea routes, but will increase the frequency of icebergs, which may damage sub-sea pipelines and offshore petroleum production facilities. Conditions in Siberia and Alaska will also be challenging, with thawing permafrost making it more difficult to transport heavy equipment over the tundra. In addition, swings in temperature will cause the frozen ground to move and thus threaten to destabilize oil and gas pipelines.

Increased activity in this sector is expected not only from climate change-related factors, such as increased access caused by receding sea ice, but also from changes such as improvements in offshore technology, oil-price development, and the political landscape in the Arctic. The International Energy Agency has estimated that the cost of petroleum extraction in the Arctic is about three times higher than in other petroleum provinces (see chapter 3). However, the Arctic regions represent stable political and institutional conditions, providing opportunity for long-term involvement for oil companies that elsewhere face diminishing access to oil provinces operated by national oil companies.

Beyond fossil fuels, the Arctic has large reserves of minerals, ranging from gemstones to fertilizers: see appendix Table A.1 as well as the treatment in chapter 3. Russia extracts the largest quantities of these minerals, including nickel, copper, platinum, apatite, tin, diamonds and gold, mostly on the Kola Peninsula but also in the northern Ural Mountains, the Taymir region of Siberia, and the Far East. In the Canadian Arctic—which includes Nunavut, Yukon and Northwest Territories— lead, zinc, copper, gold and diamonds are mined. In Alaska, lead and zinc are extracted from the Red Dog Mine, which sits atop two-thirds of the US zinc resources. In addition, Alaska mines gold in several locations.

Generally, mining on land is believed to benefit from permafrost, since it is easier to build and move heavy equipment on frozen ground. Thus, the mining industry in the Arctic may experience increased costs as permafrost in the region shrinks, but such effects are likely to vary by region and type of activity. In addition, storm surges and erosion will also increase costs. As with petroleum and gas extraction, mining activities in the Arctic are important contributors of raw materials to international markets, and likely future expansion relates not only to climate change but also to changes in technology, costs, and transportation availability. Transportation itself is affected by climate change, and itself implies challenges in terms of environmental management and international institutions.

Tourism

Tourism is expected to experience a longer season; however the sector is very dependent upon weather conditions. These are likely to get more unpredictable (and rainier) because of climate changes. In addition, the tourist sector in the Arctic regions is very dependent on nature-based activities, so disruptions of both wildlife and nature may be harmful. In extremely northern locations such as Svalbard, increased marine activity is expected to increase the visits of cruise vessels. Cruise ships currently also visit communities such as Pond Inlet, Cape Dorset, Kimmirut and Pangnirtung in Nunavut, Canada. An impact of climate changes to economic activity in these ports is anticipated because of the longer period in which cruise vessels can visit. However, increasing frequency of icebergs, due to melting sea ice, may also make access to these ports more complex.

Long-term climate changes will impact particularly on the Arctic's main tourist attractions. Tourists are attracted to the region because of the unique Arctic experience, perhaps represented directly by low temperatures and the presence of ice, and certainly by Arctic wildlife, vegetation and scenery. The polar bear, a big tourism magnet, is considered very vulnerable to climate change, since it depends on hunting seals on the sea ice. In brief, these tourist attractions will change, perhaps dramatically. In addition, snow-dependent activities such as dog sledging and snow-mobile riding are expected to decline if snow-cover is reduced.

Tourism in the Arctic will be influenced by climate change in many ways, with current impact assessments indicating substantial uncertainty. One scenario, for instance, is that accessibility will increase as sea ice recedes. Also, the Arctic regions may become less attractive if snow and ice recedes, but with an effect that is compensated by even greater removals of snow and glaciers in other regions (for instance in the European Alps). However, an opposite effect can make the Arctic less special and less attractive as the climate changes, for instance if the polar bear disappears from the fauna. There will also be other important influences—such as income growth in rich countries generating increased demand for Arctic tourism services. One may guess that an overall trend towards climate change will influence the tourism industry in

Table 6.2. Maritime activity in the Arctic regions

Activity	Expected trend in the future
Transport of general cargo, bulk cargo and containers	Increase
Fisheries	Remain stable
Tourism, including whale-watching cruises and passenger vessels	Increase
Research and other vessels	Remain stable
Transport of vessels for scrapping	Increase
Icebreakers and tugs	Increase

Source: Norwegian Maritime Directorate (2000).

the Arctic in important ways, without being able to assess exactly how, or even if, the changes will be positive or negative.

Maritime activity

Maritime activity in the Arctic consists mainly of transport, fisheries, tourism, research and icebreaking. Of all these maritime activities, the transport of general cargo, bulk cargo and containers, and fisheries have the greatest share[12]. Seasonal variation in shipping activities is caused primarily by prevailing ice conditions. In areas of lower or no ice coverage, transportation activity has a more regular pattern. Fishing varies with the resource distribution, including seasonal variations. Tourism, including cruises, is a summer activity.

Climate change is expected to increase marine access to the Arctic regions, especially with the possible opening of closed passages such as the North-West Passage and the northern sea route (north of the North American and the Eurasian continents, respectively). Thus, harbour facilities will probably have to be developed in many parts of the Arctic regions. Table 6.2 gives an overview of predicted impacts of climate change on maritime activity. One benefit of the opening of new passages is that energy companies may find it easier to transport oil and gas in the new, open sea routes. In addition, increased offshore and mining development will increase maritime activity in the region.

Shipping in the Arctic is mainly a result of transportation of goods either in or out of the region. Imports of goods are demanded by both industry and settlements. Exports are mainly concentrated around the petroleum industry, fisheries and mining. Canada, the USA, and Norway have major shares of the exports from the Arctic regions. Oil companies are engaged in petroleum activities offshore near the arctic parts of mainland Norway, but the commercial production of oil or gas in the Norwegian Arctic is yet to start (the Snow White Field). However, increased economic activity in Northern Norway is expected to increase shipping activity.

Increasing shipping activity in the Arctic raises questions of maritime law that will need to be resolved soon. These issues include accident and collision insurance, authority for regulation, enforcement and cleanup in management of natural resources and environment. These questions are important because sovereignty over Arctic waters is still not firmly settled among polar nations, and increased ship access could raise many destabilizing international issues.

Infrastructure on land

The infrastructure in the Arctic regions may experience increased incidents of floods, avalanches and mudslides because of climate changes in the region. Increased temperature is also expected to melt parts of the permafrost in the regions. Roadway quality, in particular, is expected to decrease in permafrost regions as the temperature increases.

Irrespective of climate changes, the number of scheduled flights in Arctic regions is likely to increase.[13] However, airport installations will require improved engineering designs to handle permafrost instability. Another effect of the increased activity in shipping transportation and air travel is the requirement for a more extensive weather service and navigational aids than now exist.

The impact of warming is likely to lead to increased building costs, at least in the short term, as new designs are developed to handle permafrost instability. Snow loads and wind strengths may increase, which also could require modifications to existing buildings.

Subsistence activities and small communities in the Arctic

The subsistence economy is important to many individuals and communities in the Arctic. Climate change has already affected and continues to affect their way of life. The indigenous people maintain a strong connection to the environment through hunting, herding, fishing and gathering of renewable resources. These practices provide the basis for food production that is often based on thousands of years of tradition. Cultural adaptations and the ability to utilize resources are often associated with, or affected by, seasonal variation and changing ecological conditions. Climatic variation and weather events have always affected the abundance and availability of resources, and thus the abilities and opportunities to harvest and process food in subsistence activities.

The indigenous communities are already subject to stress that restricts the harvesting and herding routines, some of which may be associated with climate change. For many Arctic communities, consuming food from animals is fundamentally important for survival and personal well-being. Indigenous people have reported a loss of vitality, a decline in health, and decrease in personal well-being when they are unable to

A fishing boat cruises in the Ilulissat fjord, Greenland/Scanpix,AFP

eat traditional foods.[14] The potential impacts of climate change thus include a concern for access to traditional food resources, and the social and economic well-being and the health and cultural survival of the indigenous people of the Arctic. These issues are dealt with in greater detail in chapter 5.

Government institutions in the Arctic

Climate change and its impacts will include challenges of coordination between nations as well as for regional levels of government. What a government does to change resource allocation is called the allocative function of government. Allocative interventions in the Arctic include the management of natural resources such as fisheries or mineral extraction, law enforcement, and institutional mechanisms such as pollution control or biodiversity protection. Government is also essential for allocation of resources to public service and infrastructure provision. The redistributive function of government refers to action to protect the poor, provision of income support, and social insurance. Both the allocative and the distributive functions of government will probably be strongly affected by how governments choose to adapt to climate change and its impacts.

In practice, government involvement usually blends the functions of allocation and redistribution, an important example being the provision of subsidized education and health services. This provision enhances the human capital of the recipient and also conveys insurance benefits, in particular when the recipient household is poor. Thus, many government services both redistribute income and influence how it is spent. For remote and sparsely populated regions such as many areas in the Arctic, such services are often expensive to provide, and the local tax base may be limited. For these reasons, service provision also in effect conveys income transfers from a higher level of government (often national) to the population in the Arctic region.[15] The recipient region then benefits both through the consumption value of the service provided and through the local economic repercussions of increased spending and increased employment. When resources are allocated to national public goods that are not principally consumed locally—such as national defence—there will still be important impacts locally, such as the positive effects on local employment.

The direct effects of climate change on government services will vary by location: less sea ice may reduce costs of sea transport; permafrost thawing may increase costs of on-land transportation, construction and infrastructure; higher temperatures will reduce costs of heating, etc. In addition to these direct effects, there will be adaptive effects related to the economic impacts of climate change. As an example, assume that there will be an economic upswing in some Artic regions because of improved fishing. An economic upswing will either improve the local tax base or reduce the need for income support from the national government. In addition, it will increase the demand for services in most areas, depending on the inflow of workers with families, and a need for supportive industries. In consequence, communitites affected positively by climate change may share the experience with communities affected negatively that change itself increases demand on government service provision.

There are no direct links between climatic conditions such as reduced sea ice and issues of national sovereignty and maritime law. There are, however, several reasons why there are issues of international relations relevant to the changing climatic conditions in the area. First and most obvious, is the fact that the conditions for harvesting natural resources will change, and this will demand changes in the institutions involved in managing these resources. The most obvious example relates to management of fish stocks. Historical examples of tragic losses due to mismanagement of marine resources are many. These range from cases in which a nation has mismanaged a resource all on its own, via mismanagement in a setting of national authority but involving harvesters from other countries that are hard to control, to examples where transnational coordination is required either because of migratory fish species or because of enforcement challenges.

Climate change influences the control regime of natural resources in many ways. Most simply, if harvesting costs are falling (because of increased stock growth,

for instance), a stock that has been "naturally protected" by high harvesting costs may be threatened by overfishing (either immediately, or when increased harvesting capacity has emerged). Sadly, the opposite effect of climate change, a reduction in the fish stock, could also result in overfishing, since both the oversized harvesting capacity and the overly generous harvesting quotas might be adjusted downwards too slowly. Such non-symmetric effects highlight how—in ecosystem management—any change in underlying conditions put strain on management institutions, since these will typically be better geared to manage the existing situation than any new situation.

Another example would be when the migratory patterns or extent of a stock changes, such that a stock that has previously thrived without transnational management institutions may come to require such institutions. The same may happen if reduced sea ice facilitates the movement of vessels between the waters of different nations, thereby reducing the effectiveness of national management schemes (via enforcement costs, for instance).

Similar issues are involved in the management of mineral resources and fossil fuels. Issues not fully negotiated or settled in terms of national control may become important—and subject to dispute—as climate change gives value to areas formerly not considered of importance. An example may be the "grey zone" in the Barents Sea between Norway and Russia. The balance of power, as well as the need to agree on a scheme for authority and exploitation, will change along with climate. In addition, economic and other activities in such areas may have consequences for future control, and will then in turn be influenced by this possibility. An example of such effects is that both Russia and Norway have included strategic considerations for future control when maintaining a presence through coal mining activities in Svalbard.

One of the projected impacts of climate change in the Arctic is increased access, which at times is assessed as one of the most important changes. BBC reports that "climate change is seen by some as a boon to businesses in the Arctic regions", and that "adventurous capitalists are desperate to obtain access to resources that are uncovered as the ice retreats"[16]. Lack of access is generally an excellent protector of natural assets, and stability is typically found to be essential to institutions for resource management. Climate change will thus increase the need for protective institutions due to increased activity levels, while simultaneously making it harder to build and maintain the institutions.

However, the predicted increase of activity in the Arctic caused by climate change factors combined with the search for new energy supplies might lead to a new "gold rush" in the far north, bringing diplomatic problems in its wake as countries vie for access to the resources. The US and Canada argue over rights in the North-West Passage; Norway and Russia bicker over the Barents Sea; Canada and Denmark are competing for a small island off Greenland, Hans Island; the Russian Parliament is refusing to ratify an agreement with the US over the Bering Sea; and Denmark hopes to trump everyone by claiming the rights to the North Pole itself.

Pollution issues will be of increased importance as economic activity expands in the Arctic. Since pollution migrates across borders and affect global public goods (biodiversity, for instance), these issues will also result in increasing demands on transnational institutions for coordination. An example of this is the regulatory regime for marine transport; another will be regimes evolving for such activities as petroleum exploration and extraction.

Concluding remarks

The ACIA report stated that changes in temperature, precipitation and storm patterns can affect the type, abundance, and location of animals and plants available to humans and may lessen the productivity of certain traditional forms of hunting and gathering. A decrease in the extent and thickness of sea ice can alter the distribution, age structure and size of marine mammal populations, expose the Arctic coast to more severe weather events, exacerbate coastal erosion, and affect modes of transportation and the ability of people to reach hunting locations and other villages. Changes in surface water budgets and wetlands can change coastal microclimates, alter the size and structure of peatlands, and result in pond drainage. These changes would in turn result in effects not only in human communities in the Arctic, but in other areas of the world as well.

Climate change is likely to be greater and more dramatic in the Arctic than in most other areas. The factor that will impact on the economy in the Arctic is first and foremost changes in mean surface temperature. An increase in temperature will result in reduced sea ice, increased precipitation and decreased snow cover in the Arctic regions. The impact of these changes on nature-based activities will be significant. In addition, climate change in the Arctic will also impact on other economies.

Climate change is expected to have an impact on most of what happens in the Arctic, and the emphasis in this study has been on resources and trade flows, which will be affected due to the importance of what we call "nature-based activities", which in addition to primary sectors include tourism and transportation infrastructure. Table 6.3 below gives an overview of expected impacts of climate change on sectors on the Arctic.

Table 6.3. Expected impacts of climate change on sectors in the Arctic

Fishing	- changes in stock and species. - alternation of migration routes. - uncertain harvesting costs. - increased stock productivity.
Agriculture, livestock, forestry	- vegetation shifts. - expansion of forests. - altered husbandry practices. - probable expansion of agricultural opportunities - increased growing season. - wetland development. - increased forest fires.
Renewables: **Hydroelectric power**	- change in precipitation affecting thereservoirs. - increased maintenance costs caused by thawing permafrost.
Non-Renewables: **Mining and Petroleum**	- shorter season for mining. - offshore production likely to benefit from less sea ice. - increased design and operational costs.
Tourism	- reduced access costs. - increased scarcity value. - snow dependent activities more limited. - longer season. - more cruise tourism. - weather events, like storms, have unknown trends.
Maritime transportation	- dependent on prevailing ice conditions. - reduced access costs.-increased appearance of icebergs. - opening of closed passages (north-west passage and northern sea route). - weather events, like storms, have unknown trends.
Infrastructure on land	- increased costs from impacts of natural disasters. - increased maintenance costs. - increased flight activity in the Arctic regions. - increased building costs. - construction season extended.
Governmental services	- increased demands on the federal budget associated with climate change. - possible increased federal economic support.
Subsistence activities	- change in harvest patterns.

With regard to economic impacts of climate changes in the Arctic, the fishing industry will most likely experience changes in stocks, and harvesting locations may change considerably. It is uncertain whether higher or lower yields will result, and a similar uncertainty exists about harvesting costs. As shown in chapter 3, the arctic is very important in providing about 10 percent of the world's wild fish, so changes in this activity will be important to the world. About 65 percent of this fish is cod and herring, and since these are species for which migratory patterns are shown to be sensitive to changing sea temperatures, it is highly uncertain how these fisheries will be impacted by climate change. With regard to cultivated fish species, expected impacts of climate change include warmer water increasing the growth rates of fish. However, if the sea temperature changes too much, and the temperature exceeds the temperature tolerance of the farmed species, increased incidences of fish diseases and likely algal blooms are expected.

Agricultural opportunities are likely to expand because of a warmer climate, moving the grain production boundary northward. Climate changes that extend the growing season and raise daily maximum temperatures while maintaining or slightly decreasing persistence of growing-season clouds and rain are likely to be favourable to agricultural production in this area. Nevertheless, apart from the importance of livestock for selected households and communities, agriculture is not of great importance in the Arctic.

Climate change in the Arctic is likely to influence the production of oil and gas in the region in many ways. Offshore oil exploration and production is likely to benefit from less extensive and thinner sea ice, although equipment may also become costlier, to withstand increased wave forces and ice movement. Onshore, the impact of climate change is expected to raise costs, but offshore the consequences are uncertain and will probably vary. For oil and gas, Arctic regions are estimated to represent 12 per cent for oil and 23 per cent for gas of global proven and expected undiscovered reserves, respectively, see Chapter 3, indicating that the Arctic will be increasingly important to the world through these critical commodities. For oil and gas together, the Arctic shares are 13 per cent of proven global reserves and 24 per cent of expected

undiscovered global reserves. Thus, the possible impacts of climate change on extractive activities – likely combining positive and negative impacts - is exceedingly relevant to the non-arctic world.

Tourism is expected to experience a longer season in the Arctic; however the sector is dependent on weather conditions, which are likely to get more unpredictable (and rainier) because of climate changes. Some areas may lose their attraction.

The impact on the Arctic economies, and on the rest of the world through trade flows, is in many ways less subtle and more direct, noticeable and predictable. Nature-based activities will be affected by climate change, in some instances by a direct boost to profitability and in other cases with a direct reduction in profitability. In all cases, the longer-term effect will depend on adaptive responses in the private and the public sector.

We have emphasized the fact that any change, positive or negative, represents increased demands on government institutions. Three illustrative points makes this evident: first, a fish stock may be "protected" by high harvesting costs, so increased fish growth may place new demands on management institutions (as would reduced fish growth). Second, a booming town may demand increased government expenditures to take care of incoming households and firms, but a town facing decline may require increased transfers for adjustment and social insurance. Third, reduced sea ice improves mobility of vessels and therefore presents new transnational cooperation challenges for such purposes as fisheries and environmental management. Climate change will put pressure on the Arctic governments' abilities to adapt to climate change and build institutions, both on national and transnational levels.

Further research

Further research is necessary to quantify the impacts of climate change in the Arctic. We have shown that for commodities such as fisheries and gas and oil, for civilian and military marine activities, climatic change will be important, and in ways that are relevant not only for the arctic regions. This report and this chapter represent some initial steps, but additional research is needed on how climate change in the Arctic might affect other economies, both globally and on a more regional level. Research on how the Arctic nations might envisage future control rights as evolving is also necessary and should be part of the future research agenda.

Notes

[1] Sources for Table 6.1: Table 4.3 (ACIA, 2005: 122), Table 4.4 (ACIA, 2005: 127), Table 6.3 (ACIA, 2005: 195), Table 6.4 (ACIA, 2005: 199) and Table 6.5 (ACIA, 2005: 200). Authors are listed in each chapter, «*Arctic Climate Impact Assessment - Scientific Report*». Edited by Carolyn Symon (lead editor), Lelani Arris and Bill Heal. New York, USA: Cambridge University Press, 2005.

[2] ACIA (2004), Hassol, Susan Joy, 2004, «Impact of a warming Arctic - synthesis report of the Arctic Climate Impact Assessment», Cambridge University Press, pages: 1-140, online: http://amap.no/acia/

[3] IPCC, Intergovernmental Panel on Climate Change (2001) Authors are listed in each chapter,»Climate Change 2001: Impacts, Adaptation and Vulnerability», Series Editor: McCarthy, James J.; Canziani, Osvaldo F.; Leary, Neil A.; Dokken, David J.; White, Kasey S., Cambridge University Press, pages: 1-1033, online: http://www.grida.no/climate/ipcc_tar/wg2/index.htm

[4] Drinkwater, K.F. (2005): «The response of Atlantic cod (Gadus morhua) to future climate change». Journal of Marine Science, 62: 1327–1337.

[5] Skjolddal, H., H. Loeng, K. Drinkwater (2006). 'The ice in the arctic is melting: what does it mean for our ecosystems?' Havets ressurser og miljø, chapter 4. .IMR.NO.

[6] ACIA (2005), Authors are listed in each chapter, «*Arctic Climate Impact Assessment - Scientific Report*». Edited by Carolyn Symon (lead editor), Lelani Arris and Bill Heal. New York, USA: Cambridge University Press, 2005.

[7] The boreal forest is defined as a belt of forest south of the tundra characterized by coniferous species, such as spruce, larch, pine and fir.

[8] ACIA (2005) Authors are listed in each chapter, «*Arctic Climate Impact Assessment - Scientific Report*». Edited by Carolyn Symon (lead editor), Lelani Arris and Bill Heal. New York, USA: Cambridge University Press, 2005.

[9] IPCC Intergovernmental Panel on Climate Change (1998), «Special Report on Regional Impacts of Climate Change», Cambridge University Press, online: http://www.grida.no/climate/ipcc/regional/index.htm

[10] EEA, European Environmental Agency, 2005. «*The state of the Arctic Environment*». European Environmental Agency, Online: http://reports.eea.eu.int/MON3/en/

[11] Norwegian Maritime Directorate (2000). «*Pame – Snap Shot Analysis of Maritim Activities in the Arctic*», revision no 01, report no. 2000-3220. Online: http://www.pame.is/sidur/uploads/Norwegian_maritime_directorate.PDF

[12] Norwegian Maritime Directorate (2000). «*Pame – Snap Shot Analysis of Maritim Activities in the Arctic*», revision no 01, report no. 2000-3220. Online: http://www.pame.is/sidur/uploads/Norwegian_maritime_directorate.PDF

[13] IPCC, Intergovernmental Panel on Climate Change (2001) Authors are listed in each chapter,»Climate Change 2001: Impacts, Adaptation and Vulnerability», Series Editor: McCarthy, James J.; Canziani, Osvaldo F.; Leary, Neil A.; Dokken, David J.; White, Kasey S., Cambridge University Press, pages: 1-1033, online: http://www.grida.no/climate/ipcc_tar/wg2/index.htm

[14] ACIA (2005) Authors are listed in each chapter, «*Arctic Climate Impact Assessment - Scientific Report*». Edited by Carolyn Symon (lead editor), Lelani Arris and Bill Heal. New York, USA: Cambridge University Press, 2005.

[15] For seven of the eight Arctic countries, the Arctic is a minor share of the country's territory and population. The exception is Iceland.

[16] BBC /Jorn Madslien, 2005, «Global Warming: Help or Hindrance?» In *BBC News*,. online: http://news.bbc.co.uk/1/hi/business/4357240.stm

Appendix

Table A1. Activities in nature-based sectors in the Arctic regions

		Fishing	Agriculture, livestock, forestry	Electric power production	Non-renewables: Mining and petroleum	Tourism	(Maritime) transportation activities
Sub-region I the European Arctic	Arctic Norway	Arctic cod, shrimp, capelin, salmon, trout[10]	Reindeer-herding, hunting, trapping[9]	Hydropower, windpower[10]	Offshore oil and gas production, offshore exploration drilling[11], coal[10]	App. 1.7 mill. guestnights in 2002[10]	Many important navigation routes along the coast, from both Norway and Russia[3]
	Arctic Sweden	No significant fishing activity	Timber, barley, wheat, sugar beets, meat, milk[9]	Hydropower[9]	Iron ore, copper, lead, zinc, gold, silver, tungsten, uranium, arsenic, feldspar[9]	App 2.7% of GNP[6]	Ice floes in the Gulf of Bothnia can interfere with maritime traffic[9]
	Arctic Finland	Inland fishing: Herring, sprat, vendace, salmon, trout[8]	Barley, oats, sugar beets, potatoes, milk, poultry, pigs, cattle, reindeer and forestry (timber)[9]	Nuclear energy, wood fuel, oil, coal, natural gas, peat and hydro-power[8]	Iron ore, copper, lead, zinc, chromite, nickel, gold, silver, limestone[9]	4.4 mill. guestnights in 2004[8]	
	East Green-land	Northern prawns, halibut, lumpfish, snow crab, cod[4]	Forage crops, garden and greenhouse vegetables, sheep, reindeer[9]	Hydro[4]	Zinc, lead, iron ore, coal, molybdenum, gold, platinum, uranium, possible oil and gas[9]	App. 64 000 guests total for Greenland in 2004[4]	Ships, aviation[4]
	Iceland	Capelin, blue whiting, cod, herring[5]	Sheep-, cattle-, hens- and mink production, small-scale agriculture[9]	Hydro, geothermal, oil[5]	Processing aluminium[13]	4.4% of employees[5]	Ships, aviation[5]
	North-west Russia	Consentrated in Murmansk. Cod, herring, saithe, capelin, northern shrimp, halibut[3]	Timber, much of the country lacks proper soils and climates (either too cold or too dry) for agriculture[9]	Relies on fossil fuels for most of its electricity generation: app. 65 % conventional thermal[17]	Offshore and onshore oil and gas production and exploration, gemstones, fertilizer, nickel, copper, platimun, apatite, tin, diamonds, gold and coal[3]	Science-based tourism and journalists. Rapidly growing industry[14]	Unfavorably located in relation to major sea lanes of the world[9]
Sub-region II	Russia (Siberia)	No significant fishing activity[3]					
Sub-region III	Russia (Chukotka)	Large-scale trawl fisheries, ground-fish (app. 90% walleye pollock)[3]					
	Alaska	Groundfish (app. 75% walleye pollock), salmon, halibut, shellfish[3]	Timber, agriculture[9]	Natural gas (51%), hydropower (21%), petroleum (15%), coal (13%)[1]	Mining for lead zinc and gold[3], off- and onshore oil and gas production and exploration[11]	Season-dependent[13] – 90% during the summer, but expanding sector	International air freight important[13]
	Canada (west)	No significant fishing activity[7]	Forestry fur trapping greenhouse vegetable potential[9]	Relies on fossil fuels for most of its electricity generation	Onshore oil production and onshore gas exploration[11], mining for diamonds, sand and gravel[13], lead, zinc, copper and gold[3]	App. 85 000 guests total in 2002[14], Aurora Tourism[15], vital and growing industry[16]	Opening of north-west passage[3]
Sub-region IV	Canada (central and east)	Capelin, cod, sand lance, herring, halibut, plaice, snow crab, northern shrimp[3]					
	West Greenland	Northern prawns, halibut, lumpfish, snow crab, cod[4]	Forage crops, garden and greenhouse vegetables, sheep, reindeer[9]	Hydro[4]	Offshore exploration drilling[11], gold exploration, zinc, lead, iron ore, coal, molybdenum, gold, platinum, uranium[9]	App. 64 000 guests total for Greenland in 2004[4]	Ships, aviation[4]

[1] U.S. Department of Energy; Energy Efficiency and Renewable Energy «EERE State Activities and Partnership: Alaska Energy Statistics». http://www.eere.energy.gov/states/state_specific_statistics.cfm/state=AK online: Feb. 1, 2006. [2] FAO Fisheries Department «Resources» http://www.fao.org/fi/Resrcs.asp online: Feb. 1, 2006. [3] ACIA (2005) Scientific report. [4] Statistics Greenland. [5] Statistics Iceland. [6] Statistics Sweden. [7] Natural Resources, Canada: *The Atlas of Canada* Fisheries—Selected-Characteristics; Pacific Fisheries http://atlas.gc.ca/site/english/maps/archives/4thedition/economic/resourceindustries/169_170 online: Feb. 1, 2006. [8] Statistics Finland. [9] CIA country information «Natural resources». http://www.cia.gov/cia/publications/factbook/fields/2111.html online: Jan. 31, 2006. [10] Statistics Norway. [11] Arctic Monitoring and Assessment Programme, «AMAP-assessment report: Arctic Pollution Issues. Figure 10-01». [12] Natural Resources, Canada: *The Atlas of Canada* Electrical Power Generating Stations, (1997) http://atlas.gc.ca/site/english/maps/economic/generatingstations/utilitybytech online: Feb. 1, 2006. [13] Econor Workshop. [14] Pagnan and Dolphins (2003) «The impact of climate change on arctic tourism – a preliminary review» http://www.world-tourism.org/sustainable/climate/pres/jeanne-pagnan.pdf. [15] Resources, Wildlife and Economic Development—Government of the Northwest Territories», Aurora Tourism-Economic Impacts in the Northwest Territories». http://www.iti.gov.nt.ca/iea/pdf/documents/aurora_tourism.pdf Online: Feb. 1, 2006. [16] Resources, Wildlife and Economic Development—Government of theNorthwest Territories. «Tourism in the NWT» http://www.iti.gov.nt.ca/iea/pdf/fact_sheets/tourism2001.pdf Online. Feb 1, 2006. [17] Carbon Sequestration Leadership Forum (CSLF) «An Energy Summary of the Russian Federation» http://www.cslforum.org/russia.htm Online: Feb. 1, 2006.

7. Discussion and concluding remarks

The purpose of the Econor project is to give a comprehensive view of the economy in the Arctic including the subsistence economy of the indigenous people of the region. In order to achieve this goal we have utilized data from the statistical agencies of the Arctic nations and from other sources when relevant. Further, the project report discusses the importance of the Arctic economy from a global perspective, with particular focus on the natural resources in the Arctic region. This latter task has required data collection from many sources and not just from the statistical agencies. Finally, the report discusses the likely effects of climate change on the Arctic economy; this being particularly relevant as the temperature rise is expected to be high and rapid in the Arctic region. The overview of the Arctic economy provided by the Econor report in terms of scale, composition and structure may help policy makers to better see the position of various stakeholders; the large scale commercial interests, the local and central governments, the indigenous peoples and the citizens of the Arctic as a whole.

The Arctic share of global population is only 0.16 per cent. With respect to the share of global production of goods and services in terms of measured gross domestic product (GDP), the Arctic share is somewhat higher; 0.44 per cent. Both these numbers seem to indicate that the Arctic plays a minor role in the global economy. However, the picture changes radically if we look at the production of raw materials taking place in the Arctic. The Arctic shares of global oil and gas production are 10.5 and 25.5 per cent, respectively. That is, the Arctic supplies one quarter of the global demand for natural gas. Further, according to the US Geological Survey completed in the year 2000, Arctic shares of global proven and undiscovered reserves of oil and gas are around 14 and 23 per cent, respectively. Hence, the Arctic is likely to continue to play a major role in the global energy supply. The Arctic also contains major stocks of renewable resources. For instance, the catch of fish in the Arctic in 2002 amounted to 7.26 million tons, around 10 per cent of the world catch. Moreover, we estimate that 8.2 per cent of the earth's global volume of forests is found in the Arctic, while only 2.2 per cent of the world's wood removal takes place in the Arctic.

Given the important role of the Arctic as a provider of raw materials of all sorts from minerals to food, natural resource management is crucial, and is likely to become even more crucial in the future due to climate change. One example could be if the migratory patterns or extension of a fish stock changes, another example is associated with the management of mineral resources and fossil fuels. Issues not fully negotiated or settled in terms of national control may become important – and subject to dispute – as climate change gives increased value to areas formerly not considered of economic importance. Lack of access is generally an excellent protector of natural assets, and stability is typically found to be essential to institutions for resource management. Climate change will tend to undermine stability and thus create new challenges for efficient protection, while simultaneously making it harder to build and maintain the institutions. Pollution issues will also be of increased importance as economic activity expands in the Arctic. Since pollution migrates across borders and affect global public goods like clean air and water, biodiversity and wildlife, these issues will also result in increasing demands on transnational mechanisms for coordination. An example of this is the regulatory regime for marine transport.

Natural resource extraction in the Arctic accounts for 31 per cent of Arctic GDP. Due to the standard method by which GDP figures are calculated, GDP figures are boosted by natural resource extraction, and it is hard to know whether levels of consumption and investment are sustainable. Natural resource dependency thus poses special challenges for the conduct of sustainable policies in the Arctic. A central element in the call for sustainable development is that our wealth should be passed on to the next generation intact, in particular it should not decrease. Besides foreign financial claims, fixed capital (machinery, buildings and infrastructure) and human capital (labour, knowledge and social capital), national wealth also comprises *natural capital*. Natural capital consists of oil and gas reserves, mineral reserves, stocks of fish and forests and undisturbed nature and scenery. Hence, when resources like oil and gas are extracted or scenery degraded, the stock of natural capital is reduced. However, this reduction does not show up in the national accounts, and a reduction of national wealth might go on for several years without anyone knowing. Clearly, it is not only depletion of non-renewable resources that should be monitored, but also the development in the stocks of renewable natural resources including the fundamental qualities of nature and scenery. For instance, over-fishing that reduces the stock and hence harvesting possibilities in

the future, will improve GDP temporarily, but could be detrimental in the long run. Similarly, degradations of nature will reduce the attraction of these areas for future recreation and tourism.

Indicators for sustainable development seek to measure to what extent depletion of non-renewable resources are replaced by investments in other forms of capital like fixed capital or human capital in the form of education levels etc, and they aim to evaluate to what extent current harvesting practises for renewable resources can be prolonged into the far future. Many Arctic nations have developed their own set of such indicators. However, even if indicators for sustainable development exist at the national level, there may be good reasons to develop the indicators further to also explicitly describe the Arctic regions and the circumpolar Arctic region in total. The large presence of indigenous people in the Arctic makes this an especially relevant consideration.

The Arctic regions are not equally dependent on the extraction of natural resources. For instance, the Arctic regions of Norway, Finland and Sweden stand out as being less dependent of natural resource extraction, and in particular Arctic Finland has a well-developed manufacturing sector. Furthermore, the Arctic regions also differ as to major type of natural resource extraction. While Alaska and Arctic Russia are oil and gas based, Canada has important extraction of minerals and Iceland and Greenland large fisheries. There are also large differences in the GDP/capita levels among the Arctic regions and nations. However, in natural resource based economies, using GDP figures to evaluate the wealth or well being of the population can be especially misleading. Since a large part of GDP in such economies comprises return to fixed capital and resource rents that theoretically can be taken out of the region as income to owners situated elsewhere, it is hard to know without a more in-depth analysis what share of GDP is actually available in the region for consumption and investments. Thus, more statistical data should be collected for the Arctic regions and new comparisons between the Arctic nations and regions should be made. In particular, one should seek to collect data on return to labour, disposable income and consumption, comparing these data to resource rents and return to capital in the Arctic regions.

Using data from the statistical agencies has proved more difficult than originally anticipated. Firstly, many types of data do not exist as regionalized data. For instance, it has been impossible to get data for the stock of fixed capital in the different industries in the different Arctic regions. These data are only available on a national level today, but we hope that it will be possible in the future to obtain them at a regional level. Secondly, there is a need to improve the data on industry level to better distinguish between extractive and other industries. This applies also to data on tourism, which already plays a significant role in many Arctic regions, but is still incorporated in the private services statistics. Lastly, it has also proved hard to calculate quantitatively the economic implications of climate change. Here, more conclusive output from the natural sciences is needed in order to make temperature dependent assessment of the Arctic economy possible. It is also crucial to build economic statistics of input structure (technology) of industries to be able to trace climate impacts on production costs.

In the Arctic, with its population of indigenous people, subsistence activities are very important for providing local food, as well as maintaining social relationships and cultural values. Subsistence activities contribute to consumption possibilities over and above what is measured as recorded consumption in the national accounts. As more attention is brought to the intertwined nature of the market economy and subsistence economy and its importance for the well being of the Arctic people, an important challenge for analysts and policy-makers is to develop measures for the subsistence activities of indigenous people, for example in the form of sustainable development indicators, or as «satellite accounts» to the national accounts.

A crucial question that we have not been able to answer in this report with any accuracy is to what extent climate change impacts and other environmental impacts, as long range transported pollution, will limit the possibilities for traditional subsistence activities in Arctic. Changes in winds, ocean currents and precipitation may have adverse impacts on the fish, birds and mammals belonging to the Arctic region. Melting sea ice will diminish the habitat of animals and the hunting opportunities. Environmental toxins, with high degree of accumulation in northern regions, are found in Arctic animals at increasingly high levels and harm subsistence living. Since environmental impacts of economic activity are not included in GDP, it is a challenge to develop environmental statistics and environmental indicators that can be applied complementarily with economic indicators. More economic production implies a higher GDP, without taking environmental impacts into account. The environmental and social sustainability of production needs to be addressed with the need for precautionary approaches in mind, given the substantial environmental uncertainty.

To conclude, we recommend a continued effort by Arctic statistical agencies and researchers to extract and compile economic, environmental and social statistics for the Arctic regions. There is a clear potential for establishing a wider set of useful data and indicators for the circumpolar Arctic.

The network that has been established as a part of the Econor project consisting of researchers and representatives from the statistical agencies of the Arctic nations should be continued and extended. We also recommend that the Econor project is followed up by more focused studies with a more direct sustainable management application. In particular, we suggest:

- Develop sustainability indicators based on the national accounts for the Arctic regions, and if possible compute these indicators for selected previous years. This will give qualified information about whether the economic development in the Arctic has been sustainable, and will provide a valuable reference for future policy.
- Improve the statistical indicators for disposable income and consumption and develop time series to give a better indication of social welfare within regions.
- Develop welfare measures taking into account the special way of life of the indigenous people of the Arctic. The welfare measures should both be based on the national accounts and on satellite accounts. The welfare measures should among others be used to yield more qualified assessment of the welfare implications of climate change and other forms of trans-boundary pollution.
- Initiate research on climate change and the consequences for future access to Arctic natural resources, with focus on management strategies combining principles of sustainability with an international environmental treaty perspective.

The list above does not at all aim to be complete, and there are certainly more areas that need further study. Taking into account that economic statistics and economic analysis of the Circumpolar Arctic hardly has been produced earlier, there are many tasks that deserve further efforts. However, a stronger focus on the income and welfare issues, resource dependence and sustainable management is to be regarded as a synthesis of the main recommendations from the Econor project.

Previously issued on the subject

Official Statistics of Norway

D 330 Svalbard Statistics 2005.

D 343 Samisk statistikk/Sámi statistihkka 2006.

Recent publications in the series Statistical Analyses

63 O. Vaage: Norsk mediebarometer 2003. 2003. 86s. 180 kr inkl. mva.
ISBN 82-537-6576-2

64 A. Barstad og O. Hellevik: På vei mot det gode samfunn? 2004. 153s. 260 kr inkl.mva. ISBN 82-537-6621-1

65 F.Bruvoll og H. Høie: Naturressurser og miljø 2004. 2004. 239s. 300 kr inkl. mva. ISBN 82-537-6680-7

66 K. Rose Tronstad: Innvandring og innvandrere 2004. 2005. 143s. 210 kr inkl. mva. ISBN 82-537-6701-3

67 K. Rose Tronstad: Immigration and Immigrants 2004. 2005. 127s. 210 kr inkl. mva. ISBN 82-537-6749-8

68 O. Vaage: Norsk mediebarometer 2004. 2005. 86s. 180 kr inkl. mva. ISBN 82-537-6766-8

69 Hundre års ensomhet? Norge og Sverige 1905-2005. 2005 160s. 260 kr inkl. mva. ISBN 82-537-6767-6

70 F. Bruvoll og S.E. Stave: Natural Resources and the Environmental 2004. 2005. 246s. 210 kr inkl. mva. ISBN 82-537-6769-2

71 M. Hansen-Møllerud, A. Kalvøy, G.M. Pilskog og H. Rød: Nøkkeltall om Informasjonssamfunnet 2004. 2005.136s. 210 kr inkl. mva. ISBN 82-537-6793-5

72 E. Ugreninov: Seniorer i Norge. 2005. 175s. 260 kr inkl.mva. ISBN 82-537-6795-1

73 O. Vaage: Norsk kulturbarometer 2004. 2005. 108s. 210 k r inkl. mva. ISBN 82-537-6803-6

74 M. Raabe: Utdanning 2005 – deltakelse og kompetanse. 2005. 300s. 340 kr inkl. mva. ISBN 82-537-6844-3

75 F. Brunvoll, H. Høie og S.E. Stave: Naturressurser og miljø 2005. 2006 268s. 300 kr inkl. mva. ISBN 82-537-6886-9

76 S.O. Pettersen, A. Bårdseth og L. Taule: Kulturstatistikk 2004. 2006. 139s. 210 kr inkl. mva. ISBN 82-537-6891-5

77 A. Alstadsæter, E. Fjærli, I. Melby og A. Walseth: Inntekt, skatt og overføringer 2005. 2006. 153s. ISBN 82-537-6934-2

78 O.F. Waage: Norsk mediebarometer 2005. 2006. 86s. 180 kr inkl. mva. ISBN 82-537-6942-3

79 F. Brunvoll, H. Høie og S.E. Stave: Natural Resources and the Environment 2005. 2006. 272s. 210 kr inkl. mva. ISBN 82-537-6991-9

80 M. Hansen-Møllerud, A. Kalvøy, O.P. Kordahl, G.M. Pilskog og A.H. Solverud: Nøkkeltall om informasjonssamfunnet 2005. 2006. 207s. 300 kr inkl. mva. ISBN 82-537-7000-6

81 E. Mørk: Aleneboendes levekår. 2006. 170s. 260 kr inkl mva. ISBN 82-537-7031-6

82 L. Taule, S. O. Pettersen og A. Bårdseth: Kulturstatistikk 2005. 134 s. 260 kr inkl. mva. ISBN 82-537-7083-9

83 Gunnlaug Daugstad (red.): Innvandring og innvandrere 2006. 164 s. 260 kr inkl. mva. ISBN 82-537-7090-1

84 S. Glomsrød and I. Aslaksen (eds.): The Economy of the North. 99s, 180 kr inkl mva.
ISBN 82-537-7111-8