Birgitta Evengård
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Editors

The New Arctic

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Foreword

The North matters! The Arctic has changed and with it the rest of the world. In a place where fast and widespread climate change is happening in front of our very eyes, perceiving what we see and acting upon it is a tough task that requires large, international bodies to cooperate on a wide scale. At the moment, change in the Arctic is outpacing our ability to understand it, which in turn undermines informed decision-making. Catching up with the myriad of changes to natural, social and political systems is a joint responsibility, which rests on everybody's shoulders – not only the knowledge providers.

The North is a tremendous resource pool. It is extremely rich in minerals and petroleum, as well as renewable resources such as fish, reindeer and freshwater – a much needed reserve for a world facing a looming population of maybe ten billion people. The North is also among our last large tracts of land not transformed by modern development. If you do not know it, it is a fantastic place to visit and to live in. The Arctic is a homeland that benefits from the skills, knowledge, cultural insight and resilience developed throughout generations by its many indigenous peoples and other northerners.

The people of the North are faced with a land that is thawing and eroding, a place where old ice caps are melting, with rougher seas and increased flooding in rivers, as well as invasive species. They face a type of globalisation that can be brutal. Mindsets based on southern solutions, for other types of societal development, are not naturally optimised for developing future ways of life in northern communities. The North needs the capacity (and mandate) to define its own way forward in order to create and secure the basis for a good and sustainable life. We should bear in mind that the region provides many of the ecosystem services and resources so urgently needed by the rest of the world.

The Arctic is currently a zone of peace and cooperation among some of the world's richer developed states. The Arctic Council gives unique status to the indigenous peoples of the North having established binding agreements for the protection of polar bears (1976), search and rescue (2011) and oil spill prevention (2013), and new policy documents and reports are in the pipeline. Regional organisations and instruments for cooperation further strengthen these instruments. The Nordic

Council with its instrument for science cooperation is a shining example of how to collaborate through the identification of emerging and critical questions and showing how to address them.

While the Arctic cannot be saved, it can be handled! The Arctic states have both the resources and good instruments for cooperation; in addition the peoples of the North have the will. The global benefits of the wise stewardship of the North will benefit us all. Such stewardship of the Arctic can also be an important inspiration to other parts of the world. This is particularly so now at a time when humankind needs to find a new way forward for future generations and the healthy stewardship of this truly unique planet.

The Arctic knowledge map has still many 'white spots'; we strongly believe that this book represents 'pathways to the new Arctic', and we trust that it will become an essential guide to new insight and wise action, which is precisely what is needed at a time when the basis for living in the North is being severely tested.

University of the Arctic Dr. Lars Kullerud
Arendal, Norway
ICSU Dr. Peter Liss
Paris, France

Preface

This book is about the Arctic, but what is that apart from a name? We all perceive the Arctic – and for some of us *the new Arctic* – differently based on our own point of departure, be that from an interested general public point of view or from a scientific one. To communicate knowledge of the Arctic, and how it swiftly transforms and interacts with the rest of the globe to a wide audience, is an important part of our objective with this book.

There are plenty of good reasons why we should question the physical and political boundaries that hitherto have defined what the Arctic is and will be. During the course of working with this book, we have found wide support from a broad range of disciplines that together helps support the observed fact that change occurs on all platforms in the new Arctic, in all camps and at all levels, and although the rate of change is faster in some compartments than others, it is, nevertheless, a fact hard to dispute. The deeper we have dug into reflecting on the new Arctic, the more certain we have become that the Arctic needs to be understood from a multitude of angles, with different eyes and viewpoints and with intelligent and complementary scientific insight – and occasionally across multiple timescales.

In this book we have addressed literature, carbon, oceans, governance, history, monitoring, glaciers, legalities, water, expeditions, globalisation, law, health, cooperation, narratives, vegetation, development, tourism, indignity, husbandry, security, food and art. These keywords represent individual pathways to the new Arctic, a place that is and is not, a place that curiously enough is developing in front of our very eyes, but do we understand what we see?

We believe that the contributions that make up this book afford a unique set of keys that can open up doors, known and unknown, that lead to not only new perspectives on the Arctic – the many possibilities and consequences that are arising due to the powers and forces at play – but also to a reaction, perhaps even a coordinated response. By making the critical challenges inherent to the Arctic accessible and intelligible to a wider audience, we dearly hope that responsible action will, in due time, be one outcome.

We thank the authors for their contributions, the reviewers for their corrections, NordForsk for the financial support and Springer for publishing the book. We hope you will come to appreciate it as much as we do.

Umeå, Sweden Birgitta Evengård
Akureyri, Iceland Joan Nymand Larsen
Bergen, Norway Øyvind Paasche
Rovaniemi, Finland

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About the Editors

Birgitta Evengard is a professor in infectious diseases and senior consultant at Umea University in Sweden with a long-term interest in the effects of climate change on health. She is chair of the first Arctic research centre in Sweden, ARCUM, and the author or editor of 10 previous books and 20 book chapters apart from an extensive scientific production. She was the chair of the Arctic Human Health Expert Group, AHHEG, during the Swedish chairmanship of the Arctic Council 2011–2013 when food security and infectious diseases in the North were priorities. Gender equality has also been a major interest for her, both in academic research and in working environment issues.

Dr. Joan Nymand Larsen is an economist, senior scientist and research director with the Stefansson Arctic Institute, Akureyri, Iceland. She has more than 20 years of experience in Arctic research, with specialisation in economic development processes, natural resources and northern sustainability. She has published extensively on the Arctic economy, Arctic human development and quality of life and the socioeconomic impacts of climate change. She is editor of notable publications such as the Arctic Human Development Report: Regional Processes and Global Linkages (2014) and Arctic Social Indicators (2010, 2014) and is coordinating lead author of the polar regions' chapter in the AR5 of the Intergovernmental Panel on Climate Change, Climate Change 2014: Impacts, Adaptation, and Vulnerability.

Øyvind Paasche is the leader of Bergen Marine Research Cluster since 2011 and also the chair of research with the University of the Arctic (UArctic). He has a PhD in Earth Science from the University of Bergen and has been a visiting scientist at the Swiss Federal Institute of Technology (ETH), in Zürich, Switzerland, and also at the Institute for the Study of Planet Earth, University of Arizona. Ha has worked as a scientist with the Bjerknes Centre of Climate Research for many years and was an author on the International Panel of Climate Change (IPPC) report WG-1 (the Physical Science Basis) in 2007. Paasche has published a number of scientific papers on glaciers, floods, weathering and palaeoclimate as well as co-authored a book about the climate system. He is also devoted to popularising science and writes frequently for the national and international press.

About the Authors

Leif G. Anderson is a professor in hydrosphere sciences at the University of Gothenburg, Sweden. His research interests focus around the oceanic carbon cycle, which includes the transformation of carbon, the fluxes within the ocean, the air-sea fluxes and the oceanic sequestering of anthropogenic carbon dioxide. These studies have largely involved high-latitude oceans, at both hemispheres, but also investigations of the Baltic Sea. His experience includes being the first vice president of the Swedish Royal Academy of Sciences, including among other things chairing their environmental committee. He has also been heavily engaged in international Arctic organisations like the Arctic Ocean Sciences Board and the Marine Group of the International Arctic Science Committee and was instrumental in starting up the International Study of Arctic Change.

Jostein Bakke is a professor in quaternary geology at the Department of Earth Science and at the Bjerknes Centre for Climate Research at the University of Bergen, Norway. During his post doc and early career period, he was a visiting scientist at St. Andrews University, GFZ, Poznan, Germany, and at ETH, Switzerland. His research interests are within palaeoclimatology, glacial history, geomorphology and lake sediments. He has taken part in many projects both nationally and internationally and has invested a lot of time on fieldwork in polar areas such as South Georgia, Svalbard, Ural Mountains, Scandinavia and Arctic Norway. In 2011 he was awarded the Fulbright Arctic Chair Award and went to UMASS to build a collaboration and network with US polar researchers. Currently he is the principal investigator on the SHIFTS project looking into the shifting climate states of the polar regions, and he is building a new national infrastructure for earth surface sediment analyses called EARTHLAB and is chairing the Quaternary Earth System group at his department in addition to chairing the PAGES Arctic2K network group.

Arvid Bring is a postdoctoral researcher at the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire, USA. He finished his PhD at the Department of Physical Geography and Quaternary Geology, Stockholm University, in 2013. His main research interest is at the interface between science and policy, with a focus on Arctic issues, the role of scientific information and water and climate change. He recurrently also teaches on managing transboundary river basins, both at Stockholm University and at the UNESCO-IHE Institute for Water Education in Delft, the Netherlands.

Terry V. Callaghan currently holds a Distinguished Research Professorship at the Royal Swedish Academy of Sciences; is a professor of arctic ecology at the University of Sheffield, UK; and is a professor of botany at Tomsk State University, Russia. He started as an Arctic plant ecologist in 1967. He has worked in every Arctic country and had been in the field for 45 years. His research has developed from plant ecology into ecosystem science and environmental change. He has developed several scientific fields and has led many initiatives, contributing to major Arctic and global organisations and environmental assessments including IPCC. In 1967, Terry became part of the International Biological Programme Tundra Biome Project and developed networking skills. For 14 years, he led the Abisko Scientific Research Station in Swedish Lapland and in 2001 developed a network of nine research stations in the North Atlantic Region which developed into INTERACT, a network of currently 65 stations (www.eu-interact.og) that he coordinates. Terry has published over 420 scientific publications and is included as a 'Most Cited Researcher' on the Web of Science. His contributions have been recognised by awards including Honorary PhDs from Sweden, Finland and Russia and medals from H.M. the King of Sweden and H.M. Queen Elisabeth of England and inclusion in the joint award of the Nobel Peace Prize to IPCC in 2007.

Susan Chatwood is the executive and scientific director of the Institute for Circumpolar Health Research in Yellowknife, Northwest Territories; past president of the Canadian Society for Circumpolar Health; and vice president of the International Network for Circumpolar Health Research. She is an assistant professor in the Dalla Lana School of Public Health. She has a Bachelor of Science degree in Nursing from the University of British Columbia, holds a Master's in Epidemiology from McGill University and is a PhD candidate in Medical Science at the University of Toronto with a focus on circumpolar health systems performance.

Georgia Destouni is a professor of hydrology, hydrogeology and water resources at Stockholm University and secretary general of the Swedish Research Council Formas. She is a Henry Darcy Medalist of the European Geosciences Union, member of the Royal Swedish Academy, and member of the Royal Swedish Academy of Engineering Sciences. Among many commissions of trust, Prof. Destouni is Vice President Elect of the International Association of Hydrological Sciences and Associate Editor for Ambio and Journal of Hydrology, and has until recently chaired the Prize Committee for the international Crafoord Prize in Geosciences.

Birgitta Evengard Is a professor of infectious diseases at Umeå University with more than 30 years of experience of clinical and academic work in the field. She moved from a professorship at Karolinska Institutet to the North in 2007 to further develop an increasing interest in the effects of climate change on the infectious disease panorama and health. She has since been co-chair of the Arctic Human Health Expert Group in the Arctic Council and is chair of the newly established board of the Arctic Research Centre at Umeå University, ARCUM. She has more than 120 articles in peer-reviewed journals and has written or been the main editor of ten books and 20 book chapters with themes on infectious diseases.

Viktoriia Filippova is a senior researcher at the Arctic Researches Department, Institute for Humanities Research and Indigenous Studies of the North, Siberian Branch of the Russian Academy of Sciences. She received her PhD in History in 2004. She is Yakut (Sakha) and was born and raised in the Viluy region of Yakutia. Her research interests include history, historical geography, GIS technology, climate change, indigenous land issues, demography and the settlement of indigenous peoples.

Dr. Gail Fondahl is a professor of geography at the University of Northern British Columbia, Canada's northernmost research university. She holds a PhD from the University of California, Berkeley. Dr. Fondahl served as the president of the International Arctic Social Sciences Association from 2011 to 2014 and remains on the governing council of that organisation. She is Canada's representative to, and vice-chair of, the International Arctic Science Committee's Social and Human Sciences Working Group (2011–2015) and co-chair of the Social, Economic and Cultural Expert Group of the Arctic Council's Sustainable Development Working Group (2013–2015). Dr. Fondahl's research has focused the legal geographies of indigenous rights to land in the Russian North, the historical geography of reindeer husbandry in the Russian North and co-management of resources and of research in northern British Columbia. She is currently involved in research on Arctic sustainability, with a focus on cultural and legal dimensions of sustainability. She is coleading the production of the second *Arctic Human Development Report* (AHDR-II), to be published in late 2014.

Bruce Forbes is a research professor at Arctic Centre, University of Lapland, Finland, where he leads the Global Change Research Group, and is a docent in plant ecology/biogeography at the University of Oulu. A geographer by training, he has been conducting field research annually on human-environment relations and land cover/land use change in Arctic regions for 30 years, working in Alaska, the Canadian High Arctic, eastern and western Siberia and Fennoscandia. Specialising in northern Russia since Soviet times, Prof. Forbes's participatory field research involving local stakeholders focuses on northwest Eurasian tundra ecosystems. Recent interdisciplinary topics include (1) resilience in social-ecological systems in cooperation with Nenets and Sámi reindeer herders, (2) social and environmental impacts of hydrocarbon extraction and (3) growth of deciduous shrubs and relation to climate change and reindeer herbivory. He has contributed to major assessments including the IPCC 5th Assessment Report (2014) and is a lead author for the second *Arctic Human Development Report* (AHDR-II, 2014). He holds adjunct positions as institutional fellow, Institute of Arctic Studies, Dartmouth College, USA, and research scientist, Institute of Arctic Biology, University of Alaska, Fairbanks, USA.

Gunnel Gustafsson is the director of NordForsk since January 2010. She served on the board of NordForsk from the start in 2005. In 2005–2010 when she was deputy director general of the Swedish Research Council, she has also served as pro-vice-chancellor of Umeå University, and she is a professor of political science at Umeå University. Her experience includes being a member of several editorial boards, expert and peer review committees, as well as boards of research financing agencies, among them the Bank of Sweden Tercentenary Foundation. During the Swedish European presidency, she very actively planned the conferences that resulted in the Lund Declaration.

Heidi Hansson is a professor of English literature at Umeå University, Sweden. In the last few years, her research has concerned the representation of the North in travel writing and fiction from the late eighteenth century onwards. She was the leader of the interdisciplinary research programme *Foreign North: Outside Perspectives on the Nordic North* where her own work concerned gendered visions and accounts of the North. She is currently completing the study *Northern Genders: Gender, Travel Writing and the Nordic North, 1790–1914*, together with Anka Ryall of the University of Tromsø. Another project deals with the intersection of the Arctic and modernity in literary fiction. She is a member of the board of ARCUM, the Arctic Research Centre at Umeå University.

Christoph Heinze is a marine global biogeochemical modeller. He received his MSc in physical oceanography from the University of Hamburg. In his PhD and habilitation thesis (Max Planck Institute of Meteorology and University of Hamburg), he focused on the role of the marine carbon and silicon cycles within the climate system. He is a professor in chemical oceanography at the Geophysical Institute of the University of Bergen in Norway. He leads the research group on carbon and biogeochemical cycles of the Bjerknes Centre for Climate Research. He coordinated the EU FP6 Integrated Project CARBOOCEAN and currently leads the EU FP7 large-scale integrating project CARBOCHANGE, both aiming at a best possible quantification of anthropogenic carbon dioxide uptake by the oceans. He is head of the Norwegian nationally coordinated project EVA on Earth system modelling of climate variations in the Anthropocene. He has worked as a scientist in Germany, Denmark and Norway and has been visiting scientist at the Lamont-Doherty Earth Observatory (LDEO, USA) as well as the Laboratoire des Sciences du Climat et de l'Environnement (LSCE, France). He is a steering committee member of the IGBP core project SOLAS (Surface Ocean Lower Atmosphere Study).

Lee Huskey is an emeritus professor of economics at the University of Alaska Anchorage. He has been with the university since 1978. He has served as chair of the university's Economics Department, director of the Experimental Economics Program and acting director of the Center for Economic Education. He is a former president of the Western Regional Science Association. Professor Huskey's main area of research is the economics of remote regions, in particular the regions of Alaska. His current research focus is migration in the regions of the circumpolar North. He has been the principal investigator for two major research projects on migration in Arctic Alaska and around the circumpolar North. He has published a number of papers on the special economics of remote economies, the Arctic economy, migration in Alaska, Alaska's economic development and the teaching of economics. He has edited two books on population change in remote regions. He has also co-authored two comic books designed to teach economics principles to middle school students. He earned his PhD and MA in Economics from Washington University in St. Louis, Missouri, and he holds a BA in Economics from the University of Missouri.

Jerker Jarsjö is an associate professor in hydrology and hydrogeology at the Department of Physical Geography and Quaternary Geology at Stockholm University (SU) and is author of about 100 scientific publications in international journals, books and report series. He is leader of the water and climate research area at the Bolin Centre for Climate Research and responsible for SU's MSc programme in hydrology, hydrogeology and water resources. His research focuses at hydrological and hydrogeological model interpretations of groundwater – surface water interactions, contaminant transport and water quality under changing hydro-climatic conditions.

Margareta Johansson is based at the Department of Physical Geography and Ecosystem Science at Lund University and at the Royal Swedish Academy of Sciences in Sweden.

Dr. Johansson has a broad experience in Arctic research, ranging from glaciology/climatology to Arctic ecology, and for the last decade she has been focussing on permafrost in a changing climate in northern Sweden. Her research experience includes helping to coordinate major environmental assessments such as a chapter in the Arctic Climate Impact Assessment (ACIA) (www.acia.uaf.edu) on terrestrial ecosystems and international networks such as Circumarctic Network of Terrestrial Field Bases (SCANNET). She is currently the executive secretary for an FP7 EU project INTERACT networking more than 60 research stations in the North (www.eu-interact.org) and for a Nordic top-level research initiative DEFROST (www.ncoe-defrost.org) and was a co-coordinator of the Permafrost Young Researchers Network (PYRN) during 2006–2008 when it was initiated. Dr. Johansson was one of two convening lead authors for two chapters (snow and permafrost) of the AMAP SWIPA assessment (Snow Water Ice and Permafrost in the Arctic www.amap.no/swipa) that is a follow-up on the Arctic Climate Impact Assessment but is focussing on the cryosphere. The SWIPA report was published in December 2011.

E. Carina H. Keskitalo is a professor of political science at the Department of Geography and Economic History, Umeå University, Sweden. She has published widely on the construction of the Arctic as a political region through region building and on environmental and resource politics. She is the scientific coordinator of the new Swedish social and human sciences programme on the Arctic, focused on northernmost Europe.

Sergey N. Kirpotin graduated from Tomsk State University (1986), with a PhD in Botany (1994) and a Doctor's degree in Ecology (2006), and was professor of the Botany Department (1998–2003); dean of the Faculty of Biology and Soil Science, Tomsk State University (TSU) (2003–2013); vice-rector for International Affairs; director of the Centre of Excellence 'Bio-Clim-Land' (from 2013), National Research Tomsk State University; Russian coordinator of French-Russian Groupement de Recherche International (GDRI) 'CAR WET SIB Biogeochemical cycle of carbon in wetlands of Western Siberia' net project (from 2007); coleader of mega-grant 2013 (Bio-Geo-Clim); and Russian coordinator of the Russian-French Centre (2013) in the field of environment, climate, continental surface and biosphere, grouping the CNRS, 20 French Universities, the SB RAS and 14 Siberian Universities, which was created under the name of 'French-Siberian Centre for Education and Research'.

Anders Koch is a senior researcher at the Department of Epidemiology Research, Statens Serum Institut, and fellow at the Department of Infectious Diseases, Rigshospitalet, Copenhagen, Denmark. At the Serum Institut he leads the department's research activities in Greenland, mainly in infectious disease epidemiology. Anders holds a PhD (2000) and a Master of Public Health (2009) degree from the University of Copenhagen and is a specialist in infectious diseases. He has published several scientific publications on a range of infectious diseases in the Arctic, has co-authored two book chapters and has supervised a number of PhD and undergraduate students. Anders is chairman of the Danish Greenlandic Society for Circumpolar Health and vice president of the International Union for Circumpolar Health.

Timo Koivurova is a research professor and the director of the Northern Institute for Environmental and Minority Law, Arctic Centre/University of Lapland. As a legal researcher, he has worked on issues related to, e.g. environmental impact assessment, climate change law, mining law, the interplay between different levels of environmental law, legal status of indigenous peoples, etc. Professor Koivurova has done general work in these issue areas but especially focused on one in the Arctic region. He has led many international research projects and served in several scientific publications (e.g. as an editor in chief of the Yearbook of Polar Law, Brill). Mr. Koivurova has also been involved as an expert in several international processes globally and in the Arctic region.

Liza Mack is a PhD student in indigenous studies at the University of Alaska Fairbanks. She received her Bachelor of Arts and Masters of Science in Anthropology from Idaho State University. She is Aleut and was born and raised in the Aleutian Islands. Her research interests include indigenous land and fisheries rights, traditional ecological knowledge, native cultures and contemporary issues and political ecology. She is currently working on her dissertation research with Alaskan native leaders in the Eastern Aleutians.

Dieter K. Müller is professor of social and economic geography and dean of the Faculty of Social Science, Umeå University, Sweden. His research interest is into tourism in rural and peripheral areas and the Arctic in particular. He has recently published on indigenous tourism, Arctic national parks, tourism labour markets and tourism and regional development in northern Sweden. He is the coeditor of *Polar Tourism: A Tool for Regional Development* (together with A. Grenier) and *New Issues in Polar Tourism* (together with L. Lundmark and R.H. Lemelin). Currently he serves on the steering committee of the International Polar Tourism Research Network (IPTRN). He is also the chairperson of the International Geographical Union's (IGU) Commission for the Geography of Tourism, Leisure and Global Change.

Lena Maria Nilsson is a research coordinator at the Arctic Research Centre at Umeå University and has a PhD in Public Health (2012), with her thesis focusing on traditional Sami lifestyle factors as determinants of public health. Since autumn 2012, she is involved in an Arctic food and water security project, initiated by the Arctic Human Health Experts Group within the Arctic Council. So far, this project has resulted in one report, one chapter in the Arctic Resilience Interim Report 2013 and five published peer-reviewed papers. Overall, at the end of 2014, Nilsson had written or contributed to 26 peer-reviewed and five popular science papers and four book chapters. Nilsson is the secretary of the Nordic Society for Circumpolar Health and a member of the steering group of NEON, the Nordic nutrition epidemiological network. She is also a deputy board member of the Centre for Sami Research at Umeå University (CeSam). Based on her broad expertise, Nilsson is often invited to speak to both scientific and public audiences.

Douglas Nord is a professor of political science and an established scholar in the fields of international relations and comparative politics. His areas of specialty include the foreign and northern development policies of Canada, the Nordic states and Russia as well as the USA. He has written extensively on the relations between the countries of the circumpolar North and on the emergence of the Arctic as a central concern of contemporary international politics. Professor Nord received his undergraduate degree in International Relations from the University of Redlands and his MA and PhD in Political Science from the Duke University in the USA. He has lectured at several universities in Europe, Asia and North America. He served as the founding dean of the Faculty of Management and Administration at the University of Northern British Columbia in Canada. In 2013 he was a Fulbright research scholar at the Umeå University in Sweden where he conducted a study of the Swedish Chairmanship of the Arctic Council, published in bookform.

Mark Nuttall is a professor and Henry Marshall Tory Chair of Anthropology at the University of Alberta and professor of climate and society at the University of Greenland and Greenland Institute of Natural Resources, where he heads the Climate and Society Department. He has carried out extensive research in Greenland, Canada, Alaska, Finland and Scotland. He is a principal investigator of the EU-funded project ICE-ARC (Ice, Climate, Economics – Arctic Research on Change).

Dr. Joan Nymand Larsen is a senior scientist and research director at the Stefansson Arctic Institute, Akureyri, Iceland, and she is also with the Faculty of Social Sciences, and the Polar Law Programme, at the University of Akureyri, teaching economics and Arctic studies. She received her PhD in Economics from the University of Manitoba, Canada, with specialisation in economic development and natural resource-based economies of the North. Her background includes many years of researching and publishing on the Arctic economy, human development and quality of life in the North. Her current research focuses on the study and assessment of living conditions and quality of life across the circumpolar region; the construction, measurement and testing of Arctic-specific social indicators and human-based monitoring systems; and the socioeconomic impacts of climate change in the Arctic. She has been leading and coordinating the work on the first and second volumes of the Arctic Human Development Report (AHDR) and Arctic Social Indicators (ASI) reports. In recent years her work has increasingly been focused on the socioeconomic impacts of climate change and options for adaptation and sustainable futures in local communities in the Arctic. She is coordinating lead author for the polar regions' contribution to the 5th Assessment Report (2014), WG-II, of the UN Intergovernmental Panel on Climate Change (IPCC), Climate Change 2014: Impacts, Adaptation, and Vulnerability.

Are Olsen is an ocean carbon cycle researcher, focusing on air-sea carbon fluxes, ocean carbon inventory changes and implications for ocean acidification and stable isotope distribution. He has authored/co-authored more than 50 publications in the international peer-reviewed literature. Dr. Olsen is heavily engaged in international coordination and synthesis activities. He is a scientific steering group member of the SCOR/IOC International Ocean Carbon Coordination Project; member of the CLIVAR Global Synthesis and Observations Panel, the global coordination group of the Surface Ocean CO_2 Atlas (SOCAT); and chairs the GLODAPv2 synthesis effort.

Øyvind Paasche has a PhD in Earth Science from the University of Bergen and has been a visiting scientist at the Swiss Federal Institute of Technology, in Zürich, Switzerland, and also at the Institute for the Study of Planet Earth, University of Arizona. He is currently the leader of Bergen Marine Research Cluster and also the chair of research of the University of the Arctic. Prior to this he worked several years as a scientist at the Bjerknes Centre of Climate Research. He was an author on the IPCC report WG-1 (the Physical Science Basis) in 2007 and has published a number of scientific papers on glaciers, floods, weathering and palaeoclimate as well as a book about the climate system. He is also devoted to popularising science and writes frequently for the national and international press.

Alan Parkinson, PhD is a deputy director of the Arctic Investigations Program and director of the Alaska Area Specimen Bank. Dr. Parkinson earned his PhD in Microbiology in 1976 from Otago University, Dunedin, New Zealand. He undertook a postdoctoral fellowship at the Oklahoma University Health Sciences Center where he developed laboratory methods for studying infection and immunity in persons living at the South Pole Station, Antarctic. He joined CDC in 1984, in the hope of working in a warmer environment. He was assigned to Alaska, to serve as AIP's laboratory chief, where he modernised and expanded the laboratory-based diagnostic and surveillance systems. Dr Parkinson was instrumental in establishing the International Circumpolar Surveillance system in 1998. This system links public health laboratories and institutions in Arctic countries to monitor infectious disease threats. Other areas of interest are the promotion of circumpolar health internationally using working groups of the Arctic Council, a ministerial forum of the eight Arctic countries, and nationally within the US Interagency Arctic Research Policy Committee.

Yana Pchelintseva is a journalist and a researcher in the laboratory 'Bio-Geo-Clim' in Tomsk National Research State University, Russia. She is interested in science journalism, and her main research is at the problems of describing climate change in media. As a journalist she works on texts about the expeditions and other scientific activities of the laboratory that is focused on biogeochemical and remote methods for monitoring the environment. She is also a correspondent of the university's newspaper.

Andrey N. Petrov is an associate professor of geography and director of the Arctic Social and Environmental Systems Research Laboratory (ARCSES) at the University of Northern Iowa in Cedar Falls, IA. He is a member of the IASSA Council and a US representative on the International Arctic Science Committee's Social and Human Sciences Working Group. Andrey's research is mostly related to economic geography, socioeconomic impact assessment, human wellbeing monitoring and sustainable development in the Arctic.

Arja Rautio, MD, PhD, ERT is a research professor and has been working in the field of circumpolar health since 2006. She is a director of the Centre for Arctic Medicine at the Thule Institute (www.oulu.fi/thule) in the University of Oulu (Finland). She is leading several research projects and the international Master's and Doctoral programmes of Circumpolar Health and Wellbeing. She is a chair of the University of the Arctic Thematic Network of Health and Wellbeing in the Arctic (www.uarctic.org). Her research focuses are in climate change, environmental health, indigenous health and wellbeing. Dr Rautio is working as a national key expert in the AMAP and SDWG Human Health Expert groups in the Arctic Council. She has been nominated as a national member to the IASC – Social and Human Sciences Group.

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Polar Region – Norden beyond Borders, ed. S. Sörlin (London: Ashgate, 2013); *The Future of Nature*: *Documents of Global Change*, coed. with Libby Robin and Paul Warde (New Haven, CT: Yale University Press, 2013); and *Northscapes: History, Technology, and the Making of Northern Environments*, coed. with Dolly Jörgensen (Vancouver: University of British Columbia Press, 2013).

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Chapter 1
Paths to the New Arctic

Birgitta Evengård, Øyvind Paasche, and Joan Nymand Larsen

Abstract In the late eighteenth century explorers and scientists started venturing into the Arctic beyond areas that were already populated by Indigenous peoples and a smaller number of new settlers, and ultimately towards the North Pole. It was about as far as anyone could get from civilization at the time, and in many respects it remains this way to this day.

What the first explorers saw had not yet been seen and recorded by Western civilization. They were the first to tell the stories and document the state of the Arctic – its physical landscape and Indigenous cultures. The prosaic descriptions are many and colourful, moving and poetic, and they also soon began to provide detailed accounts of the state of Indigenous living conditions. A shared feature in these first accounts, in prints and in paintings, is the descriptions of a harsh and barren landscape frozen in time; static and unchangeable, except for the swift sways in weather. Fanciful images of indigenous communities in isolated settlements, without any contact with "western civilization" came to shape the following generations perception of the Arctic.

While the Arctic gradually became a place where new maps and lines drawn became a reality to outsiders, it was also, and had been for thousands of years, the homeland for many and diverse groups of indigenous peoples, surviving in at times unforgiving conditions while developing vibrant cultures, including strong traditions for adapting to changing conditions. The storytelling is today highly valued by itself and for its importance as a complement to science. And northern art has become more vibrant than ever as shown in some chapters here integrating the changes occurring on so many grounds.

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It is time for new images of the region to be established. With this book we wish these new images and the new knowledge constantly being produced to reach a broad audience as the interested general public as well as policy-makers and scientific colleagues.

Keywords New images • Indigenous peoples • Sustainability • Climate change • Global impacts

1.1 Introduction

Permanence is but a word of degrees, (Ralph Waldo Emerson, *Circles 1841*)

The pristine quality of the icy, and very sparsely inhabited Arctic was unmatched outside of the region (apart from the South Pole), and was therefore also largely perceived as unchangeable by the early explorers. Fritjof Nansen (1861–1930) described it as the "eternal death-stillness of the ice", a place where man met and tested himself (and his limitations) against precisely the unchangeable nature.

Outside of the region, the image of a static Arctic nature prevailed for a long time. In fact, during the 1960s and 1970s the discussions about a new Ice Age were higher on the political and scientific agendas than discussions of an ice-free Arctic. They were not focused so much on the physical changes but at least as far as the Arctic states were concerned, more on achieving a cost-effective development in local Arctic communities.

Little attention was devoted to the environmental and human impacts of change, and the whole concept of an Arctic without sea ice and glaciers would have been considered obscure, if mentioned or discussed at all. The idea of an Arctic capable of rapid non-linear response to changing environmental and climatic forcing mechanisms such as for instance carbon dioxide, and methane, was unheard of even in the scientific community.

Today the picture of the Arctic is very different. Few other places on Earth are experiencing the magnitude and rate of natural change seen in the Arctic, and with such profound implications for biophysical and human systems – increasingly pressing against the region's ecological boundaries. This change is intimately linked to the *zero degree isotherm*, which determines whether snow melts or not. Appreciating the difference between an ice and snow covered surface and a bare surface, be that ocean or ground, is tangible and easy to grasp. Recognizing that this difference is bound to have implications for animals, people, Arctic flora and for the local climate does not require a scientific investigation or yet another expedition–it's there in the open, starring back at us; a rapidly changing Arctic on pathways to the new Arctic.

For anyone visiting or making their way through the Arctic today, it is clear that it has become a region that is culturally, politically, demographically and economically diverse. Today settlements are ranging from small, predominantly indigenous communities, to large industrial cities. At the same time, the Arctic and its people are facing drastic change. Given the close dependence on natural resources, the aggregated impacts of globalization and climate change is already being felt and are, by most scientific standards, expected to have immediate and significant consequences for Arctic populations and local communities, but also well into the distant future.

The situation and landscape today is far removed from that encountered by early explorers such as Knud Rasmussen (1879–1933) and Vilhjálmur Stefansson (1879–1962); it is one of Arctic societies and cultures faced with many stressors and complex challenges with the combined effects of environmental processes, cultural developments, and economic and political changes. From a distant past of isolation, the Arctic today has been transformed into a global player with its once distant and economically unviable resources of the far north being linked to global markets more closely and intricately than ever before, and thus playing an increasingly important role in the world economy. They constitute a new and widening frontier of investment and industrialization firmly placed in a global context.

Today, environmental conditions such as snow cover, sea ice, and river runoff or wave erosion affect nearly all aspects of life from housing, infrastructure, to hunting and fishing. Global change impacts are experienced on community infrastructure, food and water-security, human health, culture and tradition, market and non-market economic activity. These impacts have far reaching consequences for many of the Arctic region's narrowly resource-based local and regional economies, impacting on employment opportunities, distribution of income and wealth, and the allocation of resources. The image of an isolated and economically disconnected society is no longer valid.

In this book we attempt to move the Arctic discourse on global change impacts forward by bringing together a variety of Arctic scholars, each with their own scientific background, approach, and understanding of the Arctic, and with their views on what drives change, why, and how, in an effort to create a composite picture where insights from different disciplines can be intertwined and woven together. Looking at just one explanatory variable, when one is seeking to adequately explain observed change, tends to imply that one treats change in a vacuum. In seeking answers to questions of Arctic change, today's scientific community understands the importance of working together across disciplines and with communities and local inhabitants to further enhance our understanding of the complexity of change.

In the Arctic, given the complex interactions of multiple-stressors, a strategy of studying change in a vacuum quickly becomes susceptible to erroneous conclusions. The rate of change in environmental and socio-economic systems is outpacing our current knowledge and understanding of these systems, and therefore an interdisciplinary and integrated approach must be a prerequisite if a more complete picture of Arctic change is to be constructed. It is this gap in knowledge, and the desire for integrated approach as the basic framework for understanding the new Arctic that has become a central piece of inspiration for this book. Transforming this new knowledge into a toolbox that can be put to good use is a different, though necessary, step forward.

It is our impression that the scientific community today recognizes the importance of complex interrelationships among major drivers of change, but still find it hard to practically move forward, especially in truly cross-disciplinary ways.

Often immediate challenges stem from many physical, biological or social agents. Each process or phenomenon should therefore be viewed from as many competing and complementary perspectives as possible. The scientific community and others today view the integration of knowledge across scientific fields and boundaries as critical, although for different reasons.

The holistic perspectives of Indigenous cultures suggest that efforts to understand, manage, and respond to change in Arctic systems stand to benefit from the integration and complementarily of a variety of approaches, including scientific and traditional. In fact, recognizing the value of traditional ecological knowledge may contribute to enhanced resilience and adaptive capacity in local communities as demonstrated by a growing body of scientific literature. Also the Arctic today cannot be fully understood without placing it in a global context, and the level of global connectivity is changing rapidly, as for example evidenced by increased shipping or downstream geopolitical consequences of prospecting for onshore and offshore minerals.

How we handle scientific information about a natural system that is undergoing profound and far-reaching changes, and subsequently address the question of Arctic change, has become a key political question to which no single nation or region alone currently holds an adequate answer. The reasons why are manifold, but one important aspect specifically relates to the uncertainty that follows *en suit* any prediction about present as well as future changes in the Arctic.

This ‘encompassing uncertainty’ is often referred to in relation to so-called ‘tipping points’: the identification of critical thresholds when the climate system, or components within it, becomes irreversible. The complexity of tipping-points, how to, if at all, identify precursors remains an open, partly unresolved question within climate science. It is interesting to note that what is commonly referred to as ‘irreversible change’ is made irreversible precisely because of anthropogenic emissions of greenhouse gasses, whereas the defined change in the natural systems itself is in fact similar to how systems have changed in the past.

A huge push forward in our understanding of change in the Arctic region happened during the large-scale scientific effort of the International Polar Year (IPY) 2007–2008 when resources were pooled together by numerous countries in order to define and address questions across a wide variety of scientific disciplines. Coordinated, international projects brought scientists from different countries together and through this encouraging effort important observations were made and insight into fundamental processes gained. A new generation of polar researchers was trained and educated through challenging field operations, expeditions, and community studies. This raised a new awareness among polar researchers that biophysical and societal change is taking place faster than ever before and at rates beyond what anyone expected, with the sum of these changes altering fundamentally the way we perceive and think about the Arctic.

The climate system has no preference for whatever state it is in. Whether sea ice extent is ten or two million square meters makes no difference. It is what it is. It is always in motion. And regardless of what we do with respect to mitigation of greenhouse gases, the Arctic will continue to change because the carbon cycle will ensure that the anthropogenic contribution will have an impact in all foreseeable future. What's more, it is predicted that the largest change is yet to come – climate surprises stored and stocked in the polar pipelines. While current and projected climate change cast dark clouds over Arctic futures, there are, however, also opportunities associated with the climate trends projected for the next 50–100 years which can help local communities in prospering.

It is our willingness or rather capacity to adapt, which in the long run will decide whether the consequences of on-going and anticipated climate change will be largely positive or negative. And here the aspect of time must be considered. Activities with expected short-term beneficial impacts might have long-term negative consequences, such as resource development activities that may generate short-term economic benefits, but at long-term costs to the environment and local communities.

The impacts of climate change on all aspects of our lives add an additional challenge in decision-making. Climate change will have bearing on water-security, food-security, and also indirectly on infectious disease patterns, poverty, governance, and gender, and not just sea ice and phytoplankton production.

There are many different people living in the Arctic, and about one-tenth belongs to an Indigenous group. Indigenous peoples tend to live closer to and depend more on nature than other Arctic residents, and therefore may be more exposed to the consequences of climate change than others. This fact has implications for various rights and developments in political and economic autonomy in connection with the use and ownership of land and resources. This also raises the importance of outcomes in the changing balance of powers among different groups and stakeholders in the Arctic. The human rights side of the change occurring in the Arctic are of uttermost importance as many argue that the peoples of the Arctic have the right to live the lives they are accustomed to, and which many chose, and this without having to pay for the consequences of the lifestyles people live in countries in other parts of the world – such as consequences that are increasingly visible in the Arctic with the growing amounts of CO_2 in the soils, the seas and the air.

To most observers it seems self-evident that the expansion and conduct of new and existing industries in the Arctic must be adapted to the pristine and fragile environment that is already there, but what does sustainability mean in a natural system that is rapidly changing? Can it even be parameterized in a meaningful ways?

The increased acidification of the Arctic waters following from unabated CO_2 emissions will reset the premises for how these waters should be managed not least because more acid waters will impact the very foundations for life, primary production, fish stocks and so forth. Similarly, an enhanced hydrological cycle will impact the temporal and spatial distribution of snow and rain, which is of imperative importance to everything from reindeer herding to tourism to hydropower. Another aspect, which poses an equally serious threat to careful and sustainable management, is the spectre of nonlinearity, which in due course might allow for tipping points to be reached. How do we add the peculiarity called tipping points into a well-organised and carefully thought out management plan?

Although there is no easy answer to this and other questions raised here, it is becoming increasingly clear – and can be read both along and between the lines in many of the texts in this book – that sustainability needs to be considered carefully and re-approached with the insight afforded by scientific disciplines that may not always mix perfectly. A dynamic and adaptable approach will be pivotal for a sustainability scheme that will strive for success in the time to come. Another and often overlooked aspect, is that the Arctic due to its sheer size and at times inaccessibility, is best served by transnational programs that allows for data gathering, surveys and monitoring to take place across national boundaries. Following up on the IPY momentum created between 2007 and 2008, such as the Nordforsk program on Arctic change, will be critical if the science community at large can tie down uncertainties and increase the robustness of new knowledge.

As this book will show, climate change has – in combination with an unprecedented industrial push – become a remarkable scientific catalyst for new ideas, research projects and collaborative efforts that have transcended disciplinary boundaries.

In the wake of this new and stimulating wave of scientific interests a new generation of young researchers are stepping onto the stage, and many of whom perhaps have or will develop a broader and more holistic take on the Arctic. This is promising.

We welcome this renewed interest in the Arctic, and we feel confident that this book with all its rich and profound intellectual insights will ignite new thoughts and novel perspectives on change in the Arctic. Admittedly so we even hope the scientific snapshots that make up this book can lead to ways forward, and solutions that can help secure a sustainable future for the new Arctic. As we seek to demonstrate with this volume, the Arctic is not a piece of a large and composite puzzle, but rather it is an integrated part of an ever more connected World. Having moved far since the initial footsteps of the early explorers in the Arctic, today we must acknowledge that Arctic change matters to all of us – in the Arctic and far beyond.

Chapter 2
Indigenous Peoples in the New Arctic

Gail Fondahl, Viktoriya Filippova, and Liza Mack

Abstract This chapter provides a brief introduction to the Indigenous peoples of the Arctic by focusing on three issues of crucial importance to these peoples: self-governance, rights to land and resources, and traditional knowledge. We first note the diversity of Indigenous groups populating the Arctic, and discuss 'who is Indigenous', in terms of recognition/definition employed by the various Arctic states. We then consider recent developments in each of the three areas of focus, illustrating our broad-spectrum characterizations with concrete examples drawn mainly from North America and the Russian North. We underscore advancements in Indigenous self-governance, land and resource rights and the recognition of traditional knowledge in the Arctic but also acknowledge the uneven landscape of how these are realized across the Circumpolar North. The chapter is co-authored by three scholars, two of whom are Indigenous Northerners.

Keywords Indigenous • Self-governance • Land rights • Traditional knowledge

As other chapters in this book recount, the Arctic is undergoing substantial and accelerating change. When we hear the terms 'Arctic' and 'change', our thoughts often turn quickly to climate change, which has become the principal narrative regarding the Arctic. Yet cultural, social, political, and economic changes are also greatly affecting the lives of the Arctic's residents and especially its Indigenous peoples. Indeed many Indigenous northerners will note that their ancestors have for millennia adapted to what has always been a dynamic environment, and that it is other external drivers of change, such as resource development and

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industrialization, communications technologies, and in-migration, that are more difficult to accommodate. Issues of access and rights to land and resource, questions of cultural vitality, including language retention and the intergenerational transfer of Indigenous knowledge, disparities in health outcomes compared to non-Indigenous populations, and the quest for greater self-determination loom large as key concerns of Indigenous people (AHDR 2004; AHDR-II 2014). This is not to downplay the importance of climate change, but rather to underscore that it is but one of numerous challenges facing Indigenous peoples in the Arctic today.

The goal of this chapter is to introduce the reader to the Indigenous peoples of the Arctic, and to explore briefly a few of the obstacles and opportunities that the changing 'New Arctic' presents to its First Peoples. We choose to focus on three areas of change that are of key concern: self-governance and political participation, changing rights and access to lands and resources, and traditional knowledge (including language). Other crucial topics such as health and well-being and food and water security are addressed in other chapters of this book (including, but not exclusively for, Indigenous peoples). Geographically we focus in this chapter on the North American and Russian Norths, to complement the coverage of northern Sápmi/Fennoscandia and Greenland elsewhere in this volume (see especially chapters 3 and 4 by Thisted and Sköld).

2.1 Who Are the Arctic's Indigenous Peoples?

Of the estimated approximately four million people who inhabit the Arctic, approximately 10 % are Indigenous. This proportion varies greatly across the Arctic. For instance, Inuit comprise about 85 % of the population of Nunavut, Canada, and the great majority of Greenlanders are Indigenous as well, while in other areas, such as the Khanty-Mansi Autonomous Okrug of Siberia, Indigenous peoples make up less than 2 % of the population.

Given its areal extent, it is no surprise that Indigenous groups in the Arctic are culturally and linguistically diverse (Fig. 2.1), as well as varying in terms of size of population. The Inuit cover a vast expanse of the Arctic, from the edge of Asia in the Russian North across Alaska and Canada to Greenland. Within this group, as might be expected across such space, there are marked dialectical differences and variations in cultural adaptations to local environments. Straddling a much smaller area, but still four countries (Norway, Sweden, Finland and Russia), the Sámi also display linguistic and cultural diversity, as do widely distributed groups as the Evenki (in the Russian Federation) and Dene (Canada/Alaska).

Alaska is home to numerous Indigenous peoples other than the Inuit, including the Aleut, Yup'ik, Tlingit and several Dene-language peoples (Ahtna, Deg Hit'an [Ingalik] , Dena'ina [Tanaina], Doogh Hit'an [Holikachuk], Dichinanek Hwt'ana [Kolchan], Eyak, Gwich'in [Kutchin], Hän, Koyukon, Tanana). The Canadian North's Indigenous peoples include, as well as the Inuit, Cree peoples, several Dene-language peoples (Deh cho [Slavey], Denesuline [Chipewayn], Dunneza [Beaver],

Fig. 2.1 Indigenous peoples of the Arctic [map] (free to use: http://www.grida.no/graphicslib/detail/demography-of-Indigenous-peoples-of-the-arctic-based-on-linguistic-groups-major-groups_bbd8)

Gwich'in, Hän, Kaska, Sahtu [Hare], Tagish, Tlicho [Dogrib], Tutchone,) and the Innu. The Russian Federation is homeland to over 40 Northern Indigenous groups, including as well as the Sámi and 'Eskimosy' (Inuit/Yuit), the Nentsy, Khanty, Mansi, Selkup, Evenki, Even, Dolgan, Yukaghir, Chukchi, Aleut, Itelmen, and numerous others. These people vary widely in language and culture. Within some of the more widely distributed peoples, sub-groups have strong place-based identities.

Who is Indigenous is not a simple question. As well as being culturally diverse, Indigenous peoples differ in terms of their legal status and levels of self-governance. While international norms call for the right of self-identification, Arctic countries employ a variety of definitions. Indigeneity in Alaska, according to US legal protocols, is based on blood quantum. Speaking Sámi, or having a parent or grandparent who spoke it, serves as a criteria for determining who has the right to vote in the Sámi Parliament, in Norway, Sweden and Finland. The Russian Federation legally recognizes a group of "Indigenous numerically small peoples of the North". Criteria for groups to be recognized as such include "living in the regions of the North, Siberia and the Far East on the territory of traditional occupancy of their ancestors; maintaining traditional ways of life, economy and trades; numbering less than 50,000 persons, and considering themselves distinct ethnic communities" (Ob obshchix 2000). The numerically larger Indigenous Sakha (Yakut), Komi and Karelian peoples, each of whom number over 50,000 individuals, are not categorized as 'Indigenous' under this definition and thus are not the subjects of the specific legal protections that we describe below for Russia's "numerically small peoples of the North".

Added to this diversity of definitions are different state approaches to counting Indigenous populations within their boundaries. The Fennoscandian states do not collect information on ethnicity in their censuses, and the Russian Federation recently ceased to require this information as well. Greenland considers anyone born in Greenland a 'Greenlander', irrespective of ethnic identity. Thus it is impossible to give an absolute answer to the question of "how many Indigenous people are there in the Arctic?"

The Arctic Indigenous population tends to have a higher birthrate than its non-Indigenous counterpart. Unfortunately, infant mortality is also higher and life expectancy lower. Indigenous populations in some parts of the Arctic experience significantly higher levels of suicide and homicide. Rates of tuberculosis greatly exceed those in the south, in both the North American and Russian North, though not in the Fennoscandian North. The average life expectancy of Indigenous northerners in both Alaska and the Russian Federation is over a decade less than that for non-Indigenous northerners. (In Russia life expectancy for both groups is about a decade less than that in Alaska.) Many of the Indigenous peoples in the Russian Arctic have seen absolute decrease in their numbers over the past decade, due to declining birth rates and high mortality rates.

Indigenous cultures have undergone tremendous transformation, under the influence of state education policies (including those of language repression), the influence of exogenous religions, sedentarization, and forces of globalization. Traditional family structures have changed, as have socio-economic activities.

Arctic First peoples are commonly typecast as hunters, gatherers and reindeer herders, dependent on subsistence and living off the land. Such land- and sea-based activities still have great cultural significance for many, and ties to the land are often said to a defining attribute of Indigenous identities. Yet increasing numbers of Indigenous persons are part of the wage-earning labour force, as teachers, lawyers, musicians, manicurists, heavy machine operators, etc. Many now pursue 'traditional activities' as secondary pursuits or enjoy benefitting from the subsistence activities of their relatives. In northern Canada and Alaska, compensation payments for land title extinguishment have provided investment capital for Indigenous entrepreneurs, who have started a whole range of businesses, from guide-outfitter/tourism businesses to construction companies to airlines (Nordregio 2011).

While many of the North's small rural communities are predominantly native, Indigenous peoples increasingly live in urban centres. They migrate for better educational opportunities, for employment prospects, or sometimes for access to social services (Christensen 2013). Migration is gender-biased, with Indigenous women moving away from small, rural settings in greater numbers than men – who remain involved in 'traditional activities' to a greater degree (Heleniak 2014).

Finally, it merits underscoring that many individuals of Indigenous heritage in the Arctic are of mixed heritage and have 'mixed identities'. And whether of mixed heritage or not, it is common to have multiple identities. Identities are of course constructed – and reconstructed over time. Moreover, they are contextual, and often strategic, depending on the social, cultural and political milieu in which the person finds herself (see Schweitzer et al. 2014). Given forces of colonialism, globalization, rural-urban migration, socialization, ethno-political empowerment, to name a few, a person may choose to invoke different aspects and scales of her identity (e.g. Tlicho, Irish, northern, Dene, Canadian, Indigenous) – and/or may have such an identity inscribed upon her by others. This reality of course further complicates addressing the question 'Who is Indigenous' and quantifying Indigenous populations in the Arctic.

2.2 Self-Governance and Political Participation

The United Nations Declaration on Indigenous Peoples adopted by the UN General Assembly in 2007, lays out the rights of Indigenous peoples to culture, language, identity, health, education, employment and other critical issues (UNDRIP 2007). Article 3 recognizes Indigenous peoples' right to self-determination: "to freely determine their political status and freely pursue their economic, social and cultural development." Article 4 affirms their right "to autonomy or self-government in matters relating to their internal and local affairs," while Article 5 protects their right "to maintain and strengthen their distinct political, legal, economic, social and cultural institutions."

Arctic Indigenous groups self-governed for centuries. However, new forms of governance were imposed upon these groups following their encapsulation into the various Arctic states. They were often treated as 'wards of the state' with very little power to make decisions about their lives and lands. Resistance to such domination, while ever present, grew in strength over the past half-century and since the 1970s the Arctic's Indigenous peoples have made significant gains in both self-governance and in political participation at the national and international level. Devolution of power has been a trend across most of the Arctic in the past quarter-century. Greenland has increased its autonomy from Denmark, achieving 'Home Rule' in 1979, and 'Self-Rule' in 2008. Nunavut became a reality in 1999, separating from the Northwest Territories and becoming a separate territory within Canada. While Greenland and Nunavut governments are public governments, they are also *de facto* Indigenous governments, given that the majority of the population is Inuit in both cases.

Where the proportion of Indigenous population is less, institutions of self-governance at smaller scales have arisen. In Canada's Yukon Territory, 11 self-government agreements have been concluded, nine of them under the Yukon Umbrella Final Agreement negotiated among the Federal and Territorial governments and the Council of Yukon First Nations (then the Council of Yukon Indians). In the Northwest Territories, the Tlicho Agreement (effective as of 2005) provides for self-government powers, as well as speaking to land and resource issues. The Inuit of Labrador (Canada) signed a land claims and self-government agreement in 2005. Poelzer and Wilson (2014) observe that the responsibilities of such Indigenous governments are more similar to those of territories than municipalities, as they often include jurisdiction over health care, education and other domains that are usually reserved for provincial/territorial governments in Canada.

In the Russian Federation, Indigenous self-governing powers increased in the late 1990s and early 2000s, with the seizing of power by sub-federal governments during Moscow's weakened state and the establishment of sub-federal laws regarding indigenous rights in some areas (prior to federal laws). Legal reforms allowed for greater Indigenous self-governance, at least on paper, and in a few cases this was realized. 'National' (i.e., native) counties and districts were formed in some parts of the Russian North (some of them re-established on the basis of native counties that had existed in the 1920s–1930s, and then been dissolved in the late 1930s). These administrative units were originally established (at least putatively) to recognize and empower Indigenous groups, allowing for their language, traditions and culture to be protected and practiced in official institutions. Three key federal laws on Indigenous rights, including to territories, passed in 1999, 2000 and 2001 (Fondahl and Poelzer 2003). However, since the mid 2000s, some of the autonomous (native) okrugs [districts] have been abolished, their territories merged into larger units. For instance, the Evenki and Dolgan-Nenets (Taymyr) Autonomous Okrugs (created to recognize the Evenki, Dolgan and Nenets peoples), were subsumed by the Krasnoyark Kray [Territory] and no longer exist. Interestingly, the two hydrocarbon-rich autonomous okrugs, Yamalo-Nenets Autonomous Okrug and Khanty-Mansi Autonomous Okrug (created to recognized the Nenets, Khanty and Mansi peoples), have successfully resisted such merging. Khanty-Mansi Autonomous Okrug, moreover, established an Assembly of Representatives of Indigenous Northerners, a special body within the legislation of the district (Kryazhkov 2005).

Another facet of the New Arctic is the innovative power-sharing arrangements of various types, such as co-management regimes, established to ensure that Indigenous peoples have greater influence in decision-making. These types of agreements have been especially prevalent in the area of resource management, where such collaborative management decreases conflicts over resource use, and improves the likelihood of sustainable management. Indigenous involvement in local and regional resource governance has increased markedly in Canada and Alaska. Less progress has been made on this front in the Russian north (Forbes and Kofinas 2014).

Innovation in Indigenous political participation in the Arctic is noteworthy at the international level. The creation of the Arctic Council in 1996, as a high-level intergovernmental organization to promote environmental cooperation and sustainable development, revolutionized the landscape of Indigenous political participation at the international level as described later in the book in the chapter 22 by Nord. It did this by including Indigenous groups (Permanent Participants) at the table along with state representatives at the ministerial level. The Permanent Participants are the key organizations that either represent Arctic Indigenous peoples straddling more than one international Arctic state boundary (Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Council, Sámi Council) or represent numerous Arctic peoples within one Arctic state (Russian Association of Indigenous Peoples of the North, Siberia and the Far East/RAIPON). While the Permanent Participants do not have voting rights, they can otherwise fully participate in Council's Working Groups and activities and wield substantial influence in terms of Arctic Council decisions regarding priorities and projects.

Of course, capacity remains a significant hurdle for Indigenous northerners across all levels of political participation, from local co-management regimes to the level of a ministerial meeting of the Arctic Council. This includes financial capacity and human capacity, in terms of both time and skills sets. Indigenous governments and non-governmental organizations involved in political processes are regularly overwhelmed by demands made on them, operating on inadequate budgets and with limited and overtaxed personnel. Still, it is fair to assert that significant gains in terms of Indigenous self-governance and political participation characterize the New Arctic.

2.3 Rights to Land and Resources

The United Nations Declaration on the Rights of Indigenous Peoples declares that "Indigenous peoples have the right to the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired" (UNDRIP 2007, §26). Indigenous rights to land and resources is a fundamental issue in the Arctic, in that land and resources lie at the heart of both cultural and material wellbeing for Indigenous northerners. Many Indigenous peoples still heavily rely on the harvesting of biological resource – Arctic fauna and flora – for their subsistence needs. Strong ties to the land are repeatedly invoked as a key element of Arctic Indigenous cultural identity (AHDR 2004; ASI 2010). The International Labour Organization's Convention 169 (ILO 169), while also speaking to indigenous rights to land, has only been ratified by two Arctic states, Denmark and Norway. Thus, lack of recognition and unresolved questions of territorial rights have been major hindrances to the economic and cultural wellbeing of these peoples.

A rich source of hydrocarbons, minerals and fish, the Arctic is seeing increased interest in development, due to both to growing global demand for such resources and, in some areas, increased accessibility (or anticipation of such) related to climate change. Arctic tourism is also projected to grow over the next decades. These activities and their associated infrastructure compete with traditional land use, encroaching on the territories used for hunting, reindeer herding, and fishing. They contribute to habitat fragmentation, deleterious for Arctic fauna, and facilitate access by outsiders with concomitant increases in sports hunting, poaching, destructive ATV activity, etc.

Indigenous peoples in the Arctic are not reflexively opposed to developing the Arctic's resources. Indeed, in some cases, conservation initiatives that might be assumed to benefit Indigenous peoples can in fact disempower them (see Case 2.1). Rather, Indigenous peoples demand a role in the decision-making over what projects advance on their traditional territories, and how these are realized, and they want to benefit from such development. UNDRIP calls for free, prior and conformed consent regarding development on Indigenous peoples' lands, and the rights of Indigenous peoples to develop their priorities for such land and use (UNDRIP 2007).

Case 2.1: Access Rights in King Cove, Alaska

The Arctic has seen a significant expansion of parks and other types of 'nature reserves' in the past several decades. Such areas are set aside to preserve the 'natural beauty and environments' of the North. Yet "natural" is a term often defined by those in positions of power (Robbins 2004). Many consider parks success stories of preservation of the natural (as opposed to 'cultural') landscape — though parks usually contain cultural features such as roads, and the wildlife within their boundaries is managed. The fact that Indigenous northerners have used, thrived in and actively managed these environments for 1000s of years is problematic to the common, romanticized view of northern nature as "pristine" and "untouched".

One example of the erasure of human needs in "protected" lands can be seen in the community in King Cove, located at the end of the Alaska Peninsula. King Cove's residents are fighting for road access to an all-weather airport located 10 miles away in Cold Bay. Having this road would allow community members safe and reliable transportation, especially for medical emergencies. However, it will take an act of the U.S. Congress to grant

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Case 2.1 (continued)

permission because the road will run through Izembek National Wildlife Refuge, a protected area created by federal legislation.

Two laws in particular constrain how Native people in Alaska are allowed to interact with the landscape: the Alaska Native Claims Settlement Act (ANCSA 1971) and the Alaska National Interest Land Conservation Act (ANILCA 1980). Under ANCSA, Indigenous Alaskans were granted 44 million acres of land and a monetary payment of $962.5 million in exchange for lands lost (Arnold 1978). The monetary payment was made to newly created corporations of eligible Native people (as defined by the State). ANCSA extinguished aboriginal land title and eliminated 'Indian Country' status in the state, and the sovereignty inherent in that status. Aboriginal hunting and fishing rights were also extinguished, though still recognized and protected by the State of Alaska and the Secretary of the Interior (Case and Voluck 2002).

ANILCA set aside 79.3 million acres for conservation, and redefined hunting and fishing rights for rural users, under provisions in ANCSA that allowed the federal government to set aside land for "national and public interest" (Case and Voluck 2002:288). Importantly for Alaska's Indigenous residents, Section 803 of ANILCA established subsistence protections for both Native and non-Native residents in rural Alaska (Case and Voluck 2002:289). That is, the subsistence rights of *all* (not just indigenous) rural residents in Alaska were recognized. Further, ANILCA changed the designation of certain lands from ranges to refuges (e.g. the Izembek National Wildlife Range to Izembeck National Wildlife Refuge) and limited the ways in which people were allowed to hunt, fish and be present on the landscape. Restricting access to resources and managing for a limited set of species or interest group(s) over others may potentially change the landscape and directly affect the ways people are able to subsist and survive in their environment.

In terms of the Izembek National Wildlife Refuge, in response to King Cove's request for a road, in 2009 US Congress approved a land swap that would have increased the amount of refuge land by over 61,000 acres in exchange for a 206 acre easement through the refuge for the access road (Aleutians East Borough 2009). However, in December 2013, the United States Secretary of the Interior Sally Jewell rejected this land swap. The Aleut people in King Cove, along with the local Tribes, Native corporation and city government, filed suit against the federal government to reverse Secretary Jewell's decision, on the grounds that the Secretary did not meet the Trust Responsibility of the United States with the respect to the Alaska Natives and American Indians. As of mid- 2014, the State of Alaska filed a Motion to Intervene in support of the plaintiffs from King Cove. This ongoing struggle illustrates the complexities of land and resource management involving Indigenous peoples and others ("stakeholders") across multiple jurisdictions.

Land claims in the North American context have helped secure Indigenous peoples' rights to their lands and territories, but at a considerable costs. To date, most land claims agreements have involved Indigenous peoples extinguishing their claims to large portions of their traditional territories in return for legally confirmed property rights to small portions. Under the Alaska Native Claims Settlement Act in 1971 Indigenous groups extinguished their rights to 321 million acres of land, in return for recognition of rights to about 44 million acres, and a compensation payment of $96.2 million. Some point out that this means that government obtained unencumbered rights to the 321 million acres for approximately $3 per acre. Clauses in the Inuvialuit claims (1984), Nunavut claims (1999) and other land claims agreements have involved similar provisions of extinguishment. As noted above, the compensation payments have allowed some communities to successfully invest in building businesses and improving their economic situation.

In the Russian Federation, Indigenous land rights have taken a different course. After the fall of the Soviet Union, the Russian Federation began to revise its legislation, as necessary for developing both democracy and a market economy. An early Russian presidential edict (1992) called for the allocation of lands to Indigenous persons for the pursuit of traditional activities and a law to enable this. The Russian Constitution of 1993 guaranteed the rights of Indigenous peoples 'in accordance with universally recognized principles and norms of international laws and treaties.' (§69). It was almost a decade before federal laws on Indigenous rights were adopted, but in several of Russia's provinces and republics (e.g., Sakha Republic (Yakutia), Buryat Republic) regional legislation preceded the federal. Such regional laws were often based on draft versions of the federal legislation that was circulating for comment. These regional laws, and eventually federal legislation, allowed Indigenous '*obshchinas*' (often translated 'communities' or 'communes') to be established and granted territory for the pursuit of traditional activities such as hunting and reindeer herding. *Obshchinas* are formed by a group of persons, predominantly Indigenous, who wish to pursue traditional activities and need rights to a territory to do so. *Obshchinas* range in size from a family to a whole village, and their land allocations run from thousands to millions of hectares. Also, in the period before 2000, other federal laws that were focused on resource management – laws on forestry, fauna, the continental shelf, etc. – regularly contained clauses that guaranteed priority use by Indigenous persons of the resource and protected their access.

In 2000, a federal law on Indigenous *obshchinas* was adopted (Ob obshchix 2000). It stipulated the granting of land to *obshchinas* 'in perpetuity' and without any charge (rent), though the land was not owned by the *obshchina* (Kryazhkov 2013).

Another law, in 2001, directed the creation of Territories of Traditional Nature Use, which would be mostly off limits to industrial development. *Obshchina* territories could be granted within these Territories of Traditional Nature Use. The Territories of Traditional Nature Use could be established at the federal, regional or local level.

However, the laws are mainly 'declarative,' with little detail on how to move forward and few mechanisms for implementation and enforcement. In term of the 2001 law, no federal Territories of Traditional Nature Use have yet been established, and a few regional ones that have been established have been since annulled. Moreover, laws passed in 2004 rescinded the rights of Indigenous people to receive *obshchina* lands 'in perpetuity' and without cost — agreements are now usually for 25 years, and involve rents (Kryazhkov 2013). Many *obshchinas* do not have the ability to pay the rents, and thus have lost their rights to the territories granted to them.

At the same time, a requirement for "ethnological assessment" — in addition to environmental assessment —makes it harder for development projects that will disrupt traditional resource use to occur without the agreement of, and benefits to, Indigenous peoples, at least theoretically. This requirement, called for in the 1999 Law "On Guarantees of the Rights of Indigenous Numerically Small Peoples", needs to be explicated in a law on ethnological assessment (O garantiyakh 1999). While no such law has yet been adopted at the federal level, Sakha Republic (Yakutia) recently passed such a law (Ob etnologicheskoy 2010). Unfortunately the implementation of such legal protection is often uneven (see Case 2.2).

Case 2.2: Addressing Cultural Damage Due to Industrial Development in Siberia

Industrial development has increased throughout the Russian North. Negative effects of such development for Indigenous peoples' traditional activities include decreases in reindeer pasture and hunting grounds, declining populations of furbearing species and fish, the pollution of water sources, land and air. One of the ways to address such conflicts is 'ethnological assessments' (*ethnologichskay expertiza*), which, combined with environmental assessments, assess the scale of damage that an industrial project potentially will inflict on a group and the compensation that should be paid for losses incurred.

The idea is to estimate the social, economic and cultural costs of development, such as impacts on language and way of life, as well as the environmental costs, in order both to provide the basis for working to minimize the effects of development on Indigenous cultures, and to provide compensation for such losses when they cannot be avoided (Novikova 2008).

The methods that have been developed for ethnological assessment provide a quite accurate tool in terms of evaluating potential economic losses, based on calculations of daily income gained from traditional activities, the temporal duration of the disruption, and the areal extent of land and resources influenced. However, methods have not yet been perfected for effectively calculating the costs of cultural disruption.

Moreover, among Russia's northern regions so far only the Sakha Republic (Yakutia) has adopted a law "On Ethnological Assessment in Places of Traditional Habitation and Traditional Economic Activities of the Peoples of the North of the Republic of Sakha (Yakutia)" (Ob etnologicheskoy 2010). A federal law has not yet been adopted.

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Case 2.2 (continued)

How has the implementation of such ethnological assessments proceeded? In 2007, when the Eastern Siberian Pacific Ocean (ESPO) pipeline came through the traditional territory of six *obshchinas*, a law on ethnological assessment did not yet exist. However, based on the 1999 Law “On Guarantees of the Rights of Indigenous Numerically Small Peoples” (O garantiyakh 1999) that called for such assessments, a compensation of four million rubles was paid out – but only because of the intervention of the Republic’s president. Payments for losses of biological resources in the Aldan Region along a 250 km stretch of pipeline were evaluated at only 150,000 rubles. The payment was then made to the Aldan Region’s budget, not to the Indigenous villages and *obshchinas* (Sleptsov 2013).

In 2012, the first ethnological assessment under the new (2010) republican law was carried out. The Kankunsk Hydroelectric project on the Timpton River directly affects the activities of eight Indigenous obshchinas in the Aldan and Neyungri Regions of Sakha Republic (Yakutia). A preliminary evaluation of the influence of the construction on the cultural environment was carried out by “Energotransproekt”, an institute involved in energy and transport science and development, on behalf of the company responsibly for the construction of the hydroproject (Rosgidro). An Expert Commission, with representation from the Association of Indigenous Peoples of the North of Yakutia and the Union of Nomadic Obshchinas recommended that the conclusions of Energotransproekt’s assessment be rejected, arguing that these conflicted with the existing laws on the rights of the Indigenous peoples. Nevertheless, based on the assessment of materials and documents, the Kankunsk hydro-project was approved by a governmental decree on 17 August 2012.

Across the Arctic we see the increase in Indigenous peoples’ ability to share in decision-making over resource development, although the landscape of political power is definitely an uneven one. As noted above, co-management has become increasingly widespread as a means to ensure that Indigenous concerns are taken into consideration when managing land and resources. Innovations such as ethnological assessment in Russia also provide means to (hypothetically) ensure that Indigenous peoples have a voice in decisions that affect them and are compensated for any cultural and social as well as economic losses that development projects bring. Legal advances in the protection of Indigenous rights have increased notably in all areas the Arctic in the last decades.

Yet the interpretation and implementation of such legislation too often leave Indigenous peoples in a precarious, disempowered position. As exogenous demands for Arctic resources increase, will increased legal rights and protections protect the interests of Indigenous peoples to decide on what transpires on their lands? Whether Indigenous interests are respected and protected in fact as well as on paper will be a major moral yardstick for Arctic countries.

2.4 Traditional Knowledge

Traditional knowledge is another great concern for Indigenous peoples in the Arctic: both its maintenance and inter-generational passage, and its application to decision-making. Indigenous people underscore that traditional knowledge is not static – it is continuously updated, based as it is on on-going observation, experience, experimentation, application and adaptation. Traditional knowledge plays a role in self-governance and the capacity to effectively manage lands and resources. As Indigenous peoples experience a political resurgence, they are demanding that traditional knowledge be considered along side 'western scientific knowledge'.

Its continuance has been challenged by a whole set of colonialist forces including assimilatory processes, changes in family structure and co-residence patterns, sedentarization, and time spent on the land. Yet as traditional knowledge is vulnerable to loss, it is also increasingly accepted by non-Indigenous people as a valid and valuable source of information. Certainly there is growing respect for and interest in the potential contributions that traditional knowledge can make to informed decision- and policy-making in the North, especially (but not only) in the area of resource management.

There are major obstacles to the integration of traditional knowledge and scientific knowledge. These include skepticism and cultural biases of some scientists as to the value of traditional knowledge, as well reluctance of policy makers to relinquish control. Moreover, the epistemologies and ontologies underpinning these different systems make them difficult to integrate, and often lead to the continuation of privileging western scientific knowledge.

Traditional knowledge is encoded in the language of Arctic peoples. Whether through the rich and nuanced terminology related to animal characteristics and behavior, plant morphology, or landscape features, language expresses human-environment links and interactions. Yet the situation of Indigenous languages in the North has been termed "dire" (Schweitzer et al. 2014). Although Arctic languages have received significant attention in recent years, many are under grave threat. The Arctic Biodiversity Assessment notes that 21 Arctic languages have become extinct since the 1800s, with 10 of these extinctions since the 1990s. Twenty-eight more are 'critically endangered' (CAFF 2013). This has significant implications for the transfer of traditional knowledge. It should be noted that there are positive stories of language maintenance and revitalization as well in the Arctic: for example, over 86 % of those living in Greenland, whether of Inuit heritage or not, speak Kalaallisut (which became the sole official language in 2009). Such cases provide for cautious optimism, but major resources *and* political resolve will be required to stem the decline of most Arctic languages.

Numerous initiatives in the North work to enhance the use of traditional knowledge. For instance, in Alaska, the Alaska Native Knowledge Network was created not only to compile information on traditional knowledge, but to help make it accessible to 'outsiders', including government agencies, for use. In Canada, the Government of the Northwest Territories has established a Traditional Knowledge Policy, which stipulates that "aboriginal traditional knowledge is a valid and essential source of information about the natural environment and its resources, the use of natural resources, and the relationship of people to the land and to each other, and [the GNWT] will incorporate traditional knowledge into government decisions and actions were appropriate" (GNWT 2005). It notes that "traditional knowledge should be considered in the design and deliver of government programs and services". Likewise the Nunavut government has publicly stated its intent to be directed by Inuit Qaujimanituqangit, or Inuit traditional knowledge (Arnakak 2002). In the Russian Federation's Khanty-Mansi Autonomous Okrug, legal protection has been provided to some forms of traditional knowledge (Newcity 2009), but it is fair to assess that in general less progress has been made in terms of the recognition and intent to incorporate traditional knowledge into governance and resource management regimes in the Eurasian North than in North America.

2.5 Conclusion

We have focused our discussion on three areas of major concern to Arctic Indigenous peoples: self-governance, land and resource rights, and traditional knowledge. Climate change of course exacerbates the challenges to the transmission of traditional knowledge, the ability to self-govern, and the capacity to benefit from rights to land and resources. A number of Arctic communities are already being relocated, due to climate change (e.g. Shishmaref, Kivalina, and Newtok, Alaska). Changes in sea ice affect hunters' access to marine resources, while changes in land-based ice can wreak havoc on reindeer husbandry and other traditional terrestrial-based activities. Transmission of traditional knowledge is made more difficult as it becomes harder to pursue inter-generational experiencing of land-based activities, due to safety concerns, increased difficulties of access, or other issues.

Added to this, in what is referred to as 'double exposure' are the forces of globalization, such as increased exogenous demand for Arctic resources and the infliction of exogenous value systems and languages through mass media (cf. O'Brien and Leichenko 2000). Together these physical, economic and cultural forces contribute to the weakening of local cultural systems.

In spite of these corrosive forces there is a growing recognition of Indigenous rights. We have witnessed over the past quarter-century a remarkable renaissance of Indigenous self-governing institutions. We have seen a notable growth of legislation that protects Indigenous rights to their homelands and resources. Traditional knowledge is increasingly recognized as both a valid and crucial source to inform policy- and decision-making. Indigenous peoples in the New Arctic certainly face challenges. While what the next decades will bring is unpredictable on all fronts, Indigenous peoples will face new challenges with increasing powers and resources to self-determine their future in the New Arctic.

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Chapter 3
Pioneering Nation: New Narratives About Greenland and Greenlanders Launched Through Arts and Branding

Kirsten Thisted

Abstract Throughout the Arctic, identities are currently being renegotiated on a foundation that is undergoing radical changes. Global warming has led to an increased focus on arctic and subarctic areas, and thus it is not only the physical conditions for peoples' livelihood that are changing but the way in which they identify and create new subject positions for themselves in the interaction with the rest of the world. As such, there is nothing new in the importance of the Arctic in international politics. What is fundamentally different today is the status of the indigenous peoples of the far North. No longer can these peoples be governed and treated as voiceless creatures on equal footing with the marine mammals, birds and fish of the area. Today, the indigenous peoples have their own political voices, and various forms of self-rule are the norm rather than the exception. While the Arctic has for generations been described and represented by people living in the South, the peoples of the Arctic are now to a much larger degree representing themselves, both on the political stage and in the media, art, literature and film. The article demonstrates how this creates completely different images from the ones we have grown accustomed to over so many years. The new Arctic is framed by a new context where people are digitally fluent and active members of the global community in a way that makes the future development completely different from previous ages – and thus also completely unpredictable.

Keywords Greenland • Self-Government • (Self)representation • (Issues of) indigeneity • Globalization

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Throughout the Arctic, identities are currently being renegotiated on a foundation that is undergoing radical changes. Global warming has led to an increased focus on arctic and subarctic areas, and thus it is not only the physical conditions for peoples' livelihood that are changing but the way in which they identify and create new subject positions for themselves in the interaction with the rest of the world. Suddenly, the Arctic Council is courted by the biggest and most powerful nations. Nations that might be situated a good deal south of what is usually considered "the Arctic" reinvent themselves as arctic nations – or are busy digging into their history to unearth their arctic knowledge and competences. In the Scandinavian North Atlantic, Iceland and the Faroe Islands are redefining themselves as arctic nations or "gateways" to the Arctic, and the only reason that Denmark has a seat in the Arctic Council is of course the fact that Greenland is still part of the Danish Realm.

Greenland and the Faroe Islands are the only overseas territories left from the once far-reaching Danish empire. Greenland was colonized by the Danish-Norwegian state in 1721. In 1953, Danish colonialism officially ended when Greenland became an equal part of Denmark as the northernmost county. In 1979 Home Rule was implemented, followed in 2009 by Self Government, an expansion of Home Rule. Greenland has a very small population, around 56,500 people, dispersed over a large number of settlements in a huge area. With Home Rule, *kalaallisut*, the Inuit language of the (West) Greenlanders, became the country's official language. Eighty-five percent of the population live in an urban environment, with around 16,000, more than a quarter of the population, living in Nuuk, the capital of Greenland (Sejersen et al. 2009).

As such, there is nothing new in the importance of the Arctic in international politics. Through the centuries, the Arctic has often played a crucial role – not the least during the Cold War. However, what is fundamentally different today is the status of the indigenous peoples of the far North. No longer can these peoples be governed and treated as voiceless creatures on equal footing with the marine mammals, birds and fish of the area. Today, the indigenous peoples have their own political voices, and various forms of self-rule are the norm rather than the exception. While the Arctic has for generations been described and represented by people living in the South, the peoples of the Arctic are now to a much larger degree representing themselves, both on the political stage and in the media, art, literature and film. This creates completely different images from the ones we have grown accustomed to over so many years.

For an excellent example of the kind of representation that is now being confronted and challenged by the Inuit themselves, you can carry out a YouTube search for "OnThinIceTrailer".[1] The trailer introduces the documentary "On Thin Ice", made by Andreas Rydbacken for Greenpeace in 2006. The documentary is 29:46 min, while the trailer lasts 1:10 min. The trailer opens with images from Ilulissat Ice Fiord, which in 2004 was inscribed on the UNESCO World Heritage List. Shown repeatedly in the media and visited by an endless number of the world's major political and religious leaders, the Ilulissat Ice Fiord has become a key symbol of global warming (Bjørst 2011). We hear a dramatic sound, which could be the ice moving. The following captions are superimposed on the images: "Imagine the world's largest island/covered by ice/Now imagine all that ice moving/Faster than ever/Bad news for the world!" The score switches to very dramatic, action-oriented music as we watch a helicopter landing and a group of scientists disembarking on the ice with all their instruments. A moment later, we are back in the helicopter, watching a ship in the midst of the ice-filled sea, and then again, a second later, we are on board the ship, listening to the scientists discussing their results. Male scientist: "13.8 km per year!" Female scientist: "That's bad!" In the next clip, the male scientist is back on the ice. He says, "Once the icebergs come off the end of the glacier that's their contribution to sea level rising." We see images of a calving glacier and pictures of flooded southern cities embedded in the images of the ice. Then a new caption reads: "A documentary about Greenland/an island in climate crisis." Now we see a seal, a musk ox, a young girl, a man, another man, an old woman, yet another man, all distinctly Inuit in appearance. Superimposed on these images, a caption reads, "Watching their country melt." Like the seal, each of the five individuals is turning his or her head as we watch them, seemingly in deep sorrow, but without uttering a sound. The next picture is a settlement with low, modern houses, built of wood. The storm-like sky has an ominous look, and superimposed on the image is the following caption in flaming letters: "their entire culture is at stake." The trailer concludes with some very fast clips of a musk ox skull, as a silent monument to the dead nature and the dead lifestyle, and a large apartment block, a vision of the future dystopia, when the Inuit have become "climate refugees" in the big cities, severed from their previous lifestyle in harmony with nature.

There are two obvious problems with the way this is framed. (1) The silencing of the Inuit, who are turned into passive objects of others' actions: first the rampant consumption down south, which is supposed to have triggered the climate change, then the scientists, on a quest to set the record straight. The Inuit themselves are relegated exclusively to the roles of victims and witnesses. (2) The idea that modern cities are a foreign and alienating environment for the Inuit, since their true nature belongs in the wild where they are supposed to live in peace and harmony. This is an ingrained myth stemming from the Romantic notion of the "noble savage" – a myth that the Inuit themselves have made extensive use of since the 1970s, by the way. The term "indigenous peoples" with all the connotations in terms of nature and

[1] https://www.youtube.com/watch?v=5WbXxHVWtD0&noredirect=1; last accessed April 2014.

authenticity that adhere to it, was an important argument in political fora such as the UN, and the 2007 UN Declaration on the Rights of Indigenous Peoples still maintains traditions and "culture" as the focal point for the assignment of such rights (Kleist 2011; Thisted 2013). However, the truth is that many Greenlanders, especially young Greenlanders, regard that kind of narrative as a straitjacket, which locks them into identities that have become out of touch with their actual lives. The recent years, after the implementation of self-government in 2009, have been characterized by this ongoing negotiation of what it means to be "Greenlandic" in the age of globalization and climate change.

3.1 Processes of Cultural Translation

In Mary Louise Pratt's words, Greenland could be considered a "contact zone": a space "where disparate cultures meet, clash, and grapple with each other, often in highly asymmetrical relations of domination and subordination" (Pratt 1992:12). First the whalers came, then the missionaries, the traders, the administrators, the scientists. The Inuit interacted with all of them, and over the years, they changed to a point where it no longer makes sense to talk about Inuit/Greenlandic or Danish/European as two distinct cultures, which meet in Greenland. Scandinavia and Europe have long since become part of the present Greenlanders' own heritage, for better or worse. Thus, Greenland's historical experience can be described as a long series of transformations as the Greenlandic Inuit have mixed with other people and integrated new cultural elements into their own culture. "Cultural translation" is a term used by some theorists in the field of cultural and post-colonial studies, including Stuart Hall, Homi Bhabha, Robert J.C. Young and others, to characterize such a translocation of cultural forms into new contexts and regimes of power. Not just knowledge, ideas or world-views but also people and their identities are translated: as when the Europeans translated the Inuit into "wild" and "primitive" people or "heathens", and the Greenlanders decided to translate themselves into Christians – and later into "modern" people. A similar process of translation or transformation took place after the Second World War, when the status of the Greenlanders changed from colonized people to Danish citizens, and the Greenlanders needed to renegotiate their identity and find a way to become *both* Danish *and* Greenlandic. The Greenlanders had been brought up with Danish nationalism, based upon ethnicity and the idea of a close connection between the land, the people, the language and the territory; an idea the Danes had adopted from German philosophy. At the time when Greenland became part of Denmark, this kind of thinking was deeply rooted in the Greenlanders, especially the Greenlandic elite, and their aspiration was never to become entirely Danish but to somehow put the two identities on equal footing. From a Danish point of view, the Greenlanders were a distinct ethnic minority, and they continued ruling Greenland based on a politics of difference. From a Greenlandic point of view, this was experienced as discrimination, which led to the requirement for home rule, implemented in 1979. One of the buzzwords in this period was "Greenlandization": the strengthening of Greenlandic language and culture. As Tove Søvndahl Petersen, the present head of the Greenland Representation in Denmark, noted in 1996, home rule paradoxically had the opposite of the intended effect – at least if "culture" is read as "traditional" culture:

> Home Rule also means taking responsibility for one's own decisions, increased economic self-management, requirements of efficiency and rationalization, the ability to enter into beneficial agreements with foreign fisheries nations and foreign banks, [and] promoting the tourism trade by appearing exotic and exciting in a way that appeals to tourists. (Petersen 1996:23, my translation)

When the term "indigenous peoples" was first introduced in Greenland in the 1970s, not everybody was equally enthusiastic. It sounded too much of the old notions of wild and primitive savages. However, as time went by, the term became generally accepted, not least because it was institutionalized by powerful international organizations. The political process concerning the UN Declaration on the Rights of Indigenous Peoples became a very important inspiration for the Act on Greenland Self-Government, even though the term "indigenous people" – or even "Inuit" – is never mentioned in the Act itself. The reason for this is that the Act goes far beyond the UN Declaration, which is an attempt to regulate the relationship between the ethnic minority and the State. With the Self-Government Act, in many respects Greenland *is* the state, and thus, in the Greenland case, the language of indigineity shifts from a language of subordination and resistance into a language of governance. The Greenlanders have not yet reached a conclusion whether they want to detach themselves from the term "indigenous people" or whether they want to hold on to it, showing the world that indigenous peoples do not have to stay subordinated and poor. No matter what, they are right now in the process of translating themselves out of the minority and into a majority position.

3.2 Visualizing Hybridity

Not surprisingly, ethno-symbolism became an important part of the home rule process. Earlier, the Greenlanders' strategy had been to prove that they were "ready" for modernity and able to adapt to Danish culture, but now it became important to highlight all the factors that would indicate how the Greenlanders were in fact a people in their own right. The myths and stories predating Christianity were revitalized through literature, theatre and rock lyrics, and homage was paid to the hunting culture by flashing its symbols: the kayak, the harpoon, the ulu (the crescent-shaped women's knife) etc. These symbols are still in use, but a new generation has used them reflectively rather than taking them for granted. Several artists have pointed to the hybrid nature of modern Greenlandic culture, including Miki Jacobsen (born 1965), Inuk Silis Høeg (born 1972), Julie Edel Hardenberg (born 1971), to mention just a few. One of Miki Jacobsen's best-known works is the photo collage "The red Snow Mobile" from the photo series "Culture Fusion" (2003). In the foreground of this collage, a team of sledge dogs are rushing through the picture from right to left. In the background, an Air Greenland aircraft is landing, heading down the runway in our direction. In the space between the two, the artist himself, naked from the

Fig. 3.1 Miki Jacobsen: "The red Snowmobile", 2005, digital photo collage

waist up, is driving his red snow mobile full speed through the picture from left to right. In the left corner, nearest to the viewer, a snow bunting is silently, ironically watching it all (Fig. 3.1).

Likewise, Inuk Silis Høeg explores Greenlandic ideas and ideals of masculinity in his small sculptures named "Angutit" (Men, 2003). The figures relate to old potent male figurines known from ethnographic collections, mixed with limbs borrowed from male action figures from "Top Toy", creating a clash between old and new materials and an ironic comment on the similarity between two seemingly very different cultures. Taking the super masculine ideal to a grotesque level questions and de-naturalizes it (Fig. 3.2).

While intersectionality between sex, class and ethnicity seems to be at play in the works of Jacobsen and Høeg, Julie Edel Hardenberg appears to focus mostly on ethnicity. In a series of portrait photos with titles such as "Parents and child", "Siblings", "A part of me" and "Non-stereotypes", Hardenberg has explored contemporary Greenlanders' genetic and cultural makeup. Children of the same parents may come out very differently, so that some look typically "Danish", while others look typically "Greenlandic", and in addition, families often include children from previous relationships, adopted children etc. Spaces, cultures and identities mix. "Savalimmiunik aamma siuliaqarpugut" (We also have Faroese ancestors) is the caption for a photo of two Greenlandic girls with dolls in Faroese national dress, and in another, a young woman holds a sign reading "Français – c'est aussi ma langue" (French is my language too). Another photo, with the apposite title "Non-stereotypes", show three smiling children, obviously of black heritage, dressed in Greenlandic national costume (Fig. 3.3).

Fig. 3.2 Inuk Silis Høeg: "Angutit" or "Bodies I and II" 2003, Wood, Plastic, Bone 27 × 20 cm

Fig. 3.3 Julie Edel Hardenberg: "Non-Stereotypes", 2004, photo

The photos have been exhibited and reproduced in many different contexts, including the book *Nipaatsumik assigiinngisitaarneq/The quiet diversity*, 2005.

Central to the interest of the book is how we produce identifications through our looks and the symbols we wear in the form of jewelry and clothing, and the objects with which we surround ourselves. In one series of photos the artist herself dresses up in different "ethnic styles" and seems to test what it is like to move into and out of different (stereotyped) identities that match her physical features: being a Native American woman, an Indian Woman, a Chinese woman etc. In another series of six photos she portrays two young men, one of whom would be identified as Greenlandic in a Greenlandic context, while the other has features that are less clearly Greenlandic and looks more Danish or Scandinavian/European. In each picture they wear a piece of jewellery: a polar bear claw on a leather string, a Thor's hammer, which might be made of lead, worn on a chain that also seems to be lead, and a silver crucifix on a silver chain. What happens when these pieces of jewellery are placed around the necks of these two young men? What identities are implied by the different pieces, and are we more willing to accept the presumed identities created by some of these combinations between person and object than others? Another series shows photos of living rooms. We do not see the inhabitants, but we cannot help make assumptions about who lives there: How old might these people be? What do they do for a living? Common to all the homes, however, is the hybridity: Objects from all corners of the world have found their way to these interiors, which are all "European" in the sense that they are furnished with a dinner table, a coffee table, chairs, sofas etc. Yet, in each and every room there is something that makes the room distinctly "Greenlandic": bead embroidery, an ulu hanging on the wall, seal or reindeer skin in the furniture or on the floor, an East Greenlandic mask, a piece of modern Greenlandic art. This creates an impression both cosmopolitan and national, and the pictures compel the spectator to consider how people signal identity with the way they organize and decorate their space, and to rethink the preconceived ideas of "authenticity"/"in-authenticity" that characterize the debate about "identity" and "ethnicity".

A similar staging of Greenlandic identity as hybrid and elusive can be studied in Greenlandic literature, music and film (Pedersen 2008; Otte 2013; Thisted 2012a, b).

3.3 Branding the Nation

The time around the transition from home rule to self-government was marked by an intense debate regarding the outside view, in particular the Danish view, on Greenland. In Denmark, the representations of Greenland have for decades been split between two very different pictures. In the "Sunday version", which comes out on festive or solemn occasions and in official contexts, Greenland is lauded for its proud traditions, its beautiful landscape, and the harmonious relations within the Danish realm. In the weekday version, Greenlanders are stereotyped as losers, dependent on Danish subsidies, alcoholics and "lost in translation" in the modern world. Nuuk in particular has a reputation in the Danish public as a sort of "spoiled space", which stems in part from a number of documentaries that set out to look "beyond the scenic idyll" and draw out "the aspects that don't fit into the postcard image", as one of these documentaries phrased it. The most exceptional aspect of this documentary, *Flugten fra Greenland* (*Escape from Greenland*) (Heilbut 2007), is that when it was first broadcast on the national Danish TV channel DR1, it sparked the first widespread outcry against this kind of representation both from the Greenlandic community in Denmark and from Greenlandic politicians (Gant 2009; Thisted 2012b). Actually, the criticism had an impact, and there have been several initiatives to offer a more nuanced insight into Greenlandic society and to incorporate Greenland into Danish mainstream programs. For instance, the post-colonial relationship between Denmark and Greenland was the theme of one episode of the popular television series *Borgen* (*The Castle*, metonym for the Danish Parliament), DR 2010. Likewise, the TV3+ documentary series *Politistationen* (*The Police Station*) went to Nuuk in 2011. This programme also portrayed social problems but focused on the competent young Greenlanders who deal with these problems. Most importantly, however, especially from a Greenlandic point of view, was the Greenlandic participation in the popular music competition *AllStars* on Danish TV2 in 2010. The programme was a kind of talent show where four established musicians, each representing a Danish city, formed four choirs that competed against each other. One of them was the Greenlandic singer Julie Berthelsen's choir, representing Nuuk. The members of the choir succeeded in painting a very positive picture of well-adjusted, goal-oriented and competent Greenlanders, and the choir actually won the competition. In the programme, Greenlandic identity was depicted as hybrid and fluid – very much like the depiction in Julie Edel Hardenberg's photos. Some of the members of the choir had close ties to Greenland, others less so. Some were ethnically Greenlandic but had been raised in Denmark, while others had lived in Greenland all their life, even though their parents came from somewhere else. Thus, the programme sought to illustrate that cultural heritage is defined by the things we choose to identify with, and where we place our loyalty. The choir came to symbolize an ideal society, where cooperation across differences serves to strengthen internal cohesion. All of Greenland celebrated when the Greenlandic choir won, and in view of the previously very negative media coverage of Greenland, some even went so far as to call the victory "a new start for Greenland" (Thisted 2012b).

A similar attempt to manage the perception of Greenland has been made by Greenlandic business organizations in a concerted effort to create a strong brand for Greenland. A branding platform was launched in 2005, but it was not until after the introduction of self-government that there was a noticeable shift in the agenda. Greenland's national tourist board Visit Greenland has been particularly involved in this process with the aim of creating a brand that would not only appeal to tourists, telling them about all the adventures awaiting them in Greenland, but which would also put the country on the map as something that offers much more than polar bears and icebergs. Visit Greenland came up with the slogan "Pioneering Nation". This slogan draws mainly on the many narratives about adventure, exploration and discovery that already characterize Greenland. Of course, this applies first of all to the Inuit, who arrived on their dog sledges after travelling all the way from the Bering

Strait to Thule in the north-western corner of Greenland and subsequently spreading along the full length of the coast. This founding myth in the national Greenlandic narrative achieved international fame with the Danish Arctic explorer Knud Rasmussen's journey in the opposite direction in the Fifth Thule Expedition (Thisted 2010). Another narrative revolves around the Norsemen, the similarly widely travelled and adventurous Vikings, who immigrated from the south in the late 900s, around the same time as the Inuit were arriving from the north. From Greenland the Norsemen made excursions and "discovered" North America, several centuries before Christopher Columbus. Next, there are all the famous explorers, Fridtjof Nansen, Knud Rasmussen, Ludvig Mylius Eriksen and many more. Greenland still attracts people who wish to follow in the footsteps of these heroes of yore or who try to break new boundaries. All these narrative strands echo in *Pioneering Nation*, which of course also has room for the story about the small, young nation: the first case in history where an indigenous people is well on its way to full independence. Visit Greenland developed this concept into a complete "toolkit" with lots of pictures, slogans and buzzwords – freely available to all the players on the Greenlandic business market.

A central initiative in the branding of Greenland was the production of five TV programmes, each of 52 min' duration, titled "A Taste of Greenland" (Ace and Ace/Visit Greenland 2009–2013). The concept is well-known from similar campaigns. The idea is to send a chef who already has a name in the target community to travel around the country one wants to brand. The resulting film is something in between a "documentary" about the country (where, of course, one only focusses on desirable aspects) and a cooking show. In this case, the chef cooks with Greenlandic ingredients in improvised outdoor "kitchens", interspersed with scenes where we see how the food is collected and produced and get to meet the people involved and a number of other people selected to represent the community. Stills and footage from the first of these programmes were reused to create a series of short promotion videos, placed on Visit Greenland's homepage and on YouTube. One of these films in particular, the 2011 version with the title *"Be a pioneer"* received considerable publicity, not only outside Greenland but within Greenland as well. Mixed with all the images of beautiful landscapes, good food and tourism activities are five brief sequences inspired by Julie Edel Hardenberg's "Parents and child" and "Siblings" series, here reproduced in moving pictures. "Come and visit our pioneering nation" reads the caption that scrolls across the first sequence, "A mixed population – one nation" reads the next, while the last three read "Upholding traditions – forward looking"."Warm – welcoming", "Colorful – cool". In a Greenlandic context, anyone watching the film will be reminded of Hardenberg's photos and their underlying idea, and in the final sequence, Hardenberg actually poses with her own children. The film was shown regularly on the national television KNR during the fall of 2011 and spring of 2012, and thus, what served as nation branding to the outside world promoted nation building internally, in the early years of self-government.

Obviously, these images clash with the images of the victimized Inuit that have been dominant in the climate debate. The branding initiatives supported by Greenland's Self-Government all promote a picture of a population that is so much

Fig. 3.4 From the "Pioneering Nation" campaign 2012, Visit Greenland, photo David Trood

more than the frozen image of a dying hunting culture. The *Be a Pioneer* video and the *Taste of Greenland* programmes of course do mention the hunting culture – but they also focus on the new possibilities created by the warmer climate: healthy, juicy vegetables being pulled from the fertile soil in the Nuuk Fiord; the thriving sheep industry in South Greenland etc. The campaigns have resulted in the spread of pictures designed to present positive images of young Greenlanders taking active part in modern culture – while at the same time respectfully upholding traditions. It seems that a bridge is being built over the gap between ideology and reality: the idealized portrait of the free hunter vis-à-vis the demonized urban life. In a new campaign featuring the "Big Artic Five", the mixed population of Greenland is one of the five most important things to be discovered in Greenland, and in the *Colourful Nuuk* campaign, which is right now in the making, multi-culturalism, innovation and flexibility are among the key words. Greenland is preparing for a new era where mining and industry based on non-renewable resources account for a larger share of the income, hopefully finding a place alongside the well-established fishing and tourism industry (Figs. 3.4, 3.5, and 3.6).

3.4 Conclusion

Much has happened since 2006, and a similar representation to the Greenpeace video which I address in the opening sections of this article would not be possible in 2014. The implementation of the Act on Greenland Self-Government has radically changed the relations between Denmark and Greenland, and even though the first years following the new act did see a few incidents where politicians and journalists seemed to forget the new division of power, new and far more respectful

Fig. 3.5 From the "Colorful Nuuk" campaign 2014, Visit Greenland, photo Mads Pihl

Fig. 3.6 From the "Colorful Nuuk" campaign 2014, Visit Greenland, photo Mads Pihl

ways of communication and representation have become the norm. This is evident in all official statements from the Danish government. The new Arctic strategy: *Denmark, Greenland and the Faroe Islands: Kingdom of Denmark Strategy for the Arctic 2011–2020*, signed by the Government of Denmark, The Government of the Faroe Islands and the Government of Greenland,[2] is an interesting example of how the new circumstances require a new vocabulary, consistent with the equality expressed by the partnership metaphor (Ministry of Foreign Affairs 2011). In the Danish version, the expression "The Kingdom of Denmark" has replaced "Denmark" or "the Danish Realm" as the signifier for the unity of Denmark, The Faroe Islands and Greenland, while the term "rigsdelene" (parts of the Realm) is used for the three individual entities. In Danish, this expression sounds a bit odd, but the word makes it possible to avoid more problematic terms such as "countries" or "nations". It could be discussed whether this new language in fact reintroduces the idea of an empire - which of course is an interesting thought, considering the development in the Arctic. On the cover of the strategy paper, the Greenlandic, the Faroese and the Danish coats of arms are represented side by side, underlining the equality of the three entities. However, the Danish coat of arms is placed on a red background in contrast to the white background of the other two, which blend in with the white background of the title and the white and blue of the Arctic landscape into which the coats of armor are inserted. Furthermore, the red of the Danish coat of arms is reinforced by a stripe of the same red color running down the left side of the picture. In this way, Denmark's continued supremacy position is discreetly indicated and upheld. In 2013, The Faroe Islands published the report *The Faroe Islands – A nation in the Arctic. Opportunities and Challenges.* One observes the use of the word *nation* – no mention of "rigsdele" here! In this way, the balance of power is constantly being negotiated within the Realm.[3]

Current scientific reports also bear witness to the new awareness concerning the equal representation of Greenland. Scientists have understood that the people actually living in the Arctic need to be included in the research, not only as objects of the study but as participants and stakeholders in the research activity. Therefore, great efforts were made to include the Greenlandic flag on the official photo of the international LOMROG III Expedition[4] that visited the North Pole in August 2012. Unfortunately, the flag does not show on the photo but is hidden behind the American Stars and Stripes (Breum 2013: 110–11; 112–115). Likewise, scientists of Greenlandic heritage are much in demand in new projects and expeditions, which opens great opportunities for young Greenlandic academics.

Thus, a key new development in relation to "the new Arctic" is that while the area was previously viewed as pristine – a blank area on the map – it has taken on a new

[2] PDF available: http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/mss-denmark_en.pdf

[3] The Faroe Islands got home rule in 1948, supplemented by the so-called "Take Over Act" or "Self-Government Arrangement" from 2005.http://www.stm.dk/_a_2956.html

[4] http://polar.se/en/forskarrapport/lomrog-iii-slutlig-datainsamling-i-omradet-norr-om-gronland/

The expedition was part of the Danish Continental Shelf Project which aims at identifying potential claim areas in the polar regions in accordance with the United Nations Convention on the Law of the Sea (UNCLOS). http://a76.dk/lng_uk/main.html.

status that requires actors within all fields, including politics, economics and science, to include the population which now speaks with their own voices.

Another key aspect is the gap between outsiders' notions of the life that is lived in the Arctic and actual daily life, for example in Greenland, where the hunting culture only represents a small percentage of the country's revenue (Rasmussen 2005). In fact, the peoples of the Arctic often share these ideals themselves. In Greenland, hunting is a high-priority occupation, and everything related to this activity represents valuable cultural capital. On the other hand, few people actually wish for their sons to live as hunters, and hardly anyone wants for their daughters to live the life of a hunter's wife. In a sense, therefore, many Greenlanders have adopted the outside world's romantic notion of the "free" life of the hunter, who is his own master. A life that everyone agrees is ideal – as long as they do not have to live it themselves.

In Greenland, the debate over mining, the end to the zero-tolerance policy to uranium extraction and the so-called "Large-Scale Projects Act" have set a new agenda, not least in terms of visions and concerns for the future. The Large-Scale Projects Act allows foreign companies to contract foreign workers on collective (time-limited) agreements negotiated with trade unions outside Greenland. This will allow large numbers of foreign workers in, including Chinese labour. The law was passed by the Greenlandic parliament on December 7, 2012 after intense debate. Many Greenlanders fear that this spells the end of the Greenlandic welfare society. They also fear that Greenlanders will once again be by-standers to development. The Greenlanders have considerable experience with exactly that situation, since this was largely what happened in the 1950s and 60s when Greenland was opened up to foreign (then mainly Danish) investments and labour. At least in the public administration, this system survived long after the introduction of Home Rule, and in many industries Danes are still heavily over-represented, especially in top management positions. If the Greenlandic Self-Government wants to avoid a similar development, Greenland clearly needs well-educated people who can play an active part.

Greenland's biggest problem, however, is a lag in terms of highly educated and qualified labour. In many parts of the country, the current generation is the first aiming for high-school and university. Greenlanders often argue that Greenland's longstanding relationship with Denmark as a "model nation" has led to a lack of self-esteem and, to some extent, a lack of independence and willingness to take on responsibility. Thus, new, positive self-images are a fundamental necessity for building a population where people are able to see themselves as key actors in a society based on a combination of renewable and non-renewable resources. In that situation, initiatives such as the Pioneering Nation brand are of obvious importance.

Young Greenlanders are striving to become educated to be able to act as competent citizens in a globalized world. It is, however, no secret that many fall short and have trouble meeting the demands. Many Greenlanders find it obvious that Greenland should aim to become an independent nation. That is also the vision that most politicians hold up. However, political independence requires economic independence. As long as Greenland continues to be dependent on large subsidies from Denmark, it must remain a part of the Realm. The consequences of leaving the Realm may seem daunting, and while Greenland is actively seeking new partners and breaking off old ties to Denmark, Denmark and the Nordic region still offers a lifeline that few are willing to abandon. The dream of political independence is therefore carefully weighed against all the risks that are associated with the large-scale projects.

This is a complex scenario, but for now, some of the optimism that emerged with the Self-Government Act in 2009 still persists. And the Greenlanders were quick to join in when everybody suddenly began to record "Happy videos": videos of people dancing to Pharrell Williams's song "Happy".[5] The video is an excellent example of the contemporary mix of old and new: young people wearing national costumes and modern ski clothes, drum dancing and hip-hop, all of it with a heavy dose of mirth and irony. The video also illustrates that the new Arctic is framed by a new context where people are digitally fluent and active members of the global community in a way that makes the future development completely different from previous ages – and thus also completely unpredictable.

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Chapter 4
Perpetual Adaption? Challanges for the Sami and Reindeer Husbandry in Sweden

Peter Sköld

Abstract Reindeer husbandry is of vital importance for the Sami living in Sweden, Norway, Finland and Russia. With a focus on Sweden we can conclude that through a colonial history the reindeer herding Sami have achieved legal rights that to some extent guarantee their existence. This is largely due to a successful political mobilization. On the other hand conflicts over land use with non-Sami settlers and the Swedish state have been a frequent element in the industry. The Sami must also combat a stereotypical understanding of reindeer herding that often has difficulties in understanding the constant modernization and technical development. Today the reindeer herders compete with industries such as mines, hydropower, windmill parks, forestry and tourism. An additional threat is the predators and state policies around them. Reindeer herding is of vital importance to all Sami, but the legal system prohibits the large majority to be involved, something that has had recent political complications in the Sami society.

Keywords Reindeer husbandry • Sami • Indigenous • Political mobilization • Indigenous culture

4.1 Introductory Overview

Reindeer herding is an important traditional economy of about 30 indigenous peoples in the Arctic. Reindeer herding is conducted in all Arctic countries except Iceland, and also in Mongolia and China. Reindeer herding is ancient and still today performed with few differences in the Arctic. It is important in different ways for all members of the indigenous socities, herders and others. The relation between humans and reindeer is characteristic for the Sami, who is an indigenous people living in an area covering parts of northern Norway, Sweden, Finland and Russia, an area known as Sápmi in the Sami language.

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In the early history of reindeer husbandry, domesticated reindeer were used as decoys in the hunting of wild reindeer and for transport purposes in wintertime. Reindeer husbandry, being a nomadised occupation, requires large areas of pasture for transhumance. By virtue of their longstanding use of northern regions for reindeer husbandry, hunting and fishing, the Sami have acquired a right to this land use through what is termed the *time immemorial principle*. Both this right of reindeer husbandry and protection of Sami culture are inscribed in Swedish constitutional law (Allard 2006). The right of reindeer husbandry entitles the Sami to use land and water for their own sustenance and that of their reindeer and entitles them to reindeer pasturage, hunting, fishing and the erection of certain chalets and other structures as well as the taking of timber from the forest for fuel, building material and handicraft activities (Karlsson and Constenius 2005).

The Lapp Codicil of 1751 continues to govern the right of the Sami to cross the border between Sweden and Norway. No such right exists between Sweden and Finland. A convention has existed since 1925, indicating how reindeer straying onto the wrong side of the border are to be returned. It was still possible at the beginning of the twentieth century for the Swedish Sami to drive their reindeer out to the islands of North Norway in summertime. That right, however, has become increasingly circumscribed, and at the close of the century the Norwegian-Swedish Reindeer Pasture Convention became a subject of protracted negotiations between the two countries (Regeringen 2004, 2009). There are also areas in Swedish conifer forest regions where Norwegian Sami are entitled to graze their herds in wintertime (Gustavsson 1989).

The areas used by the Sami began to be nationally colonised by farmers – "colonists" – above all from the seventeenth century and some way into the twentieth (SOU 2006). In Lappmarken this was based on the so-called parallel theory (Göthe 1929), whereby reindeer herdsmen and farmers were to work side by side without impinging on each other's preconditions. This theory, however, did not always tally with reality, because during the snow-free period of the year the reindeer used the same pasture as the colonists' cattle (Lundmark 2008). Exact figures concerning the head of reindeer in Sweden have always been hard to come by. There is much uncertainty as to which reindeer have been included in the statistics. The first official reindeer count took place in 1911 and the most recent in 1970 (SOU 2006) (Fig. 4.1).

Sweden today has 43 reindeer herding communities, so called Sami villages, and 9 concession areas. The Sami villages are voluntarily affiliated to the National Association of Swedish Sami (SSR), whose mission is to safeguard the economic, social, administrative and cultural interests of the Sami, with special emphasis on the continuance of reindeer herding and its ancillary occupations. A number of Sami associations are also affiliated to SSR, which is open to Sami who are not members of any Sami village (Gustavsson 1989) (Fig. 4.2).

There are today some 950 reindeer husbandry enterprises. For a full-time livelihood the family undertaking needs between 400 and 600 reindeer, but for many families a sideline occupation is a matter of necessity. The biggest earnings are derived from the sale of reindeer meat. Other sources of income are the sale of fish and game and various encroachment compensatory payments (Karlsson and Constenius 2005).

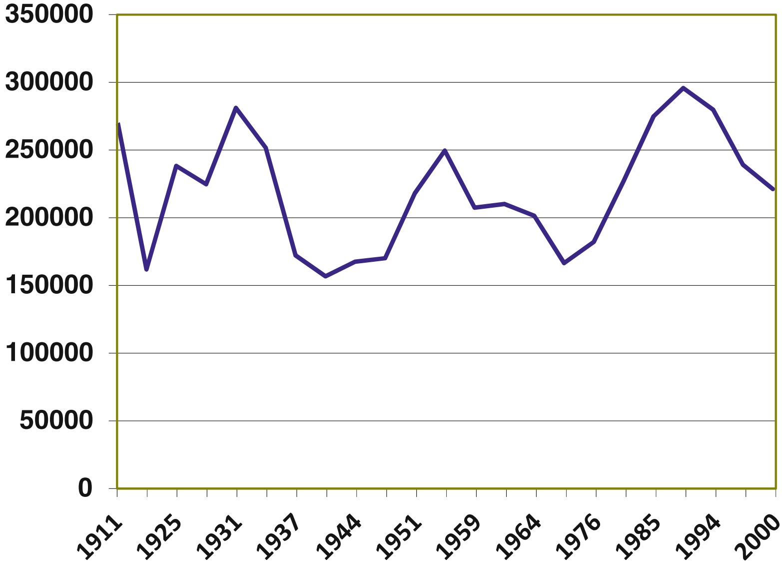

Fig. 4.1 Sweden's reindeer population, 1911–2000 (Source: Lantto (2000: 427), SOU (2001: 71, 2006: 88))

Sweden's reindeer pastures total 160,000 km^2 in area, which is nearly one-third of the whole country's area. Reindeer are moved in a fixed order between the east coast and the mountains bordering on Norway, according to a system geared to their differing needs of climate and nutrition at different times of the year. For this reason the Sami are sometimes referred to as the People of Eight Seasons. The reindeer have to grub up their staple diet – reindeer moss – themselves in wintertime, from under the snow and icy crust. A pregnant doe weighing 70 kg needs to find about 6 kg reindeer moss in order to meet her daily energy requirement (Gustavsson 1989). Reindeer can intermittently subsist on a more monotonous diet such as hay, but their main problem is coping with periods of starvation which occur, for example, when the snow crust makes the reindeer moss hard to get at. In summertime the reindeer move mainly on bare mountain areas, in forestry cutting areas, in natural meadows and in fenlands. The nutrient plants most vital to reindeer include above all various grass species and wetland plants, the most desirable being garden angelica, fireweed (Chamerion angustifolium), wood crane's bill, common cow-wheat and water horsetail. In autumn reindeer mostly eat fungi, preferably large Boletales, but also hay, sedge and grass. As nutrient content diminishes throughout the autumn, reindeer consume more shrubs, such as ling and blueberry (Svenska Samernas Riksförbund 2010b).

In wintertime lichen (reindeer moss) becomes more important as a vital basic feedstuff. It contains an abundance of energy, especially easily digested carbohydrates, but its protein content is low. Apart from reindeer moss, the most important nutrient plants for reindeer are shrubs of various kinds and wintergreen parts of hay and grass which the reindeer grub from beneath the snow. Reindeer meat is lean

Fig. 4.2 The Sami villages of Sweden, from North Dalarna County to the County of Norrbotten. *Thick blue line* limit of cultivation, *orange line* Lappmark boundary and *thin blue line* boundary of the Sami villages (Source: Samebyar (2010))

with a mild gamey flavour. The killing-out total can vary considerably, from 40,000 to 120,000 animals. The composition of the reindeer herd in terms of sex, age and weight greatly depends on the meat production outcome and an judicious choices of grazing areas and culling rates (Svenska Samernas Riksförbund 2010b).

The Reindeer Herding Act (SFS 1971) guarantees the Sami exclusive reindeer-herding rights. The definition of Sami is here based on descent, and parents or grand-parents must have had reindeer herding as a permanent occupation. Since reindeer husbandry and the traditional land is of immense cultural value, far beyond the group of reindeer herders, it is a problem when the whole ethnic group is not included in access rights. As a reaction to this the largest Sami political party in Sweden, Jakt- och fiskesamerna (the hunting and fishing Sami), is against a ratification of ILO 169 until the internal distribution of rights among the Sami has been solved.

The right of reindeer herding is held by about 8,000 people in Sweden but can be lost if the occupation is not sustained (Gustavsson 1989; Torp 2008). It is, however, very difficult to state the total number of Sami, since ethnicity as a variable has been excluded in official registers in Sweden since 1945. This causes serious problems to address any kind of statistical approach to the Sami society. We simply do not know how many Sami that enter universities or immigrate to other countries. Before 1945 there is on the contrary excellent population statistics that literary makes it possible to create complete digitized life biographies at the individual level for every person that was ever living in any of the parishes in the traditional Sami area (Axelsson 2010). An initial challenge for the Sami is to decide the principles of Sami ethnicity, or to simply answer the question who is a Sami. The Sami Parliament states that the criteria for inclusion in the electoral register is that a person can prove that they within three generations back have used Sami language in the home, and to state that they have a Sami identity. Every year a number of applications are rejected by the Sami Parliament. There are also informal systems of ethnic hierarchies where Sami can experience that they are not always included into the Sami community on equal terms. Notions exist where a "real Sami" must be able to talk the language, live in the traditional area and have a tight connection to reindeer herding (Åhrén 2008).

Box 4.1: How Many Sami Are There?

Sweden, Norway and Finland lack statistical data for the Sami people for the last 50 years. This makes it very difficult to estimate numbers, also for reindeer herding. Since it is an industry there is some accessible information relating directly to those who have reindeer husbandry as a direct income, but the overall figures are only estimates. There are reasons to believe that the figures presented here might be considerably higher.

	Sweden	Norway	Finland
Sami	20–40,000	50–65,000	8,000
Reindeer herders	2,000	2,700	500
Reindeer	250,000	200,000	200,000
Sami Parliament electoral register	8,322	13,890	5,155

Source: www.sametinget.se

4.2 National Sami Policy

Many of the preconditions of reindeer husbandry have hinged on national government policy (Mörkenstam 1999; Rumar 2008). The twentieth century was a period of turmoil, with many chops and changes in Swedish policy-making. When the century was only a few years old, the State adopted an approach based on the principle that "A Lapp must be a Lapp", the idea being to protect the Sami from what to them would be the harmful effects of *civilisation*. In the eyes of the politicians, the

Sami's only aptitude was for reindeer herding, and if they attempted anything else it would assuredly end in failure and poverty. Indeed, the politicians took these conclusions so far that they were convinced the Sami would die out and vanish as an ethnic group if they abandoned reindeer herding (Lundmark 2002).

Up until WW2, Sweden's Sami policy bore the imprint of ideologies which were conspicuously apparent in education and housing policy (Pusch 2000). Basically, the children were to be kept clear of Swedish culture and were only to be taught together with other Sami children, in ambulatory "nomad schools" (Sjögren 2010). At mid-century the aim instead was to educate Sami children to be *Swedish*. Speaking Sami in school was therefore still prohibited in the 1950s, and schooling has all the time made Sami society invisible, hence the striking ignorance prevailing in most connections (Sköld 2005). In addition it was firmly intended that reindeer husbandry should be conducted in accordance with ancient methods. The end of the war, however, was followed by a sea change. The new policy was aimed instead at integrating the Sami with welfare society and restructuring reindeer husbandry so as to maximise its financial return. The State wanted efficiency, with technology and modernisation replacing intensive manning. In addition, it advocated extensive reindeer herding only, thus completely abandoning the focus on intensive forms of herding. Compensation would be payable for damage and changed circumstances on the same terms as in agriculture (Lantto and Mörkenstam 2008). Today there are special environmental grants within the EU, aimed at preserving Sami heritage environments through reindeer grazing (SOU 2003). With the implementation of the new Reindeer Herding Act in 1971, it was deemed logical to do away with the old so-called Lapp Administration, with its special Lapp Bailiffs and transfer responsibility to the county agricultural boards (Lantto 2000). The Ministry of Agriculture became the central government agency responsible for reindeer husbandry issues. Reindeer husbandry was still portrayed in national government remits as being highly important, but its existence was now a prerequisite for the survival of other cultural manifestations, such as language and handicraft (SOU 2006; Green 2009).

In 1998 the Swedish Government publicly apologised for the oppression which the Sami had suffered at the hands of Swedish society (Jordbruksdepartementet 2004). Much remains to be done, however, and Sweden has been massively criticised, e.g. by the United Nations, for its way of dealing with Sami issues (Internationella justitiekommissionen (International Commission of Jurists) 2010). It is unclear how the Rio Declaration has been observed in the exploitation of the reindeer husbandry region (Antonsson 2003; Baer 1998) and Sweden has yet to ratify ILO Convention No. 169 (Indigenous and Tribal Peoples), adopted more than 20 years ago (SOU 1999, 2006).

4.3 Sami Political Organisation

To a great extent it was reactions against Sweden's reindeer grazing legislation that prompted to the Sami to begin seriously organising themselves politically in the early years of the twentieth century. Following some years of tentative efforts, the first Sami Congress took place in Östersund in 1918, and in that connection a central federation was formed and *Samernas Egen Tidning* ("The Sami people's own newspaper") began to be published (Lehtola 2002). The Sami had now equipped themselves with a forum for discussion and action. The 1919 Reindeer Pasturage Act impeded migration to the Norwegian side of the border in summertime, and the resultant problems became the core issue of the debate which followed.

Compulsory relocation of Sami from the Karesuando region and compulsory culling of reindeer herds had the effect of also initiating Norrbotten into the political process (Lantto 2004, 2008). For a few decades into the twentieth century, Sami politicians entertained a fairly pessimistic vision of the future prospects for reindeer husbandry and to a great extent envisaged having to phase it out and switch to a more agrarian activity. Even so, it was reindeer husbandry issues that intensified the political organisation of the Sami, and when SSR (the National Association of Swedish Sami) was formed in 1950, it was above all in order to represent the interests of the Sami villages. By and large, though, the Sami were tied to the Swedish Government's definition of Sami policy, which left a profound imprint on the political issues which the Sami were in a position to pursue actively. The State emphasis was on reindeer-herding Sami, which created a division between them and non-reindeer-herding Sami (Lantto 2000).

The scope of Sami political initiative expanded during the second half of the twentieth century, due above all to the revolutionary changes occurring in the sphere of reindeer herding. Rights issues, the international perspectives and the survival of reindeer husbandry became increasingly heated topics (Lantto 2003). From the 1970s onwards, the Sami became more and more closely involved in the Government Commissions which, ever since then, have done much to inform governmental actions in the field of Sami policy. But criticism was frequently expressed regarding the substance of participation. The formation of the Sami Parliament (Sametinget) occurred in 1993. This body has a dual task, being both a national authority and an elected assembly (Jordbruksdepartementet 2004).

Since 2007 the Sami Parliament has taken over much of the responsibility formerly invested in the County Administrative Board where reindeer husbandry issues are concerned, especially as regards reindeer counts, allowance within reindeer husbandry for nature conservation and heritage conservation interests, registration of business undertakings, price support, predator compensatory payments, the reindeer branding register and conciliation. The Parliament is also responsible for administrative affairs relating to the Sami villages (Fig. 4.3).

The Sami Parliament is also responsible for the maintenance of national boundary fencing, certain reindeer pasturage facilities and communication of knowledge concerning reindeer husbandry in the context of urban planning. The County Administrative Boards, however, retain certain responsibilities relating to reindeer husbandry, such as defining the maximum head of reindeer, supervising consideration by the Sami villages for the interests of nature conservation and heritage conservation, deciding on grants of user affecting land above the cultivation boundary and on reindeer pasturage mountains, and mediation in disputes concerning reindeer grazing on arable land (Central rennäringsförvaltning 2010).

Fig. 4.3 The Members of the Sami Parliament in 2009 (Photo by Hans-Olof Utsi, Sametinget)

4.4 Co-operation and Conflicts

Conflicts within Sápmi (Sameland, Lapland) receive a good deal of media coverage, but it is important to remember that cultural co-existence has in no way been entirely a matter of disagreements but has above all entailed unique forms of co-operation. This close conjunction of the cultures of northern Sweden has entailed reciprocal influence, manifested by language, culture and identity (Sköld 2009).

Perhaps one of the best examples of good co-operative relations between reindeer herdsmen and colonists was the so-called contract reindeer system (*skötesrensystemet*), whereby the in-migrating population were able to own reindeer which the Sami tended in return for assistance with overnight accommodation and other benefits. It is also likely that the reindeer owners favoured this co-operation for the simple reason that they appreciated the value of good relations. The colonists often had reindeer pastures of their own and gained access to meat, transport and hides. The crisis years of the 1930s brought widespread mortality among contract reindeer, and subsequent industrialisation transformed the structures on which the contract reindeer system had been based. The contract reindeer remaining today are a manifestation of the cherishing by the Sami villages of relations built up over a long period of time, apart from which they give non-reindeer-herding Sami an opportunity of close contact with the industry (Nordin 2002).

Nevertheless, relations between various groups in the reindeer husbandry region have been characterised by conflicts. The disagreements concern winter pasturage for the reindeer and the right of reindeer farmers to use areas which they have been using for ages past (Bäck et al. 1992). Reindeer herding leaves relatively few traces on the ground. This, coupled with the late development of a Sami written culture, has made for an onerous burden of proof. The concept of usage from time immemorial (*urminnes hävd*) has been of pivotal importance in the litigation which several conflicts have led to. Landowners suing Sami villages for trespass and damage maintain that it is only lately that the areas concerned have come to be used for reindeer husbandry, and problems occur when the Sami have difficulty in proving the contrary. Lawsuits of this kind are major undertakings, with preparations lasting several years and hearings lasting for several weeks. In the so-called Härjedalen Case, which ended in 2004, the court ruled that the reindeer owners had failed to prove rights of reindeer pasturage in large areas (Lundmark 2008). This has had far-reaching consequences. Negotiations for a settlement have deadlocked, and several landowners have claimed damages for encroachment. The Nordmaling Case, in which 120 landowners sued three Sami villages, was won by the reindeer owners, partly because this time the question of proof and the construction of ancient usage were viewed in a different light (Svenska Samernas Riksförbund 2010a).

Mining and reindeer herding operate in the same areas of northern Sweden. Their relation is complex, and there are evidence of both good cooperation and conflicting interests. Good forms of partnership have now been devised for the interaction between reindeer herding and forestry, e.g. through the setting aside of large eco-parks for the preservation of valuable lichen areas (Nilsson Dahlström 2003; SOU 2001).

4.5 Modernisation and Changes in Family Life

Up until the 1950s, reindeer herding was still based on traditional methods, with the herdspeople following the reindeer's migrations on skis and on foots. The whole family travelled with the *rajd* (pron. "ride"), consisting of between four and six traditional Sami *ackja* sleds pulled by special draught reindeer. Everything, from food and cooking vessels to the *gåetje* tents and the children, was loaded onto the different sleds. The intensive period came with migration down to the spring and autumn pastures, when the reindeer needed help with feeding (Kuhmunen 2000). A quieter period followed in the winter pastures, if grazing conditions were reasonably normal. Sami settlements leave few traces in the landscape. The hearths are usually easiest to find, and on closer inspection one may also find postholes (Halinen 2009). Hearths and hut floors often consist of a single ring of stones big enough to carry. Other remains are the areas of land with higher nutrient content due to natural manuring, indicating the spot where small herds of reindeer were penned in as a part of traditional reindeer herding. The flora there is more nitrogen-fixing than in the surroundings. Since 1998 the EU has been paying grants for the preservation of such sites (SOU 2003). Remains also occur here and there in the landscape in *sjïele* votive locations. A site of this kind may perhaps be just a natural formation, but still an important place redolent of tradition.

Towards the middle of the century, many reindeer-herding families settled near a main road or railway. They built themselves rudimentary houses consisting of one or two rooms. They retained their *lavvu* "*smoke huts*" as summertime accommodation and went on using them for smoking meat and fish. When reindeer husbandry entered a rationalisation phase in the 1960s, technical innovations began to be introduced. The snowmobile has been the most important among them. It is used all through the winter season and today is indispensable for corralling reindeer, watching over them and moving them. Off-road motorcycles and, more recently, helicopters have also come to be used for gathering and driving reindeer herds. In this way the work situation has been radically transformed within a short space of time (Kuoljok 2008; Kuhmunen 2000). Lorries are used for carrying reindeer long distances. Reindeer farmers have often been on the leading edge of technology use. When radio phones came on the market in the 1960s, the Sami quickly made use of them, and since then they have kept abreast of developments by means of MRG technology, computers and GPS monitoring of reindeer (Kuhmunen 2000; Skarin et al. 2008).

The rationalisation of reindeer husbandry also includes changed strategies regarding slaughter, the composition of reindeer herds, and feeding (Beach 1981). At the same time as reindeer husbandry can be seen to have developed successfully on the technical side, the fact is that people have had little choice in the matter. Extensive rationalisation notwithstanding, reindeer husbandry is still wrestling with financial problems. It is above all new technology and mechanisation (petrol) that have made reindeer husbandry an expensive operation to run (Jernsletten and Klokov 2002), which in many cases means poor profitability. The fact of the Sami nonetheless continuing with reindeer herding has to do with its being part of a long-standing cultural tradition, a way of life which leaves its mark on the whole of existence and makes for good quality of life. Often this makes families dependent on ancillary sources of income, such as craft occupations, land clearance and transport. Just like small farmers in parts of Sweden, the Sami are often dependent on the woman of the family going out to work and thus bringing home an extra income (Nordin 2007; Riseth 2003).

The traditional reindeer-herding community presupposed complete families consisting of man, wife and children. Their work was resource-demanding and all hands were needed. Today more than half of all reindeer-herding enterprises consist of single men. This contrast epitomises the extensive changes undergone by Sami society in the twentieth century. Up until 1971, Sami women forfeited their reindeer-herding rights if they married a man with no such privileges (Amftt 2000). In modernised reindeer husbandry, women assume a great deal of responsibility for money matters and children, but there are also women who are employed full time on reindeer herding. Here as in many other connections, gender equality issues have been highlighted in Sami society of late. One important aspect concerns the changed position of women in reindeer husbandry, and another concerns their role in politics (Blind 2003; Sunna 2004).

4.6 Landscape and Environment

Many river beds were drained and large areas of pasturage flooded as a result of extensive water regulation between the 1940s and 1960s. Valuable riverside pasturage, natural pasturage boundaries and migration routes disappeared. The pasturage areas have been replaced with paddocks and the natural migration routes by road transport. Reindeer husbandry has received a measure of financial compensation for these impaired circumstances, but the far-reaching consequences are not easy to size up (Össbo 2014). Through clear-felling, soil scarification and the construction of new roads, forestry has broken up winter pasturage areas and reduced the supply of winter grazing for reindeer. In year-round areas, the Silviculture Act enjoins consultation of the Sami villages prior to clear felling. Peat-cutting and extraction activities also have an adverse impact on pasture lands (Karlsson and Constenius 2005).

South Västerbotten and the north of Jämtland were worst hit by radioactive fallout following the Chernobyl nuclear power accident in 1986. What is particularly serious is that lichens and fungi absorb caesium, thus increasing wintertime toxin concentrations for the reindeer. True, excessive rejection of reindeer presenting caesium concentrations above the permissible 1,500 Bq per kilo can be avoided by slaughtering earlier in the autumn and feeding reindeer in winter, but there is no doubt that the Chernobyl disaster has left its mark on Sápmi for a long time to come (Broadbent 1989; Bostedt 1998).

The Sami have been herding reindeer in the north of Sweden for centuries. Sustainable utilisation of resources has been one of the preconditions of this practice. Thanks to their traditional knowledge of conditions and consequences, the Sami have by and large succeeded in conducting their activities in the region without impacting heavily on the ecology (Utsi 2007; Uddenberg 2000; Hållbar utveckling 2006). In this way the interests of reindeer husbandry have converged more and more with those of nature conservation, and in the Environmental Code the most important areas for reindeer husbandry are classed as areas of national interest. This can apply, for example, to herding points and to difficult passages and fords along the migration routes. If there are more reindeer than the resources can provide for, this will reduce the lichen cover, which has an annual growth rate of about 10 %, which in turn can lead to a transformation of landscapes and biotopes and to soil erosion. The big challenge to reindeer husbandry lies in managing pasturage in such a way as to preserve biodiversity (Liljelund 1997). Reindeer pasturage counteracts the steady advancement of the tree line, in this way maintaining an open mountain landscape and biodiversity.

4.7 Predators and Exploitation

Predators have always been feared by the reindeer-herding community. The predator problem existed all through the twentieth century, but its economic consequences have steadily mounted. Basically, the controversy regarding predators concerns demands for a compromise between predator preservation and the preservation of sustainable reindeer herding. Predators are now estimated to be killing between 45,000 and 50,000 reindeer annually in Sweden. Failing a reduction of this figure, the whole industry will be in jeopardy (Nilsson Dahlström 2003).

The wolf can kill between five and seven reindeer in a single night and often scatters the herd over large areas (Sikku and Torp 2004; Kuhmunen 2000). But the worst damage is inflicted by the wolverine and lynx. For both these species, reindeer are the staple diet in the north of Sweden. The wolverine is slower than the wolf and instead takes advantage of conditions when the snow cover is deep and has a frozen crust that will bear the weight of the wolverine but not that of the reindeer. The wolverine has the stamina to go on hunting a reindeer for miles without giving up the chase. The lynx, a skilled stalker, takes the lives of an estimated 23,000 reindeer in Sweden annually. The brown bear also hunts calves in spring, but not on such a scale as the lynx. The golden eagle hunts on open ground and mainly kills reindeer calves in the spring and early summer, but it is also capable of killing adult reindeer weighting up to 60 or 70 k (SOU 2007). It is important to remember that the size of predator stock is largely regulated by political decisions.

Reindeer herding needs to be able to use different pasturage areas at different times of the year, and winter pasturage is the bottleneck deciding how big a herd one can run. Large-scale mining operations are a phenomenon mainly associated with the twentieth century, and most mines today are located within the reindeer-herding area. Prospecting has led to an escalation of disputes with reindeer husbandry over the past years. And as has already been shown, hydropower development also poses a problem. Compensation rates varied, very much due to the Sami village not becoming a legal entity until 1961 and thus being unable, before that date, to file encroachment proceedings (Lundmark 1998). The wind power development of recent decades also threatens to circumscribe reindeer pasturage, and protests have been voiced in many quarters, though there are also Sami villages which have taken an active interest in wind farms (Labba 2004).

Then again, tourism in Sápmi grew steadily throughout the twentieth century. Mountain treks were already being organised by the Swedish Tourist Association when the century began, and today more and more people are making for the reindeer pasturage areas in order to hunt, fish or indulge in other outdoor activities. There are now between 40 and 50 Sami tourist undertakings in Sweden. Many of them are run by women, and about half of them combine tourist enterprise with reindeer herding or some other Sami economic activity. Sami tourism offers a variety of attractions, such as overnight accommodation in a *gåetje* tent, taking part in reindeer sorting and calving, lassoing, trekking with tame reindeer, visiting a Sami camp, taking part in everyday Sami life, sitting in on storytelling sessions, sampling

Sami food, attending *jojk* performances, going on guided tours and so forth (Pettersson 2004; Sundström 1999).

4.8 Most Important of All: Empathy with the Landscape and Fauna

Relating to the landscape plays an important part in Sami self-understanding, the landscape being a source of clan history insights, through place names, monuments and oral tradition. This contextualises the understanding of skills and of the dynamic between humans, animals and nature. The landscape provides a better reflection of Sami everyday life. Continuity of cultural traditions is best communicated through physical, acquired actions. These can be either informal or ritualised. They can also legitimise power hierarchies. Forms of linguistic expression can decide how a place is perceived. Often this is a matter of collective frames of interpretation. It is through participation that one learns how to behave in different situations. The capacity for deciphering and understanding landscapes can be developed over time (Jernsletten 2010).

In the everyday run of things, fluid boundaries exist between practical chores and religious acts, such as gathering the bones after a meal. Collective memories are created and patterns of action ritualised – often without any verbal explanations. One learns to show respect for different places. Place names encapsulate a meaning at a given point in time. Sami place names are often characterised as precise. The double meaning of place names often has a religious/ritual significance and/or describes topography and reindeer pasturage conditions.

It is not economic motives that make many Sami continue with reindeer herding, but the quality of life, the quasi-existential persuasion that reindeer herding is the meaning of life. Or, as one informant put it to the historian Åsa Nordin:

> Today it's a lifestyle. So long as we carry on reindeer herding the way we do, with extensive herding, migrations and guarding, it's a lifestyle. […] Especially when reindeer herding doesn't bring in most money, you factor other Sami values into it, values which cannot be stated in money terms, and when you assimilate and experiences those values as well, it's a lifestyle (Nordin 2007: 82)

Many families have been herding reindeer for generations, and to them it goes without saying that one must do everything in one's power to perpetuate the heritage and tradition. Love of reindeer and the satisfaction of being out in the wide open spaces with them are the main source of inspiration. To many Sami, the very thought of having to give up reindeer herding is a terrifying prospect:

> No, but I can't stop living. I can't do it. For as I see it, this is my life. To me, this is everything. […] It would be terribly hard. Oh dear, many tears would be shed. The reindeer die and there you sit. I can't sit here prophesying, but it would be terrible. I think it would kill one completely, half of me would surely disappear (Nordin 2007: 114).

There is a great need for improved conditions for reindeer husbandry today. Research show that the current governance structures marginalize and disempower reindeer herders, and that there, not least in the light of additional negative climate change effects, is a need for political awareness, action, and an over-all improved dialogue (Löf 2014). Reindeer herding and the landscape in which it goes on are of pivotal importance to a Sami community and to Sami culture. But the reindeer-herding Sami are not the only ones feeling strong ties to their home areas, and one challenge to be faced by tomorrow's reindeer husbandry will be that of devising forms of co-operation, both within Sami society and with other groups active in the region.

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Chapter 5
On Past, Present and Future Arctic Expeditions

Peder Roberts and Lize-Marié van der Watt

Abstract Today the term "Arctic expedition" conjures up images of heroic men chasing knowledge, but also personal and national glory. Geographical goals such as the North Pole, the Northwest and Northeast Passages and the discovery of new lands became major cultural touchstones during the nineteenth and early twentieth centuries. Individuals such as Sir John Franklin, Fridtjof Nansen, and Robert E. Peary became household names. Many smaller expeditions also ventured to the Arctic from Eurasia and North America. This chapter is about how large, publicity-friendly expeditions related to smaller, more prosaic ventures, and how the term expedition is used in the present to denote everything from seasonal fieldwork conducted by scientists to one-off feats of travel. We conclude with some reflections on how Arctic expeditions may look in the future – and how the term expedition continues to carry meaning in terms of culture and memory.

Keywords Arctic Expedition • Arctic Exploration • Northwest Passage • Northeast Passage • Nationalism • North Pole • Magnetic Crusade • Spitsbergen • Sweden • Norway • Arctic Science

5.1 Introduction

What images do the words "Arctic expedition" bring to mind? An expedition involves travel from a home base to somewhere less well known – usually distant – with a specific goal in mind (though what that goal is can vary). For many of us, the term "Arctic expedition" evokes heroic quests to probe the limits of knowledge and discovery while simultaneously pushing the boundaries of human endurance and

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ingenuity. These were deeds that won glory for the individual and the nation. It also calls to mind a past when Europeans had only sketchy conceptions of far northern lands and seas. At the same time, smaller expeditions ventured north for more prosaic goals – for hunting, whaling, or specific scientific tasks. These expeditions never quite gained the same cultural standing. This is important to remember, because expeditions have always been more than simply practical exercises in data collection: they also convey values and ambitions that speak to wider cultural and political contexts. Expeditions, in the opinion of sociologist Alex Soojung-Kim Pang, are worth studying not only in terms of their output. In following the planning process of an expedition, and how it was executed, one can delineate the active construction of the expedition's social dimension (including aspects such as domesticity, gender and class), its intellectual legitimacy and how it was linked to contemporary economic and political interests.[1]

This chapter does not seek to list or describe all major Arctic expeditions. Rather, the aim is to give an overview of some of the best-remembered Arctic expeditions in Europe and North America, to ask why they are well-remembered, and to reflect on how that particular idea of what an Arctic expedition is has influenced the present (and might well influence the future).

Today it is difficult to view the Arctic as an unknown space in quite the same way as a century ago. Moreover, we have moved away from the Eurocentric view that the Arctic is by definition unknown. Indigenous residents of the Arctic have not viewed their own lands in this way. Yet there is still a sense that the Arctic is a frontier that expeditions can penetrate, in the name of science or a more personal form of exploration, such as that expressed by, for example, adventure tourism. Thinking about what it means to have an Arctic expedition – scientific and otherwise – in this modern age allows us in turn to think about how the new Arctic is in some ways still thought of as a space for generically white men to discover afresh – and perhaps also what this says about how residents of lands further south see the Arctic and its residents as exotic.

5.2 Grand Expeditions of the Past

Although continental Eurasia and North America both stretch well above the Arctic Circle, travelling to the high Arctic from Stockholm or Toronto was a long and difficult process until recently. The Norse reached Greenland around the tenth century CE and Spitsbergen was discovered by the Dutchman Willem Barents in 1596. The geographical outlines of northern Scandinavia were far better known than those of North America or even Russia, where a major archipelago (Severnaya Zemlya) was discovered as late as 1913. Many of the first European travellers to these lands did so for commercial reasons or to seek lands to settle. Barents, for instance, was looking for new whaling grounds and his expeditions were financed by Dutch investors.

[1] Pang (1993).

Commerce helped create the need for Arctic expeditions in the eighteenth and nineteenth centuries. Even the greatest Arctic expedition of the eighteenth century – the Great Northern expedition of 1733–43, which charted much of the Siberian coast and discovered the Bering Strait and Alaska – was inspired by a desire for a faster passage from Europe to East Asia in addition to a more general aim to map and potentially control what became far eastern Russia.

The Northwest Passage, like the Northeast Passage, became an important goal. As its name suggests, this reflected a European perspective on the world. Britain, which styled itself the world's leading maritime trading nation in addition to its greatest naval power, placed a high value upon shorter trade routes and upon the more general need to compile a global magnetic atlas to assist with navigation. Both these needs led to state-sponsored Arctic expeditions and helped to establish Arctic exploration as a notable activity in British culture. The founding of the Royal Geographical Society in 1830 was evidence that exploration was becoming a socially important activity. The Royal Society, under Sir Edward Sabine, launched a "Magnetic Crusade" to chart the world, an event that included the region around the north magnetic pole.[2] The expedition commissioned to do this helped set a template for scientific research of the Canadian Arctic, argues historian Trevor Levere, through a detailed and broad set of scientific instructions that went beyond the main task of magnetic observation.[3]

The search for the Northwest Passage, which preceded the Magnetic Crusade, continued through most of the nineteenth century.[4] The most famous of all these expeditions was also the most disastrous – the expedition led by Sir John Franklin that departed Britain in 1845 with two ships and 129 crew, of whom none returned alive. Successive expeditions to find the lost expedition returned clues to its fate, including evidence of cannibalism, in addition to completing the charting of the northern coast of North America. The fate of the Franklin expedition became a fixation in Victorian British culture, and continues to inspire novelists, conspiracy theorists and nation builders today.[5] The grim fate of other contemporaneous expeditions to Arctic waters, notably that led by the American George DeLong to eastern Siberia, helped establish Arctic expeditions as noteworthy and exciting public events that the emerging newspaper business viewed as excellent copy.[6] The first successful traverse of the Northeast Passage, led by the Swedish geologist Adolf Erik Nordenskiöld from 1878 to 1880, became a defining event in the history of Swedish science and a significant cultural event despite the realization that the route was essentially without commercial value.

The drive to explore the Arctic for its own sake is a comparatively recent phenomenon. The Northwest Passage was originally a commercial goal, but the honour associated with completing the traverse helped make it an end in its own right,

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[2] The British Government approved the scheme in 1839.

[3] Levere (1993).

[4] See Berton (1988) and Williams (2003).

[5] See for instance Long (2014).

[6] Riffenburgh (1993).

demonstrating superiority through adventure and grit. By the time the Norwegian Roald Amundsen completed the first such journey in 1906, it was clear that like the Northeast Passage, it could have no commercial significance. Amundsen was concerned not with economic gain but with gaining renown for himself and his nation – which only gained independence from Sweden in 1905. His compatriot Fridtjof Nansen became the archetype of a new kind of Arctic explorer fit for an age of nationalism. Nansen led the first crossing of Greenland in 1888, traveling by ski – a technology that was strongly associated even then with Norwegian national identity. His achievement led directly to the formation of the Norwegian Geographical Society in 1889, with the goal of promoting Arctic exploration as an expression of Norwegian national strength. Nansen's most famous expedition took place from 1892 to 96, when he sailed the specially-designed ship *Fram* into the pack ice north of Siberia and deliberately allowed it to be frozen in. Debris from DeLong's expedition had washed up on the shore of Alaska, leading Nansen to hypothesize a transpolar series of currents that would carry his ship to the North Pole – the geographic goal that had become most important in the eyes of the public. Nansen decided to leave the *Fram* when it became clear it would not reach the Pole. Although he and his colleague Hjalmar Johansen failed to reach the Pole, their return across ice and water to eventual rescue on remote Franz Josef Land helped cement his fame. The failure did little to dampen Nansen's reputation, which crossed science and politics in addition to polar exploration. Indeed, historian Robert Marc Friedman has argued that a spirit of "Nansenism" became widespread among geophysical scientists in Norway, and describing fieldwork in harsh conditions as an "expedition" became a means of identifying oneself with a masculine, rugged tradition of research that went beyond mere intellectual demands.[7]

Given the implications of cultural primacy and progress, it is not surprising that 'firsts' bestowed legitimacy in an Arctic context – and the questions of who was first to the geographic Pole should be read in this context. The American naval officer and engineer Robert E. Peary's claim from 1909 to have reached the North Pole is widely accepted, despite doubts about whether he actually reached it, yet the rival claim by Frederick A. Cook to have attained the Pole a year earlier still has few supporters. The fact this controversy still arouses passions over a century later points to the deep emotional value invested in geographic firsts. Neither man had great pretensions to scientific achievement – although Peary's travel technique was hailed by many. Rather, the expeditions were public spectacles that made the individuals who led them into national heroes like Amundsen or Nansen. Once aircraft and airships became widespread from the early 1920s they became vehicles for new feats of travel, this time crossing geographic points through the air rather than on the ground. Amundsen eagerly took part in these and in 1926 became the first man to visit both the earth's geographic poles, having reached the South Pole in 1911 and now crossing the north in an airship. These expeditions continued to seek new lands – traversing areas that until then had never been viewed by human eyes – and showcased new technologies that in turn reflected upon the explorers and their sponsors.

[7] Friedman (2002), pp 107–173.

We might note that in the Soviet Union Arctic pilots became important cultural figures in the 1930s precisely because their bravery and nerve was combined with mastery of technology.[8]

Independent of the quest for the Pole, major expeditions other nations helped gain knowledge of the Arctic and its residents. Knud Rasmussen, himself born in Ilulissat, ventured to far northern Greenland in 1912 to determine whether it was separated from the mainland by water. His later expeditions would focus more strongly on the Inuit, among whom he had grown up. The Canadian anthropologist and explorer Vilhjalmur Stefansson led a number of expeditions, the most notable being the controversial Canadian Arctic Expedition of 1913–18, in which several members lost their lives. Stefansson's polymathic interests in the Arctic ranged from the domestication of its animals (notably muskoxen, which he hoped to introduce to more southerly latitudes) to understanding its people and their ways of life. Indigenous techniques of travel and survival became central in Stefansson's approach to Arctic exploration, although the intellectual contributions of indigenous people went unacknowledged.[9] We might think of both Rasmussen and Stefansson as transitional figures, who began their careers at a time when blank spaces on the map required filling and whose later work focused more on understanding the Arctic than discovering it. Levere has argued that an era in Canadian Arctic exploration ended in 1918, to be replaced by smaller, more prosaic expeditions.

But such divisions can also be questioned. Danes were still seeking money to explore little-known parts of Greenland even after 1945, and Stefansson's interests in colonizing the Arctic ran throughout his career. Perhaps the age of great Arctic expeditions did not have a definite conclusion. Instead of ending, they petered out, as the line between a heroic achievement and an extension of everyday life became more blurred. Aviation opened a new means of reaching unexplored areas of the Arctic, and polar aviators gained considerable public recognition. In a sense exploration by air was different in degree rather than kind from commercial travel. Once the North Pole had been reached by land it was conquered by air and then by submarine. The USS *Nautilus*, which surfaced at the pole in August 1958, showcased American military know-how during the Cold War – just like the Space Race or the massive International Geophysical Year programs in Antarctica during 1957–58. Yet the crew of the *Nautilus* never became as famous as the astronauts who became established as the new vanguard of exploration.

In addition to these highly-publicised expeditions, which marked the Arctic as a space where nations and individuals could win honour, the longer-standing vision of the Arctic as a place for business and even domestication persisted from the days of Barents. Once again we are wary of drawing sharp distinctions, but it is worth reflecting on how Arctic expeditions could possess value through repeated engagement with an already-discovered space rather than discovery anew – and how the Arctic thus became a laboratory and field site, in addition to a frontier.

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[8] See for instance McCannon (1999).

[9] Pálsson (2004).

5.3 Smaller Expeditions of the Past: The Case of Spitsbergen and Other Islands

If we think of the grand expeditions described above as acts of territorial discovery, revealing new places previously unknown to Westerners, the process of which they were all part was one of erasing blank spaces and replacing them with knowledge. It is no coincidence that the interior of the Scott Polar Research Institute, for many years the world's leading centre for Arctic explorers, featured a dome in which a map of the Arctic was accompanied by the names of the explorers responsible (and their ships). But charting the broad outlines of the Arctic and its people constituted the first rather than the last step in understanding Arctic spaces in terms of various scientific disciplines – and in many cases, establishing settlements or exploiting natural resources. Smaller expeditions were means to these ends, but the comparative lack of public fascination should not blind us to the fact they too carried political and cultural meaning.

In the section that follows we focus on Spitsbergen – the archipelago now known as Svalbard – because it nicely illustrates how cultures and traditions built around smaller expeditions provided foundations for activities in the present. Spitsbergen was a good deal closer to Europe than the North Pole, and travelling there was far less hazardous. This permitted regular visits by whalers, hunters, and even tourists in addition to scientists. Small whaling stations were established on the archipelago early in the seventeenth century and regular expeditions by hunters and whalers made it an economically productive space.

A new tradition emerged in the nineteenth century through a series of expeditions by Swedish scientists that began in 1837. These were comparatively small in scale and certainly did not capture public imagination like Franklin or even the Magnetic Crusades. Nevertheless, they produced a great deal of knowledge concerning the geology, cartography, and zoology of the Spitsbergen archipelago and established in Sweden what we might think of as a national Arctic research tradition – one based on small, serious-minded expeditions conducted by trained specialists rather than dashing attempts to discover new lands. This did not prevent them boosting the glory of the Swedish nation. Historian Urban Wråkberg is right to describe them as "the Viking raids of science" for their significance as expressions of nationalism, and Adolf Erik Nordenskiöld – the famous conqueror of the Northeast Passage – first gained Arctic experience through geological fieldwork on Spitsbergen.[10] Nevertheless, we find it instructive to consider why the Royal Swedish Academy of Sciences rejected Nordenskiöld's nephew Otto Nordenskjöld's application for support for an Antarctic expedition in 1901. Sweden had established a proud tradition of scientifically valuable polar research conducted by experienced specialists, the Academy's experts wrote, and Nordenskjöld was admonished for putting haste to be the first to discover new territory ahead of the thorough prepara-

[10] Wråkberg (1999).

tions necessary for making sound scientific studies with lasting value.[11] An expedition should be best, not first.

Spitsbergen remained a “no man’s land” outside national sovereignty until 1925, when a treaty confirmed the archipelago as Norwegian territory – albeit with guaranteed rights (mainly economic) for citizens of other signatory states. By 1920 a number of syndicates had claimed rights to mine coal there. The increased traffic had made it easier for scientists to visit and study, and geologists aided the practical business of identifying mining sites, giving science an important place within the boom of mining-driven interest at this time.[12] Mining was hard work and could certainly be conceived as a tour of duty, but hardly as an expedition. Regular scientific expeditions helped to justify Norwegian sovereignty and in 1928 the Norwegian state founded a new organisation to oversee scientific activity on the archipelago (NSIU, Norges Svalbard- og Ishavsundersøkelser – Norway’s Svalbard and Polar Sea Investigations). The name connoted an ongoing research program rather than a one-off expedition and carried echoes of another state-sponsored polar research scheme of the time: the Discovery Investigations, launched by the British government in 1923 to study the Southern Ocean and the whales that lived within it in order to place whaling regulation on a rational footing.[13] The geologist Adolf Hoel, a regular visitor to Svalbard since 1907, became NSIU’s leader. For Hoel, part of the goal was for regular expeditions to deepen Norway’s knowledge of Spitsbergen’s fauna, flora, geology, and topography in order to justify Norwegian administration. Knowing the islands inside out provided a practical basis for management and also a moral basis for claiming superior authority. Regular expeditions were a way of demonstrating continued national commitment to the archipelago.

At the same time, Hoel also saw oversight of expeditions conducted by nationals of other states as part of his mandate. A memorandum circulated widely by the Norwegian Foreign Office in 1928 – in several languages – stated clearly that Hoel and his office would provide guidance to prospective expeditions in order to prevent them repeating work already done or from getting into danger through poor preparation.[14] In turn, those expeditions would be encouraged to publish their results in the official publications of the NSIU – and Norway would assign place names in order to avoid confusion. Depicting an expedition to Spitsbergen as a task to be managed with maximum efficiency rather than a bold, risky penetration of the unknown in turn supported Norway’s view of the archipelago as a space under effective administration rather than a blank frontier. We might point to Danish administration of Greenland as reflecting a similar approach. The often bitter conflict between Denmark and Norway over which state held sovereignty over East Greenland lingered even after the International Court of Justice ruled in Denmark’s favour in 1933. Here again conducting regular, systematic scientific expeditions

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[11] See the report in KVA protokolls-bilagor, 13 February 1901. Held at the KVA Center for the History of Science Archives.

[12] Avango et al. (2014).

[13] See Roberts (2011).

[14] Copy printed in Norsk Geografisk Tidsskrift, 1928.

within a territory claimed as part of the state was a means of showing legitimate control over that space – as was getting other expeditions to acknowledge that control by seeking assistance and approval.

What kinds of expeditions took place within this framework? Hoel continued to oversee regular expeditions to Spitsbergen, and to some extent East Greenland, where his nemesis – the Danish geologist Lauge Koch – also oversaw a large program. Yet citizens of other states were able to conduct expeditions that contributed to specific branches of scientific knowledge. Among the most important were the Greenland expeditions of the German meteorologist Alfred Wegener. Today best remembered for developing the theory of continental drift, forerunner of plate tectonics, Wegener's career was directed more toward understanding atmospheric circulation near the poles[15] and in some cases also enabled their participants to imagine themselves as part of the glorious tradition of heroic Arctic exploration. Oxford and Cambridge universities sponsored a number of expeditions to Spitsbergen, Greenland, and other islands in the far north Atlantic that included a range of objectives, with cartography usually the most prominent. These expeditions were about adding to scientific knowledge, but also about building character in the young men.[16] Authorities in Denmark and Norway generally viewed the expeditions favourably, as they complemented rather than threatened national sovereignty: Britain was not interested in making territorial claims in the arc from Greenland west to Russia, and the expeditions functioned more as validations that the existing administrative framework could facilitate research. This is important to remember, because even the stridently nationalist Hoel – who had worried about matching the fine tradition of Swedish scientific research on Spitsbergen in order to not appear inferior – was able to cooperate with Swedes in the 1930s.

In 1930 the Swedish geographer Hans Ahlmann, who had for some years studied the composition of glaciers in Norway, approached Hoel with a plan for a Swedish-Norwegian expedition to Spitsbergen that would address a specific research question – how did the geophysical processes determining glacier mass operate on Spitsbergen? – and place field studies there within a wider geographical perspective. Ahlmann, who had cooperated for many years with Norwegian researchers, was insistent that such an expedition would bring the tradition of serious Swedish scientific research on Spitsbergen together with the present-day administrative authority of Norway, with Swedes and Norwegians working side by side in a way that strengthened rather than challenged the status quo. His case was strengthened when an NSIU expedition resolved the mysterious (and tragic) fate of the Swedish engineer Salomon Andrée's attempt to reach the North Pole by balloon in 1898. Ahlmann promptly used the discovery of that expedition's remains to revive Swedish interest within a context of necessary assistance from Norwegians.[17] His first expedition took place in 1931 and was sufficiently successful that Ahlmann led another expedition to Spitsbergen in 1934 – again with explicit international cooperation – before

[15] Teichert (1991).

[16] Roberts (2011).

[17] Roberts (2011) and Sörlin (2013).

taking his glacier studies to Iceland in 1936 and East Greenland in 1939. The overall effect was to make Arctic expeditions means to a greater end – in this case, understanding the physics of glaciers – with individual ventures conceived as fieldwork within a broader research program. Ahlmann himself made this point in 1932 when he denied that there was any such thing as a polar scientist; only a scientist whose research happened to require polar field sites.[18] The spirit of great expeditions from the past deserved applause and their legacies should be nourished in the present. But the modern Arctic was a laboratory rather than a frontier.

Elsewhere in the Arctic we can discern similar trends. The Soviet Union attached great importance to developing Siberia after the 1917 revolution, including natural resource extraction but also development of the Northern Sea Route (a less Eurocentric name for the Northeast Passage). Here again a major national institution was organized. Under the charismatic mathematician Otto Schmidt, the Chief Directorate of the Northern Sea Route (*Glavsevmorput*') took responsibility for scientific stations on the Arctic coast in addition to logistics related to transport from its founding in 1932. Despite the organization's focus on practical industrial development, as befitting an arm of the Soviet state, it also sponsored scientific expeditions that visited unknown areas of the Arctic Ocean – most notably the famous series of stations established upon drifting ice. The scientists and aviators who participated on those expeditions became famous, but at the same time, we suggest there was an element of showing mastery over territory by rendering it a controlled field site where routine scientific work could be done. Soviet sea ice research remained well regarded in the West right through the early Cold War. We should note an important difference, however. The scientific exploration of the Soviet Arctic was a far more nationalized process, with very few scientists from other states participating in expeditions there. Hosting or cooperating with foreign expeditions was a good strategy for smaller states such as Norway or Denmark, but unnecessary – and perhaps even dangerous – for the Soviet Union. This was particularly true after 1945, as the Cold War established the Arctic as a strategically important space for military planners.[19] Major pieces of infrastructure such as the Distant Early Warning (DEW) Line across northern North America demonstrated the militarisation of Arctic regions, a process that extended to Greenland.[20]

With the outlines of Arctic lands and seas known, obtaining detailed knowledge of those spaces became the most important aim, a task fulfilled through regular, smaller expeditions and field stations rather than grand ventures. State investment in Arctic science reached new heights, fuelled by the need to know the Arctic thoroughly for purposes of effective administration – particularly in Canada – as well as potential warfare. Expeditions that functioned as singular events were associated far less with individual explorers than with the strength of the states and institutions that made them possible. Operation Muskox, a well-publicised journey

[18] Ahlmann (1932).

[19] On Arctic science and the early Cold War, see for instance the work of Matt Farish and of the recent BOREAS project.

[20] Farish (2010).

from Churchill by the shores of Hudson Bay up through Victoria Island, the Great Bear Lake and down to Edmonton, was run by the Canadian armed forces in 1945–46 to test their vehicles' capacity for cold weather warfare. The small Swedish-Finnish-Swiss geophysical expedition to Spitsbergen for the International Geophysical Year (1957–58) was an expression of geopolitics: the three participating states were all ostensibly neutral in the Cold War, and their joint expedition to demilitarized Spitsbergen was a statement in the spirit of Hans Ahlmann – expressing fraternity between particular nations rather than downplaying the importance of the nation altogether.

5.4 Conclusion: Arctic Expeditions Today and Tomorrow

In the early twenty-first century the term "Arctic expedition" is associated primarily with two quite different forms of activity. On the one hand, the national research institutions that sponsor most large-scale Arctic science send regular expeditions in addition to maintaining field stations and conducting remote sensing observations. It is as yet unclear to what extent the continuing development of satellites and drones for scientific use (both above and below the seas) will cause another shift in how technology impacts expeditions, especially in the case where going to the field becomes less essential for gathering data. Nevertheless, there is precious little heroism in these processes, even though it would be wrong to suggest that the Arctic has become a hazard-free workspace. Geopolitics continues to play an important role in some instances, such as expeditions related to seabed claims under UNCLOS. On the other hand, commercial imperatives continue to underpin some forms of Arctic exploration – particularly for minerals and hydrocarbons. Most interestingly, individuals and small groups have continued to find new ways to justify feats of Arctic travel that can be viewed as part of the same tradition as Nansen and his ilk – even if their scientific credentials are usually pale in comparison, and the feats themselves speak more to challenges of the human spirit than contributions to geophysical knowledge.

What does this tell us about the contemporary and future Arctic? The change in how the Arctic is viewed today as opposed to a century ago is a product of more than just the cumulative acquisition of geographical knowledge that erased blank spaces on maps of the far north. Recognising that indigenous Arctic residents have inhabited these lands and seas for long periods and, come to understand and know them, has altered perceptions of just how unexplored the Arctic really is. It can feel anachronistic to describe an "expedition" to a space that is populated and in a sense already explored by its residents. Even unpopulated spaces are now known sufficiently well that high-profile visits can easily evoke the age of great national rivalries. Indeed, when a Russian expedition planted a flag on the seabed at the North Pole in 2007 (ironically financed in large part by a Swedish industrialist), commentary focused heavily on whether this signified a return to a time many thought had passed.

This in turn helps explain why those who embrace the language of expeditions and explorers in the present often describe their activities as part of a separate tradition to that of large-scale science. The act of travel tends to be more important than the knowledge acquired. In his study on modern Norwegian Arctic explorers, historian Matti Goksøyr has drawn attention to the importance of recreating great deeds and unwritten codes with parallels to organized sport.[21] Within this framework, the Arctic can once again become an arena for testing human qualities.

Today explorers do sometimes claim that their travels contribute to science through observations made on site, often pointing to the importance of documenting climate change, which allows them to present their expeditions as resonating with the concerns of the present. A good example is the British explorer Pen Hadow, whose personal story is rooted in the great tradition of British polar exploration – from the formative influence of his nanny – to his desire to complete hazardous and unique polar journeys (such as a solo crossing on foot from Canada to the North Pole) while conducting scientific observations *en route*. In a revealing 2013 magazine feature written by the British author and explorer Sara Wheeler, Hadow suggested that the future of exploration lay in the "micro level… to support science in the more hazardous technical challenges. They can help chart markers of change. A chapter has closed in a spatial sense, but another has opened."[22]

There is much to admire in Hadow's commitment to environmental protection, but his conviction that the explorer speaks on behalf of Arctic nature – the "chaperones" to a "defenceless princess"[23] – continues to draw on an image of the Arctic as a pristine, virgin territory to be described by the enlightened explorer that strikes us as rather outdated. The new Arctic in which we live today is widely recognised as containing fragile ecological and geophysical systems that are under threat from anthropogenic climate change. But it is also a thoroughly researched and explored set of lands (many inhabited) and seas where human activities from mining to tourism to science already take place, and where a range of cultures have long since built a sense of attachment to Arctic places.

We suspect that there will be Arctic expeditions for many years to come. Interest in the great expeditions of the past continues unabated; consider the 2011 commemorations in Norway for the 150th anniversary of Nansen's birth or the continued fascination in Canada with the Franklin expedition.[24] Even if the quest to devise and then perform new Arctic journeys eventually reaches a tipping point of irrelevance, savvy tourist operators will undoubtedly be able to sell historical recreations of past journeys (with greater levels and safety and comfort). Already today, past expeditions are eagerly mobilised by tourist operators seeking to locate their wares within a glorious and exciting historical tradition.

Whether the term "Arctic expedition" will be used by any serious or culturally sensitive investigator is another matter entirely.

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[21] Goksøyr (2002).

[22] Wheeler (2013).

[23] Wheeler (2013).

[24] For a nice example see Long (2014).

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Chapter 6
Arctopias: The Arctic as No Place and New Place in Fiction

Heidi Hansson

Abstract In fiction written from the outside, i. e., not by the indigenous population, an Arctic setting has long been used to emphasise the tough and heroic qualities of predominantly male main characters. The primary genres have been adventure stories and thrillers, with the region depicted as a natural rather than a social world. But there is also a counter-tradition where the Arctic is perceived as the route to or the place of an alternative world. Such utopian, or Arctopian works, appear in the nineteenth century when Arctic exploration maintained public interest and seem to reappear in the form of so-called cli-fi or climate fiction today. The works usually describe new forms of social organisation, and as a result, they contribute to changing persistent ideas about the Arctic as pristine nature. At the same time, genre characteristics rely on conventional ideas of the Arctic as empty space, which means that fantasies of the region continue to play a comparatively important role, despite increasing knowledge about actual conditions.

Keywords Utopian fiction • Hollow-earth fiction • Climate fiction • Mary E. Bradley Lane *Mizora: A Prophecy* • Tobias Buckell *Arctic Rising*

When the British Arctic Expedition of 1875–1876 returned to England after failing to locate the North Pole, there was obviously a great deal of public disappointment. *The Times* had reported extensively throughout the project, and after the expedition's return, published articles that attempted to transform the failure to at least a modicum of success. The argument in one of these articles runs that the expedition had after all managed to "dispel some illusions" and "add some miles of coast line to the Polar charts" (The contest between mind and matter). The illusions referred to concerned the belief that there existed a different, perhaps even tropical world that could be accessed via the North Pole:

> As those illusions were fondly cherished in many minds, we presume they were not utterly ridiculous; but it seems now to be placed beyond doubt that there is no open Polar sea; there is no oasis of milder temperature created by unknown conditions at the very Pole; there is no genial shore where Arctic fowl build their nests and rear their young; there is no coast

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> line at least in that direction, likely to reach the Pole; there is nothing, in fact, but a perpetual aggravation of the difficulties found insurmountable by former discoverers. (The contest between mind and matter)

The fact that the article writer remarks on these misapprehensions suggests that they continued to influence common perceptions of the polar region as late as at the end of the nineteenth century, but in the effort to reject them, the writer reinstalls two considerably more damaging ideas about the region: the Arctic is empty and it is dangerous.

As the site of numerous exploration ventures in the eighteenth and nineteenth century, the Arctic was conceived as the last frontier. The cluster of associations surrounding the region includes severe cold, distance from civilisation, dangerous conditions, barrenness and exposure to natural forces. Such images create “a dramatic atmosphere for challenge and adventure,” as Sherrill Grace notes in relation to northern Canada (2007:16), and Peter Davidson suggests that even today, a “voluntary northward journey implies a willingness to encounter the intractable elements of climate, topography and humanity” (2005:9). As literary matter, the idea of nothingness, pristine nature and harsh natural conditions has been particularly conducive to adventure stories and thrillers, as a kind of fictional development of the narratives of discovery published by Arctic explorers. In the last few decades of the twentieth century, the Arctic was frequently imagined as a conservative space where Nazi ideologies are still alive, the Cold War is still going on and themes like gender equality or indigenous rights remain in the background if they exist at all. The main characters in these examples of genre fiction are predominantly white men, and snow and ice are depicted in terms of conflict, conquest and struggle.

But as *The Times* article shows, there is also another strand of thought where the Arctic emerges as a transitional space between the familiar and the truly alien. The region exists in a kind of dream-time where real-world developments have had no effect and embodies primitivism as well as future potential. As the ultimate opposite of modernity it both defines metropolitan existence and provides a perspective on modern life. Ideas like these materialise in different ways in literature that could be termed Arctopian, or works with utopian features that are set in or take their departure from the Arctic. In contrast to the adventure stories, several of the utopian works represent feminist world-views or explore all-female worlds or at least alternative social arrangements. In some respects they therefore function as oblique rejections of the masculine image of the dominant heroic genres.

The coinage Arctopia combines the original Greek meaning of *topos* as place, simply referring to the geographical Arctic, and the history of neologisms where this word-element is combined with others to suggest an imaginary, alternative world. The most well-known of these terms is “utopia,” first used by Sir Thomas More as the title of his philosophical story of an ideal world (1516). The original meaning of the word is “no place” – outopia –, but over time, the term has been conflated with eutopia, “good place,” since the words are pronounced in the same way. Similar combinations are gynotopia, denoting a world of women, ecotopia, suggesting a world in ecological balance, euchronia, referring to an ideal time rather than an ideal place and of course dystopia, imagining a dysfunctional, often post-catastrophic world. The ideas could be projected onto any unmapped zone like the desert, the jungle, the highest mountain tops or outer space, but they are particularly resonant in relation to the Arctic since apart from the long-lived conception of the region as empty, there is a tradition of imagining the Pole as the entrance to another world.

Utopian stories appear particularly in three main periods, all of them marked by a sense of geographical, social and intellectual confusion. In very loose terms, these periods can be described as early modernity, high modernity and late modernity. In the sixteenth and seventeenth century, exploration and colonisation push the boundaries of the physical world further and further which means that established certainties are continuously challenged. A corresponding sense of uncertainty emerges towards the end of the nineteenth century when scientific discoveries lead to religious doubt and the rejection of old truths, and societies in Europe and North America experience rapid change as the result of industrialisation and urbanisation on the one hand and political ideas like feminism and socialism on the other (Kumar 2010:551). Today, the industrialised world is faced with what could be labelled a crisis of progression, when developed technology and increased productivity begin to seem increasingly unsustainable as routes to the future at the same time as previously peripheral regions like the Arctic gain increasing geopolitical significance. Realist literature thrives in periods when the society seems fairly stable and there is widespread consensus about what is right or wrong, but the model is less useful when it comes to representing an unstable, confusing present (Beaumont 2004:34). Experiences of insecurity as well as the realisation that the unknown places of the earth are disappearing encourage fiction that explores alternative societies, often with environmental messages at the centre.

Utopian literature is consequently not really about imaginary worlds. Rather, the works contain “a diagnosis of the ills of the present society, together with more or less elaborate schemes for its transformation and perfection,” as Krishan Kumar notes (2010:556). This requires a distance between the real and the utopian world that makes the genre unsuitable for depictions of a region as “home.” Inside representations of the Arctic therefore take other forms, such as realism or nostalgia, and to the extent that they display semi-utopian features, they are more properly defined as Arcadian than utopian in tone. Arctopias are more or less exclusively written from the outside, and in the past, usually by writers with little or no actual experience of polar conditions. Increasing knowledge about the Arctic will certainly affect the range of literary genre where the region is used as a setting, but genre characteristics also determine how the region can be described and what messages can be conveyed. At least the Arctopian genre seems to rely on conventional ideas where the Arctic is primarily understood as a natural as opposed to a social environment, although the respective value of these qualities differs.

In what follows, I will give a brief exposé of Arctopian fiction from what might be the earliest example, *The Description of a New World Called the Blazing-World* by Margaret Cavendish, Duchess of Newcastle, first published in 1666, to the surge of hollow-earth fiction appearing in the nineteenth century and the emerging genre cli fi, or climate fiction, that seems to be the most recent variety of Arctopian writing. My point of departure is that the Arctic environment matters as more than background and setting, both when it is only relevant in the earliest sections of the books and when the entire work is set in the region. The experience of the Arctic is a threshold that forces the protagonist to go through a process of estrangement where all signs of civilisation are stripped away in preparation for the encounter with utopia. In this way, the central characters are both related to and dissociated from the real world they and their readers inhabit.

A common scenario is that the main character leaves the metropolitan centre and ends up in the Arctic, sometimes by design but more often by accident. This is the case in Margaret Cavendish's prose narrative, which begins when a young lady is kidnapped by a love-sick merchant and taken on board his ship. The ship is blown off course and ends up at the North Pole where the crew members freeze to death and the young woman is transported to a parallel world where she becomes the Empress (Cavendish 2004:125–133). It is no coincidence that Cavendish's tale begins with a shipwreck, since many early modern maps show a procedure where the water of the oceans is emptied out at the Poles, creating a vortex that sucks down ships that sail too close to the edge. Although the "blazing world" is not itself Arctic, the work begins a long tradition of imagining the Poles as the passage to alternative realities.

The most elaborate theory of the polar passages is probably Symmes' theory of the hollow earth. In 1818, Captain John Cleves Symmes (1780–1829), Ohio, suggested that the earth is hollow and open at the poles, and that it is inhabited or at least inhabitable both on the inside and the outside (Griffin 2004:382). The theory was taken quite seriously, at least by some, and when Symmes petitioned the Congress of the United States to send an exploration party to the Arctic to search for the entrance to this inner world, 25 congressmen voted yes (Bailey 1942:285 n. 4). The idea inspired a great deal of fiction, beginning with the pseudo-travelogue *Symzonia: A Voyage of Discovery* (1820), allegedly written by a Captain Adam Seaborn who may have been Symmes himself. *Symzonia* is unusual in that there is a conscious attempt to find the utopian world, but in other ways, it exhibits the same type of characteristics as other Arctopian fictions. Immediately before the explorers enter the internal world, the compass becomes useless (Seaborn 1820:78) as a symbolic sign that ordinary means of orientation are no longer sufficient. As a literary trope, malfunctioning technology suggests that the power relations between nature and culture are reversed which leads to a loss of the characters' social and cultural selves.

In later hollow-earth fiction, the Arctic repeatedly functions as an alien space that takes the protagonist out of his or her comfort zone physically and cognitively. Extreme natural conditions expose the visitor to an environment where familiar ways of interacting with the surrounding world are challenged. As nature and emptiness, the region becomes an imaginative space where society is left behind. It is no coincidence that so many of the works begin with an accident: losing control is a necessary preparation for the encounter with the utopian world because it strips away the visitor's cultural constraints and certainties. Thus, shipwreck leads to the discovery of an alternative world in William George Emerson's *The Smoky God*

(1890) and in William R. Bradshaw's, *The Goddess of Atvatabar* (1892), whereas William Jenkins Shaw's *Under the Auroras* (1888) and Robert Ames Bennet's *Thyra: A Romance of the Polar Pit* (1901) begin with hot-air balloon crashes in unexplored parts of the Arctic. The initial accident causes a sense of disorientation that prepares the protagonists for an alien experience that will require cognitive reorientation. The governing idea is that logical processes will not be sufficient for the radical rethinking necessary. The initial encounter with the Arctic breaks down established structures and this process is continued in the utopian sections of the novel where the old paradigms are replaced with alternative social, technological and spiritual models. It would be a mistake, however, to expect the utopian worlds to be politically radical in the sense normally given to the word. Although many, perhaps even most of them, exhibit some variety of communal sharing of resources and rejection of individual ownership, their political vision is often some kind of benevolent dictatorship, ruling the worlds through emperors and empresses, as in *The Blazing World*, a "Best Man," as in *Symzonia* or semi-divine leaders, as in *The Goddess of Atvatabar*. As genre fictions, they are interesting not primarily for their aesthetic qualities which are generally slight, but as cultural phenomena, contributing to our knowledge about the Arctic as metaphorical space.

Mary E. Bradley Lane's 1890 novel *Mizora: A Prophecy* was first published as a newspaper serial in the *Cincinnati Commercial* 1880–1881 and imagines an all-female society accessed through the North Pole. The Arctic is only a factor in the first ten pages of the story, but it plays a crucial role as the space where the protagonist is primed for her encounter with new ways of thought. The first-person narrator Vera Zarovich is a member of the Russian nobility and belongs to a family of wealth and political power. After supporting a radical Polish friend, she is sent to prison in Siberia. She escapes on a whaling ship but has to abandon the vessel when it is caught between ice floes (Lane 1890:5). The notion that utopia can only be found by accident is emphasised when she states: "Had I started out with a resolve to discover the North Pole, I should never have succeeded" (Lane 1890:8).

After the shipwreck, Vera finds refuge in an Esquimaux settlement where she is stripped of most of the physical signs of her metropolitan self: "I at once proceeded to inure myself to the life of the Esquimaux. I habited myself in a suit of reindeer fur, and ate, with compulsory appetite, the raw flesh and fat that form their principal food" (Lane 1890:11). Her mental faculties remain intact, however, and she impresses the Esquimaux by her technological aptitude: "I secured the esteem of the Esquimaux by using the compass to conduct a hunting party in the right direction when a sudden snow-storm had obscured the landmarks by which they guide their course" (Lane 1890:11). The fact that the instrument she uses is a compass may be taken as an indication that she is still in control of her Western self and able to orient herself in the world. This situation changes when she reaches Mizora.

Although the indigenous population is depicted in a fairly positive way in the text, the Esquimaux group is portrayed as a premodern collective and never individualised. The idea of Western and metropolitan superiority informs the description, as illustrated when Vera's refers to them as "these poor children of the North" (Lane 1890:11). The Arctic environment is however also a positive contrast to the metropolis, as a simple world that can be grasped and understood in contrast to the uncertain society Vera has left behind. Unlike the unpredictable politics of Russia and Poland, the Arctic dangers are understandable and consist of bad weather, lack of food and cracking ice. The goal of the indigenous community is simply to secure food and shelter and it is non-political because it is pre-political: “I soon discovered the necessity of being an assistance to my new friends in procuring food, as their hospitality depends largely on the state of their larder” (Lane 1890:11). In comparison with the Esquimaux community, metropolitan Russia and Poland emerge as unpredictable and confusing, with old social structures and privileges crumbling.

An important idea in the text, and indeed in utopian fiction generally, is that out-moded certainties have to be removed to make room for new ideas: “It is so hard to get human nature out of the ruts it has moved in for ages. To tear away their present faith, is like undermining their existence” (Lane 1890:7). The primitive Arctic life-style is one of the experiences that prepares Vera for the mental reorientation she will undergo in Mizora and loss of control is the other. After staying in the settlement for a while, Vera tries to travel on in a small boat, only to be drawn into a maelstrom that carries her to the country of Mizora: “My feeling of distress increased when I discovered that my boat had struck a current and was beyond my control” (Lane 1890:13). But even after she has left the Arctic, the region is implicitly present as comparison and contrast. As a representative of metropolitan modernity, Vera is positioned between the primitive social organisation of the Esquimaux and the ultra-refined society of Mizora at the other end of the spectrum. Her position between two extremes is emphasised when her racial and cultural superiority in relation to the Esquimaux is transformed to racial inferiority in Mizora where she is the only brunette in a society of blonde women. Different food habits draw further attention to the tri-partite division of life-styles. The Arctic is carnivorous and finding food requires weapons: “A few hours [sic] work furnished us a new house out of the ever present ice. We feasted on raw meat—sometimes a freshly killed deer” (Lane 1890:12). Mizora, on the other hand, is a society of eternal peace and vegetarianism, and the raw meat of the Arctic is contrasted with the natural fruit served in the utopian world: “Fruit appeared to be the principal part of their diet, and was served in its natural state” (Lane 1890:18). Vera occupies the middle ground as somebody who is unused to both unprepared meet and a vegetarian diet: “I was, however, supplied with something that resembled beefsteak of a very fine quality. I afterward learned that it was chemically prepared meat” (Lane 1890:18).

Another tri-partite division is the absence of money in both the Esquimaux settlement and Mizora in contrast to the wealth of Vera’s family. Metropolitan capitalism is implicitly critiqued in relation to both primitive and futuristic social arrangements, since the family money proved insufficient to protect Vera from prison. The silence of the Arctic environment and Mizora, likewise, are opposed to the bustle of the modern world: “I stood upon the uplifted verge of an immense city, but from its broad streets came no sound of traffic, no rattle of wheels, no hum of life” (Lane 1890:16). While most of the text is obviously concerned with the alternative life in Mizora, the three possible organisations of the Esquimaux settlement, metropolitan Europe and utopia are indirectly addressed throughout.

The modern world is in many ways the least attractive, as unpredictable and socially unstable in comparison with the functional communities in both the Arctic and Mizora. Both the ultra-primitive and the ultra-sophisticated societies thus offer an escape from the pressures and confusions of modernity.

The Arctic is not only, then, a convenient blank surface for projections and images in turn-of-the-century utopian fiction. There are also thematic functions, such as the role of the Arctic as a distinct contrast to the civilization left behind and a refuge from the pressures of modernity. As an environment that is regarded as pre-social, it is a mediating space between the modern present and the utopian future. As a dangerous place, it is a symbol of peril and the potential loss of self that is necessary for mental reorientation. As an alien space, it escapes cognitive control. These imagined qualities mean that the Arctic is frequently represented as a place of becoming. These tendencies persist in certain varieties of present-day Arctic writing.

The developing genre cli-fi or climate fiction can in many ways be seen as a twenty-first-century equivalent of the utopian genre. It builds on the conventional idea of the Arctic as pristine nature, but to add a "green" dimension to the representations is to trouble the previously "white" dimension, or the idea that the Arctic is virgin territory to be claimed by the adventurous explorer. Works often introduce near-future, post-catastrophic scenarios where global warming has created a new Arctic, and the stories are commonly constructed according to pastoral or apocalyptic models, as the main ecological patterns in fiction. There is sometimes a quite didactic or prescriptive side to the novels which causes trouble for critics, since it invites an approach that is less concerned with the literary representation than the ecological threats represented.

A recent example of cli-fi is Tobias Buckell's *Arctic Rising* from 2012, set in an Arctic where the North-West passage is open and the "Arctic Tigers" Canada, Greenland and Russia emerge as new world powers:

> [T]he basin is full of gas and natural resources, all easier and easier to get at now that the ice all but gone. Greenland is a natural resources superpower, a few hundred thousand Inuit made rich by nationalized returns of their claims. Canada exploiting these islands hard. And where oil is plenty, intrigue comes with it. Basic history. Middle East, Nigeria, South America … when it's outside their borders, the other big nations play hard for control of it. (Buckell 2012:159)

The Arctic is a political hotspot as well as a multi-cultural region where people from all over the world go to reinvent themselves. The novel plays with conventional ideas like the contrast between the metropolis and nature, with ultra-modern technology both threatening and protecting the natural world. The eco-terrorism plot is not the most interesting feature of the novels but rather how Buckell imagines the new Arctic:

> The Arctic still had an island of ice floating around the actual Pole. It was kept alive by a fusion of conservationists, tourism, and the creation of a semi-country and series of ports that sprang up called Thule. They'd used refrigerator cables down off platforms to keep the ice congealed around themselves despite the warmed-up modern Arctic, a trick learned from old polar oil riggers who'd done that to create temporary ice islands back at the turn of the century. (Buckell 2012:4)

Thule is divided into different experimental societies, or demesnes, each with their own system of rule and life-style options: "Last count, Anika recalled there being some 40 mini-countries within Thule, each an experiment in whatever its founders considered the most optimal way to thrive" (Buckell 2012:233). These include, for example, the dictatorship Pytheas, the radical democracy Peary and the demesne set apart for the 400 surviving polar bears.

The story ticks all the boxes, with the main character a Nigerian gay woman who works as an airship captain for the international United Nations Polar Guard, policing the semi-lawless region. The novel is politically correct to a fault, and Buckell does not succeed in making his characters believable, but the work is interesting as an example of a new kind of writing about the Arctic where the Arctic is central rather than peripheral. The region is itself a site of modernity and future development, a social arena where things happen: "Someone, somewhere, once realized that the Arctic Circle needed its very own Hong Kong, its very own Singapore" (Buckell 2012:230). Compared with the utopian novels of the late nineteenth and early twentieth century, recent cli-fi uses the Arctic as a setting, not only the transition to an alternative world. The familiar preconceptions nevertheless continue to be circulated, albeit in a new way. Referring back to the article about the British Arctic Expedition in *The Times* 1876, works build on the idea that there is, in fact an "open Polar sea," there is an "oasis of milder temperature created by unknown conditions at the very Pole," there is a "genial shore" in the far North and there is a coast line that reaches the Pole (The contest between mind and matter). The difference is of course that these conditions have been created by global warming and ecological disruption, and are far from desirable in the way they were thought to be.

It would be unfair to criticise Buckell's novel for what it does not set out to do, but it is worth noting that the Arctic is a settler region in his text and there is little if any evidence of an indigenous population. In many ways, the idea of the Arctic as an empty space for fantasies and projections still remains. In the Arctopian genre, this is perhaps to be expected since it allows both disaster narratives and more hopeful developments. What seems to be happening, even if fairly slowly, is that the Arctic is more and more used as the setting for realist, literary fiction, as in Vendela Vida's *Let the Northern Lights Erase Your Name* (2007) or Kevin Patterson's *Consumption* (2007). In popular fiction, crime writing is becoming increasingly common, with examples like Dana Stabenow's series about the native Alaskan investigator Kate Shugak, Sue Henry's series about the sled dog racer Jessie Arnold and John Straley's comic mysteries about settler communities in Alaska. Similar tendencies can be seen in the Scandinavian countries, with the prize-winning novel *Kautokeino, en blodig kniv* (*Kautokeino, a Bloody Knife*) by Lars Pettersson (2012) or Åsa Larsson's novels about the north of Sweden. As opposed to adventure fiction, detective stories normally require an urban, or at least social setting, which ought to change the way the Arctic is represented. One effect of this development is that indigenous people begin to appear as protagonists and supporting characters, individualised rather than collectively described.

So what stories can be told about the Arctic today? The world's interest in the region primarily focuses on geo-political matters such as natural resource extraction and security or its function as early warning system in relation to climate change. In fiction, this seems to mean that fantasies of the Arctic continue to play a comparatively important role, despite increasing knowledge about actual conditions. New genres are certainly appearing, and slowly help to change the fictional images and uses of the area, but at least in the field of popular fiction, the dominant genres are still the ones where the real Arctic takes second place to its imagined counterpart.

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Chapter 7
The Fleeting Glaciers of the Arctic

Øyvind Paasche and Jostein Bakke

Abstract Glaciers and snow are the very symbol of the Arctic, covering large parts of its terrestrial surface throughout the year. The cool temperatures that have allowed for the widespread coverage of glaciers are now trending towards a warmer climate, and with this gradual shift we observe an abrupt response in the cryosphere of which glaciers are a key component. This change is manifested in retreating fronts and an overall thinning. Because the typology of Arctic glaciers is rich and varied, the response pattern to the on-going warming is not unison. Instead, there are large spatial variations due to the critical balance between summer temperature and winter precipitation in addition to other factors such as aspect, altitude, geographical location, debris cover, calving and so forth. Still, minor variations is superimposed on a larger trends which suggests that in a not so distant future, glaciers will probably be less abundant than what has been common for the last 100 years. In the context of the last 10,000 years it is evident that arctic glaciers have changed significantly and they have even been smaller than they are today, which was the case 9,000 to 5,000 years ago. On Svalbard, two glacier lake sediment records foretell of large past variations, indicating a more articulated sensitivity to climate change than what is commonly perceived for the Arctic cryosphere.

Keywords Arctic • Glaciers • Svalbard • Climate change • Lakes • ELA

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7.1 Introduction

Glaciers, masses of moving snow and ice occupying cirques, valleys and mountain caps, are still the hallmark of the Arctic. On Svalbard glaciers cover around 60 % of all landmasses (Hagen et al. 2003) (Fig. 7.1), on Novaya Zemlya island glaciers extends down into the adjacent sea covering one fourth of the total landmass, mostly north of 74 °N. On Greenland, over 80 % of all land is covered by a massive ice sheet with numerous outlet glaciers. The present day picture of a glacierized, white Arctic has a broken history that goes thousands of years back in time, probably longer. Even so, this picture is now changing: where white is substituted with grey, green and blue!

Fig. 7.1 Overview map of Svalbard where the two key localities are represented by *red circles*

In all quadrants of the Arctic, glaciers are retreating, not all glaciers, but the trend is unmistakable, and if anything, the retreat rate appears to be accelerating. This detailed and fairly accurate picture of the Arctic cryosphere is drawn pixel by pixel by a series of satellites that permit the constant collection of data across vast areas, at high resolution and from places on Earth that otherwise is cumbersome and time-consuming to access. Between 2004 and 2009 Novaya Zemlya alone lost, based on the GRACE satellite, 5.8 ± 3.0 Gt a^{-1} (Moholdt et al. 2012), whereas the Greenland Ice Sheet (GIS) is loosing mass equally fast. Unfortunately, remote sensing covers only the last 30 years, leaving for other types of data to fill in the many gaps.

Extrapolating trends based on year-to-year observations are sometimes necessary and frequently valuable, but when what we seek to grasp is a type of variability best explained by trends that play out on multi-decadal, centennial or even millennial time scales, other data sources become relevant and occasionally critical. Consequently, the observations we see through the eyes of the satellites needs to be evaluated within a somewhat longer temporal frame such as for instance the last 11,700 years commonly referred to as the Holocene (representing a significantly warmer mean climate state than that compared to the ice ages).

Appreciating and approaching change in natural systems across multiple timescales is the very essence of *paleoclimatology* (*palaios*, of Greek meaning ‘ancient’), which includes climate characteristics and variability on all relevant time scales. One major motivation for reconstructing past climates is precisely that it provides a unique perspective on natural climate variability; environmental trigger points, trends and means! A classical example is atmospheric CO_2. The concentration of atmospheric CO_2 has risen systematically since monitoring started in 1957–a stand-alone observation of immense and growing value. On longer time scales, and with the aid of kilometre long ice cores from Antarctica and Greenland, we now know that CO_2 and temperature operates in tandem whenever you switch from an interglacial to a glacial climate throughout the last 800,000 years, and additional data from deep sea cores indicates that the present atmospheric CO_2 level of 400 ppm hasn’t been higher during the last 55 million years (Zachos et al. 2008)! Providing a temporal context to present day variability and dynamics is, in other words, a key deliverable from the paleocommunity.

Arctic glaciers have, as mentioned above, changed considerable during the last decades, and are likely to continue doing so due to unabated emission of greenhouse gasses, but part of the picture is that the same glaciers were at, or close to, maximum positions (in terms of extent) just 90 years ago or so; and that in the context of the last 10,000 years or so. And from that observation, it seems logical to conclude that part of the retreat we’re observing just now is simply part of natural fluctuations. As it turns out, providing exact figures on how much of the current retreat that can be attributed to anthropogenic forcing versus natural, internal variability is relatively demanding, and a question that remains to be answered with some precision. On the Agassiz Ice Cap (AIC) in the Canadian Arctic, it has for instance been documented in detail in several ice cores that surface melting was much more common in the early Holocene (Fig. 7.2) probably due to higher summer insolation (e.g., Fisher et al. 2012). Clarke et al. (2015) shows that by the twenty-first century glaciers of Western Canada will be reduced by 70±10% compared to the year 2005,

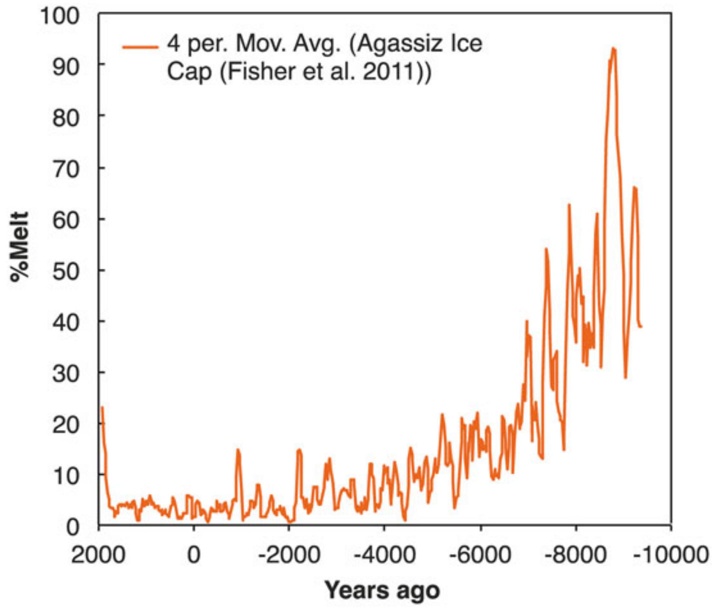

Fig. 7.2 A composite of several ice cores from the Canadian arctic ice cap Agassiz reveals years where enhanced melting occurred. The degree of melted layers is summarized and shown as %. The trend is in line with summer insolation, which suggests strong melting 10–12,000 years ago followed by a gradual decrease towards present day

which suggests a return to less Arctic ice, but for other climatic reasons (i.e. CO_2) an increasing impact due to continued CO_2 emissions.

The internal dynamics of landbased Arctic glaciers vary greatly, although their surface appearance may be similar (Fig. 7.3). Take for instance *surging glaciers* being best characterised by sudden (on seasonal time scales) bursts of downstream advances of the glacier snout, which at first order, is unrelated to climate change (Yde and Paasche 2010). In 1995–6 the Kuannersuit glacier on Disko Island surged (Yde et al. 2005), but interpreting the following retreat as part of a response to the current warming makes no sense. In fact, it appears that this type of glaciers tend to surge repeatedly, if not periodically (Eisen et al. 2005). Understanding *that* variability is key to understanding how Kuannersuit glacier interacts with climate, but it should not necessarily be generalized to other glaciers. On Novaya Zemlya, marine-terminating outlet glaciers have during the last 20 years or so receded with 52.1 m a^{-1}, which is an order of magnitude higher than the land-terminating glaciers (Carr et al. 2013), indicating yet a difference.

Because local variations of glacier movement can be large, notwithstanding the type of glacier in question, it is clearly an advantage to have more than one glacier reconstruction from a certain area if one are to draw inferences about past glacier activity which otherwise can be the random result of internal variability (Roe and Baker 2014). Here we present results from two small cirque glacier systems (Linnébreen and Karlbreen) from Svalbard where the size of the glacier, and hence

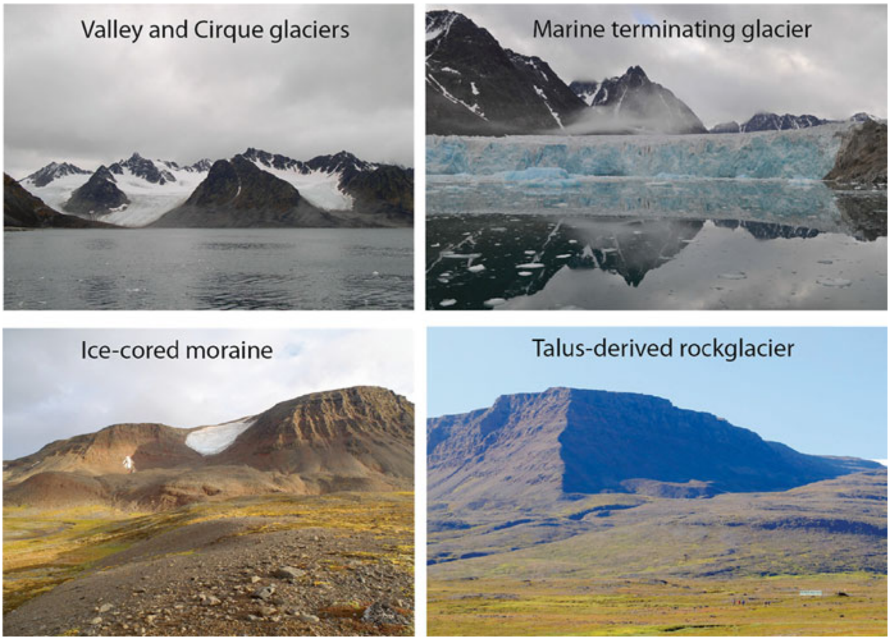

Fig. 7.3 Picture of various types of glaciers typical found in the Arctic. *Upper pictures* shows Valley and Cirque glaciers on Svalbard (*left*) and a tidewater glacier on Svalbard (*right*). The two *lower pictures* shows an ice-cored moraine on Disko, Greenland (*left*) and talus-derived rock glacier on Disko, Greenland. Glaciers are typically defined by hypsometry, geometric configuration, thermal regime and in what climatic regime they are found. Jostein Bakke took the upper two photos whereas the lower two were taken by Øyvind Paasche

the ELA, appears to respond rapidly to changes in climate forcing. These state-of-the-art reconstructions suggest some regional coherency in terms of glacier activity, but deviations also exist.

In the following, we assess cirque glacier variability in Svalbard throughout the last 11,700 years, from the exit of the last Ice Age and up until present day. We show that the glaciers of the Arctic have undergone significant changes throughout the last 10,000 years, and many of them were probably melted away during thousands of years before rejuvenating circa 4,000 years ago. We introduce glaciers and their dependency on certain climate parameters, the methods involved in the reconstructing past change before discussing trends and variability in existing and new records.

7.2 Glacier-Climate Interactions

Glaciers are climate sensitive natural systems whose very existence is neatly balanced by the competing forces of temperature and precipitation. The Swedish glaciologist and geomorphologist Hans W: son Ahlmann, and later the Norwegian glaciologist Olaf Liestøl, pioneered work on the climate-glacier connection. They realized, in essence, that glacier's presence in the landscape is determined by a non-linear relationship between temperature and precipitation. Simply put, glaciers found in areas with warm summer temperatures (Ts) need large amounts of winter precipitation (Wp) in order to remain in place and vice versa. This guiding relationship is expressed by the Equilibrium-Line-Altitude (ELA) which marks the balance between snow added (accumulation) minus snow melted (ablation). The balance between Ts and Wp is near universal, although noteworthy exceptions exist in the tropics and elsewhere. In the Himalayas, for instance, many glaciers receive, due to the altitude and configuration of the surrounding catchment, large amounts drift-snow and also snow avalanches ends up at the glacier surface adding positively to the mass balance. There is also the case of debris-covered glaciers, which dampens the response to external forcing due to the insulation effect of the overlying debris.

Another more curious, but common type of glaciers in polar regions of the world, including on Svalbard is rockglaciers (Fig. 7.3) (Ohta et al. 2008). They have characteristic lobe-like shape, with a coarse and angular shaped rocky surface, which often consists of transverse furrow-and-ridge topography. They are typically located at the foot of a rock free-face where supply of debris is high, although deformation rates are much lower than in glaciers (down to 1 cm per year). They can originate both from stagnating glaciers and develop from scree slopes and interstitial ice. The internal core of ice in rockglaciers cannot be seen with the naked eye, only the rocky surface preventing melting of the underlying ice. Due to this, and other processes, rockglaciers are, as with dirty glaciers, less sensitive to climatic ameliorations than a temperature glacier with a relatively clean surface. Even so, they carry information about mean annual air temperatures which otherwise can be hard to come by (Paasche et al. 2007a).

7.3 Past Glacier Variability on Svalbard: Methods and Results

7.3.1 Methods

There are a number of ways to reconstruct past glacier extent and activity, which range from satellite imagery to moraine mapping (for a more detailed overviews see Bakke and Paasche 2011). Downstream basins, which trap river-transported sediments produced by upstream glaciers, represent a robust archive that can store information about past glacier activity for thousands of years and, which under most circumstances can be retrieved by means of coring from rafts or lake ice surface. The continuous layering of sediments in lakes, which takes place throughout the year, allows for meticulous studies of glacier and catchment process and dynamics, and are generally easier to interpret the smaller the catchment is due to reduced "sediment pollution" by extra-glacier processes such as floods and avalanches (e.g. Rubensdotter and Rosqvist 2009).

Typically a study of this type starts out with a survey of all types of glacial-geomorphological features in the selected catchment with emphasis on mapping of former marginal moraines, glacier meltwater channels, various ice-flow indicators and sediment accumulations with the potential to influence sedimentation processes within the lake (Bakke et al. 2010). The mapping of glacial features is important for obtaining cosmogenic samples and also for the lichenometric measurements directly on marginal moraines for age constrain. Recent results show that it is possible to establish cosmogenic chronologies that overlap with historical records and, in turn, modern observations (Schaefer et al. 2009).

If the selected catchment seems promising the coring devices are transported into the area with helicopter, snow scooter or by boat to access the lakes. The coring device and the raft should be portable giving the research team's flexibility to move from one site to another without external help. The size of the team will usually vary between three and five crewmembers. The most common approach is made up of various types of piston coring devises in combination with a small gravity allowing sampling of up to 1 m of undisturbed surface sediments. This is important for precise ^{210}Pb dating and subsequent estimation of sedimentation rates. During the last decade better and lighter seismic equipment has become available. Nowadays, it is therefore common to survey the lake sediment infill prior to coring in order to identify optimal coring sites being representative for the external system that delivers sediment to the lake. This could either be done with a Ground Penetrating Radar (GPR) or a pinger system mounted on an inflatable boat (Bakke et al. 2010).

Downstream lake sediments and their properties can hence be linked to upstream glacier activity through a suit of methods that can shed light on physical properties (grain size, density, organic content, water content), geochemical properties (trace elements analyzed at high resolution with XRF scanner), and different rock magnetic properties (e.g. magnetic susceptibility, paramagnetic susceptibility, diamagnetic susceptibility, ferromagnetic susceptibility, natural remnant magnetisation and so forth) (Paasche et al. 2007b; Vasskog et al. 2012; Bakke et al. 2013).

Producing accurate glacier reconstructions based on lake sediments require a reliable chronology, which usually is obtained by means of radiocarbon- and lead dates (^{14}C and ^{210}Pb). Uncertainties arising from these dating techniques typical result in age-depth models with ±100 years, although variations can be large. Other dating techniques that can be invoked in order to complement the lake sediment records are cosmogenic (^{10}Be) measurements of rock surfaces or sediment profiles, which can provide precise ages of glacier deposition of a moraine or the retreat pattern or both.

After finalising a range of quantitative analyses of the sedimentary records, the aim is to develop a coherent model describing the relationship between glacier sizes and different physical properties and geochemical variability site specific for the individual distal glacial-fed lakes. The reconstructed glacier variability might subsequently be correlated to climate changes depending on the study site and its processes (Bakke et al. 2010).

7.3.2 Previous Studies on Svalbard

Svalbard is an archipelago consisting of a number of islands where Spitsbergen is by far the largest. There is a wide variety of glaciers on the island with large tidewater glaciers, many of which surges, polythermal valley glaciers, surge-type, huge icefields with outlet glaciers, smaller valley and cirque glaciers, rock glaciers and also smaller cirque glacier, often with disproportionally large ice-cored moraines present in the foreland (Fig. 7.3).

Small cirque glaciers (0.5–3 km^2) respond rapidly to climate change and produce relatively little sediments compared to larger glaciers and are therefore often favoured for glacier reconstructions based on lake sediment studies. In the following we present results from to previously studied cirque glaciers (Linnébreen and Karlbreen) located along the western part of Spitsbergen. New, and complimentary results from Linnévatnet capturing the past history of Linnébreen are also included and discussed in a wider context in Sect. 7.4.

Linnebreen is presently ca. 1.6 km^2 and produces sediments that are brought in suspension down to Lake Linevatnet where it is partly deposited. The lake was initially surveyed and cored (Bøyum and Kjensmo 1980), and later re-cored (Svendsen et al. 1987) in order to investigate glacier activity. Svendsen et al. (1987) argued on basis of changes in lake accumulation rate that Linnebreen had varied significantly in areal extent during the last 10,000 years, ever since the lake was isolated from the Sea due to isostatic rebound (Cf. Werner 1990). According to this study, the largest frontal position during the last 10,000 years was reached in 1920 AD after intermittent growth during the prior 600 years, and that the glacier was completely melted away in the period from 8,000 to 4,400 years ago.

A more recent study using cosmogenic nuclide dating by Reusche et al. (2014) complement earlier lake sediment studies in Linnédalen. They argue, based on ^{10}Be dates of boulders on frontal moraines that Linnébreen had retreated since 13,600 ± 500 years ago throughout the early Holocene until it had melted completely away (e.g. Svendsen and Mangerud 1997). According to Reusche et al. (2014), Linnebreen rejuvenated and reached a maximum position just prior to 1,600 years ago. Svendsen and Mangerud (1997) argue that the glacier reformed 4,600 years ago, which suggests that Linnébreen reached a Neoglacial maximum position sometime between 4,600 and 1,600 years ago. The glacier retreated after this Neoglacial max position and did not reach a similar extent until the end of Little Ice Age (1920 AD). The Linnéglacier has, with a few exceptions, been in constant retreat since, and is today only half the size it was during the LIA (>3 km^2).

Karlbreen is located on Mitrahalvøya, which is a peninsula, located at the northwest coast of Svalbard. Here a mountain range stretches from south to north on the peninsula with summits reaching 700 m altitude. Karlbreen flows down from Chunfjellet (688 m) towards a series of down-valley lakes. Karlbreen and the down valley lake Kløsa was surveyed and cored by a team from University of Bergen in 2012 and the sediments was used in a multi-proxy study with the aim to resolve the Holocene history of the glacier Karlbreen (Røthe et al. 2015). Karlbreen has not been classified as a specific glacier type, although small alpine glaciers on Svalbard are usually polythermal (Hagen et al. 1993). There is no geomorphological evidence of surge-type behaviour found in the catchment of Karlbreen. A distinct moraine ridge forms the southeast shoreline of Kløsa. The distal side of the ridge is steep (between 45° and 60° and 12–24 m high along the ridge) compared to the proximal side (between 2° and 10°) (Røthe et al. 2015). The size (height), shape and position of the moraine ridge matches the Svalbard land system model by Glasser and Hambrey (2005), and most likely contains a core of glacier ice.

This exceptional continuous sediment record extends back to 6,700 cal. year. BP and it reveals that Karlbreen was close to or had melted completely away during the Holocene Thermal Maximum (HTM) from 10 to 6 ka BP on Svalbard. The onset of the local Neoglacial period occurred around 3,500 years ago. The glacier was close to or at its maximum position several times during the Neoglacial (at 1,700, 230 and 130 years ago). A more or less continuous rise of the ELA has been observed for the last 100 years (Røthe et al. 2015) (Fig. 7.5), which is in accordance with the general trend on Svalbard (Hagen et al. 2003).

7.3.3 New Results from Linnébreen

The sedimentary analysis presented here shows variations in magnetic susceptibility from a core retrieved from nearby the inlet to Linnévatnet (Svendsen et al. 1987). The age-depth relationship is based on radiocarbon dates presented in Snyder et al. (1994), which are calibrated using the latest version of CALIB 7.0. The age-depth relationship is obtained using a higher-order function, as shown in Fig. 7.4. The average resolution is 1 cm ≤ 5 years, which suggests that each measuring point of MS on average equals 1 year.

The new, ultra high-resolution curve reflects variation in sediments that is produced by the glacier, transported with the Linnériver and subsequently deposited in the lake, just outside the inlet (Fig. 7.5). Since the glacial meltwater cuts through the LIA moraine as well as running across several kilometres with superficial deposits the signal gets homogenised and pre-existing sediments might get entrained and transported downstream in suspension. Nevertheless, the sediments derived from glacier production probably dominate the lake sediment signal, meaning that there is proportionality between signal MS strength and glacier size, i.e. larger glacier equals higher MS-values and vice versa.

The MS-signal in Linnévatnet, as shown in Fig. 5, is characterised by two time intervals with high frequency and magnitude variability. The first period lasts from 9,900 to 8,300 years and the second extends from around 4,200 years and up to present day. During this latter interval there is a period of enhanced variability lasting from circa 2,600–1,600 years ago, when the MS-signal reached the highest values in the entire record. The two high-frequency intervals are intercepted by a smooth low-frequency period between 8,300 and 4,200 years ago reaching minimum values around 6,500 years ago.

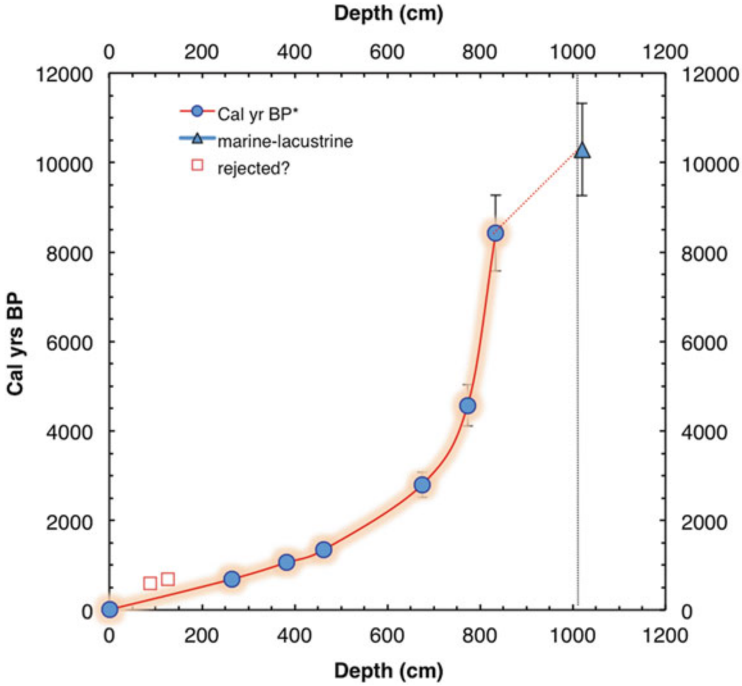

Fig. 7.4 Age-depth model of a lake sediment core 6 retrieved from Lake Linné close to the river inlet reaching the lake in the southern end (Svendsen et al. 1987). Snyder et al. (1994) analysed the core for macrofossils and constructed an age-depth model. The radiocarbon dates are re-calibrated here giving a slightly updated age-depth model compared to previous versions

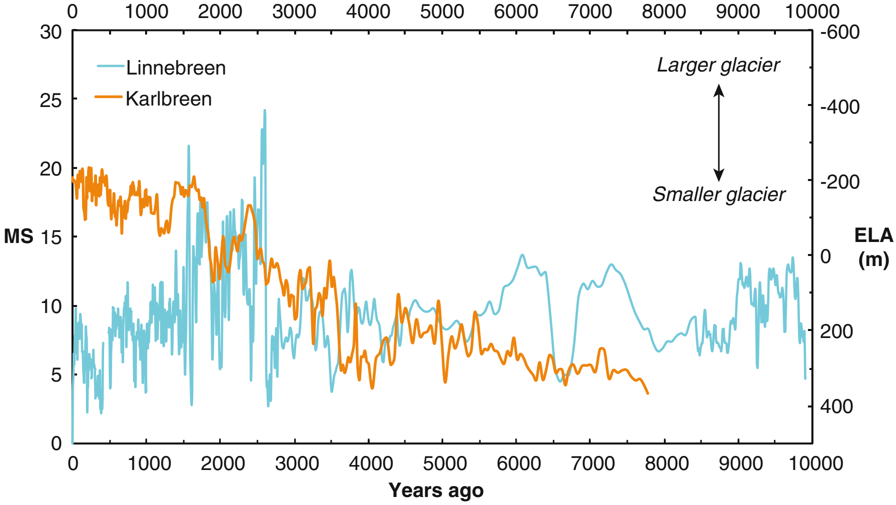

Fig. 7.5 Glacier variability as reconstructed from Linnébreen and Karlbreen (see Fig. 1) based on lake sediments. The Equilibrium-Line-Altitude (ELA) reconstruction of Karlbreen (Røthe et al. 2015) shows that the glacier was absent until 4,000 years ago whereupon it quickly reaches a maximum position around 2,500 years ago, which coincides well with the record of the Linnébreen. After 2,500 years, glacier activity is characterized by a high degree of variability that culminates in Little Ice Age (LIA) maximum positions which was reached around 1920 AD

7.4 The Arctic View on Glacier Variability

A detailed knowledge of past climate variations in the Arctic is important for understanding present day changes in the Arctic and fundamental for defining the influence of anthropogenic greenhouse gasses in the climate system of the Arctic. Over the last decades a substantial research effort has contributed with valuable data including dating of glacial landforms, macrofossils beneath glaciers, lake sediment studies, marine sediment records and the study of raised shorelines. However, the Arctic "normal" is still unknown as the Holocene history of the Arctic is heavily influenced by the changing insolation that has occurred during the present interglacial. Some clues can be found in the study of long-term changes in the cryosphere and by revealing these changes it might be possible to sort out the Arctic "normal" that can be used to define the *new* Arctic.

A reoccurring feature in many paleostudies from the Arctic is the presence of a warmer-than-present early Holocene climate at high latitudes (Kaufmann et al. 2004). Variations in pollen assemblages in Skardtjørna, a lake on central Svalbard, suggests air summer temperatures to have been 1–2 °C warmer during 8,000–4,000 years ago (Birks 1991). During this time interval, glaciers on Svalbard were small as demonstrated by both Karlbreen and Linnebreen, and many cirque glaciers were probably completely melted away due to the relatively warmer summers.

The cooling trend over the Arctic of the last 6,000 years are a response to declining summer insolation at high northern latitudes (Wanner et al. 2008). This coincides with the overall trend in the North Atlantic region, with the onset of the Neoglaciation in Scandinavia (Bakke et al. 2010; Bakke et al. 2005), lower SSTs reconstructed from the marine core MD95-2011 (Berner et al. 2010), lower temperatures derived from δ^{18}O values in the Renland ice-core (Vinther et al. 2008) and reconstructed summer temperatures from terrestrial pollen records (Bjune and Birks 2008). This gradual cooling allows for the onset of the Neoglacial period on Svalbard, when glaciers in Linnédalen (southwest Svalbard) and Karlsbreen started to grow again (Svendsen and Mangerud 1997).

The Skardtjørna pollen record from the west coast of Svalbard, close to Linnèbreen, indicates a climatic deterioration between 4,000 and 2,500 cal. year. BP (Birks 1991). Humlum et al. (2005) recognised an advance of the glacier Longyearbreen around 1,100 years ago. This inference was based on preserved mosses that were found ~2 km upstream from the present glacier front, which indicates that the glacier must have been much smaller prior to this advance than at present. Werner (1993) suggests moraine stabilisation to occur on the west coast of Svalbard, between 650 and 700 years ago, which corresponds to the rise in ELA at Karlsbreen following the advance between 1,150 and 850 years ago.

The two only continuously reconstructed glaciers from Svalbard based on lake sediment studies, Linnébreen and Karlbreen, shows frequent glacier expansions and retreat during the Neoglacial period, culminating in the "Little-Ice-Age" (LIA) (Lubinski et al. 1999; Luoto et al. 2011; Mäusbacher et al. 2002; Røthe et al. 2015; Svendsen and Mangerud 1997; Werner 1993). A two-step model of glacier advances during the LIA on Svalbard has been suggested, separated by a distinct warming from 200 to 250 years ago. Interestingly, a warming is inferred from ice-cores from the Lomonosov Plateau (Gordiyenko et al. 1981).

The impact of feedback mechanism at higher latitudes (e.g. sea ice, albedo effect) complicates the picture of how winter precipitation and summer ablation influences Svalbard glaciers. Müller et al. (2012) propose that the northward retreat of the sea ice cover, triggered by temporally strengthened West Svalbard Current and/or change in the atmospheric circulation pattern, could cause abrupt glacier advances. Supporting this is the abrupt increase in SST at the continental margin of the Barents Sea at ~2,200 and ~1,700 years ago (Sarnthein et al. 2003). This coincides with alpine glaciers of Scandinavia being at, or close to, its largest extent from ~1,700 to ~1,500 years ago.

The open waters on the west coast of Svalbard is a moisture source for the glaciers along the west coast of Spitsbergen, implying that winter precipitation may be dominant in the annual mass-balance of the maritime glaciers along the western coast of Svalbard, at least during certain time intervals. However, on a shorter timescale, D'Andrea et al. (2012) show how winter precipitation might have been have been an important factor in the most recent glacier advance (within the last 250 years) on Svalbard. Their work from Kongressvatnet, revealed a 1–2.5 °C warmer climate than during the previous glacier expansion on Svalbard, indicating that higher ablation rates (i.e., summer alt) occurred during a period when the glaciers were expanding.

As mentioned above, the late Holocene glacier maxima are also observed by ^{10}Be dating of terminal moraines in front of the Linnébreen (Reusche et al. 2014). During the twentieth century, mass balance measurements and glacier front variations show a general retreat of glaciers on Svalbard (Hagen and Liestøl 1990; Hagen et al. 1993; Hagen et al. 2003). δ^{18}O measurements of ice-cores from Lomonosovfonna and Holtedahlfonna has yielded valuable information about the most recent environmental change on Svalbard, making it possible to reconstruct winter surface-air temperatures for the past 1,200 years showing a gradual winter cooling from 800 AD to 1800 AD (Divine et al. 2011).

7.5 Conclusion

Here we have shown that present glaciers are rapidly changing in the Arctic, but that in the context of the last 10,000 years periods equally large or larger changes took place, although for different climatic reasons. The HTM caused a widespread retreat and downwastage of glaciers, and it seems plausible that a number of cirque glaciers were completely melted away or possibly present simply as perennial snowfields or ice aprons. On Mitrahalvøya, central Spitsbergen, Karlbreen was completely melted away (Røthe et al. 2015) and this was most likely also the case for Linnébreen, although data presented here are not unambiguous. Both glaciers rejuvenated around 4,000 years ago and reached maximum positions around 2,500 years ago. This Neoglacial maximum lasted until 1,600 years ago, as demonstrated in the

Linnévatnet record, which is corroborated by ^{10}Be dates on a moraine slightly larger than the LIA-max position (Reusche et al. 2014). The higher MS-values in conjunction with high frequency variability might suggest that the glacier might have been more temperate during the 2,500–1,600 time interval than during the LIA?

From roughly 1,600 years ago and onwards to present day glacier variability is characterized by a high degree of variability with significant fluctuations of the ELA. Recent max positions were reached 1920 AD or a few decades earlier. Since then, glaciers referred to here have almost lost half their volume, which is comparable to other arctic glaciers.

We speculate that, given that the on-going warming trend continues unabated, the smallest cirque glaciers will, for the first time in 5,000 years, start to melt away, probably within the next 50–100 years (cf. Clarke et al. 2015). If this speculation holds true, it will not only change landscape dynamics in the Arctic, it will also have a huge impact on societies, animals and ecosystems.

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Chapter 8
Arctic Carbon Cycle: Patterns, Impacts and Possible Changes

Are Olsen, Leif G. Anderson, and Christoph Heinze

Abstract Land and ocean uptake and release of carbon dioxide and methane play important roles for regulating their atmospheric concentrations. For example, over the industrialised period the terrestrial biosphere and global oceans have acted as net sinks of carbon dioxide, having absorbed CO_2 corresponding to more than 50 % of the accumulated emissions from fossil fuel burning, cement production and land-use change. This uptake has clearly reduced the human footprint on climate development. However, we cannot expect that the strength of these sinks will remain unaltered in the future as the processes that are involved are sensitive to climate change. This is in particular the case for the Arctic where ocean circulation changes, sea-ice and permafrost thaw and increased land and ocean primary production—all excerting direct influence on CO_2 and methane—are expected to occur. Further, the ocean uptake of CO_2 leads to ocean acidification that may have deletorious effects on many marine organisms. The Arctic Ocean appears particularly vulnerable to this threat. In this contribution we provide an overview of the land and ocean components of the Arctic carbon cycle and their climate change sensitivities.

Keywords CO_2 • Carbon dioxide • Ocean uptake • Biomass • Anthropogenic • Arctic ocean • Carbon cycle

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8.1 Introduction: Carbon and Global Change

That carbon dioxide, CO_2, is a decisive factor for the strength of the earth's greenhouse effect has been established beyond any doubt. The molecular structure of CO_2 causes it to absorb radiation at a wavelength of about 15 μm, which is near the peak of the terrestrial emission spectrum: CO_2 in the atmosphere traps longwave radiation from the earth's surface and atmosphere. In preindustrial times, the atmospheric CO_2 level was around 280 ppm and this radiative forcing corresponded to 50 W m^{-2} (Dickinson and Cicerone 1986). Since then the atmospheric CO_2 concentration has increased to its present day (April, 2014) value of 400 ppm, as measured at the Manua Loa Observatory, Hawaii (data from www.keelingcurve.ucsd.edu). This corresponds to an increase in radiative forcing due to CO_2 of 2.2 W m^{-2} (Houghton et al. 1990). Using a climate sensitivity parameter of 1.8 W ± 0.7 m^{-2} K^{-1} (Sarmiento and Gruber 2006), this increase in radiative forcing will result in a global surface temperature rise of somewhere between 0.9 and 2 K.

The accumulated CO_2 emissions from fossil fuel burning and cement production since the industrial revolution until 2013 corresponds to 395 ± 20 Gt C (Boden et al. 2013; Le Quéré et al. 2014), where 1 Gt is 1 giga- or billion tonnes, or 10^{15} g C. The increase in atmospheric CO_2 until that year is, however, much less, namely corresponding to 250 ± 5 Gt C (Joos and Spahni 2008; Le Quéré et al. 2014). This implies that other carbon reservoirs of the earth must have absorbed CO_2 corresponding to a large fraction of our emissions. One of these is the global ocean, which has absorbed 170 ± 20 Gt C since 1750 (Khatiwala et al. 2013; Le Quéré et al. 2014). This corresponds to a reduction in the atmospheric growth rate of 80 ppm (Prather et al. 2012), *i.e.*, without the net ocean CO_2 uptake since the preindustrial era, the average atmospheric CO_2 concentration in 2013 would have been 475 ppm, instead of the observed 395 ppm. In addition to the oceans, the terrestrial biosphere has absorbed more CO_2 after the industrialization in response to the atmospheric increase (CO_2 fertilization), nitrogen deposition, longer growing season and biomass increases. Its accumulated sink size over the industrialized period corresponds to 160 ± 70 Gt C (Le Quéré et al. 2014). This uptake has, however, been more than offset by loss of carbon from terrestrial ecosystems subjected to land use change, corresponding to an accumulated source size of 185 ± 65 Gt C (Houghton et al. 2012; Le Quéré et al. 2014). The global CO_2 budget is summarized in Table 8.1.

Table 8.1 The global emissions and fate of man made CO_2 until 2013, as summarised in Le Quéré et al. (2014). Positive numbers represent a source to the atmosphere

	Source/sink size (Gt C)	Corresponding atmospheric CO_2 change (ppm)[a]
Man made emissions	395 ± 20	186 ± 9
Ocean sink	−170 ± 20	−80 ± 9
Net land use change	185 ± 65	87 ± 31
Land sink	−160 ± 70	−75 ± 33
Atmospheric increase	250 ± 5	117 ± 2

[a]Calculated using a 2.12 Gt C/ppm conversion factor (Prather et al. 2012)

The key feature that follows from these considerations is that the size of the ocean and land carbon sources and sinks are of the same order of magnitude as the emissions resulting from human activities, and has significantly offset our footprint on the course of climate. Understanding the behaviour and vulnerability of these sources and sinks are key for our ability to understand and predict climate change. This contribution focuses on the Arctic (Fig. 8.1), one of the most climate sensitive regions of our planet. Arctic sea ice cover reduction, ocean circulation change, permafrost thawing, and forestation are the result of global warming. These changes will significantly affect the Arctic carbon stock sizes and fluxes.

We review estimates of Arctic Ocean carbon inventory and fluxes to illuminate the role of the Arctic Ocean in the global carbon cycle, before we discuss the vulnerability of the Arctic Ocean carbon sink. We also present and discuss the ocean acidification that follows from the increasing uptake of CO_2 by the oceans, and why the Arctic may be particularly sensitive to this problem. We end with a brief presen-

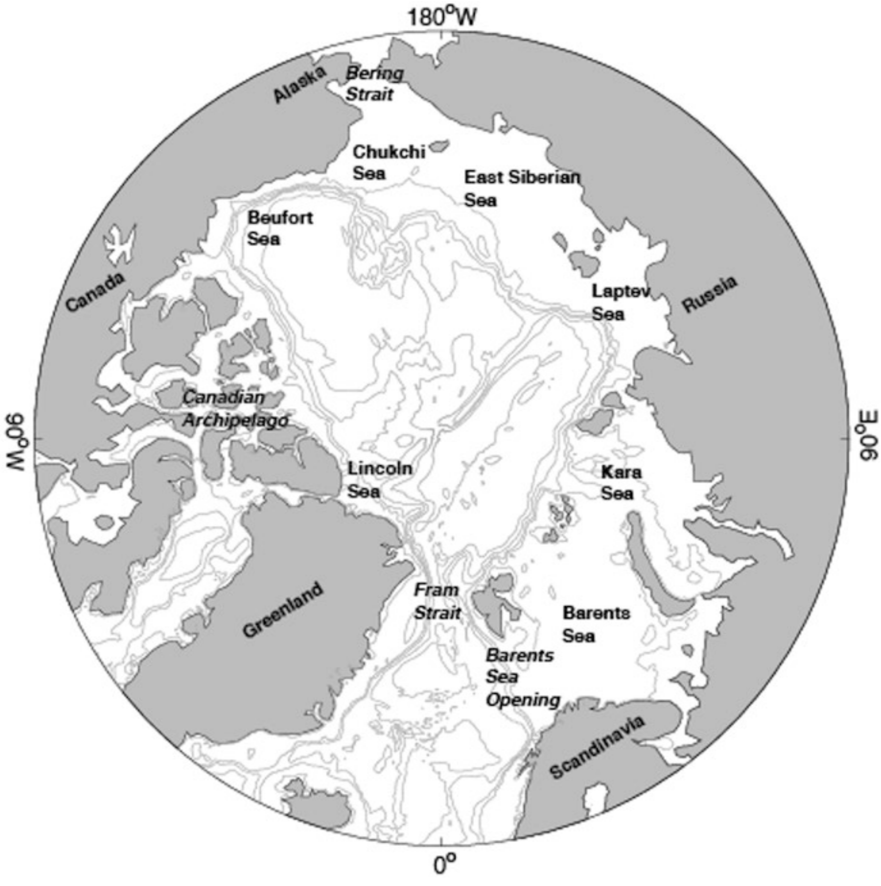

Fig. 8.1 The Arctic Ocean, shelf seas, gateways and surrounding land masses

tation of the Arctic terrestrial carbon cycling. Our discussion is not limited to CO_2, but also includes consideration of the vulnerability of the Arctic methane (CH_4) pools to climate change. Methane is a potent greenhouse gas, buried in sediments and permafrost, and a presentation of the Arctic carbon cycle would be incomplete without a discussion of this aspect.

8.2 The Arctic Ocean and the Global Carbon Cycle

8.2.1 The Anthropogenic Perturbation of the Ocean Carbon Cycle

The magnitude of the exchange (*i.e.*, the flux, *F*) of CO_2 between the ocean and atmosphere is estimated according to:

$$F = S \times k \times \left(pCO_2^{atmosphere} - pCO_2^{ocean} \right) \tag{8.1}$$

where *S* is the CO_2 solubility in the seawater, *k* is the gas transfer velocity, *i.e.*, the volume of air exchanged across one unit of the air-sea interface per unit time, and the partial pressure difference in the parenthesis is a measure of the atmosphere—ocean CO_2 concentration difference. This latter term is the thermodynamic driving force of the exchange, and determines its direction, *i.e.*, into or out of the ocean. Whenever the ocean is undersaturated with respect to the atmospheric CO_2 concentration a net flux of CO_2 into the ocean will occur, and vice versa. The increase of atmospheric CO_2 following anthropogenic emissions has incurred an average global ocean undersaturation that drives a net transfer of CO_2 into the ocean. This comes on top of the exchanges between the pools of carbon that exist naturally in these two reservoirs, and that take place in response to ocean biological processes, circulation, warming and cooling. The carbon that is added to the ocean carbon pool following the increased uptake is commonly referred to as anthropogenic carbon (C_{ant}). The C_{ant} pool size is 170 ± 20 Gt C, which is equal to the accumulated net ocean uptake since the industrial revolution, while the pool size of natural carbon (neglecting any organic forms) is much larger, ~38,000 Gt C (Sarmiento and Gruber 2006).

More than 90 % of the pool of natural carbon in the ocean exists in the form of the two ionic inorganic carbonate species, HCO_3^- and CO_3^{2-}, and upon entering, anthropogenic CO_2 reacts with the latter, the carbonate ion, to form more bicarbonate:

$$CO_2 + CO_3^{2-} + H_2O \rightarrow 2HCO_3^- \tag{8.2}$$

Because of this reaction the majority of the C_{ant} molecules that enters the ocean is transferred to ionic forms and only one out of every 20 C_{ant} molecules actually remains as such in seawater and reduces the undersaturation that drives the flux. It is this buffer effect that is the main cause of the ocean's vast capacity for absorbing

CO_2. Accessible fossil fuel reserves correspond to some 1,800 Gt C (Rogner et al. 2012); if everything is combusted the ocean's carbonate buffer capacity enables it to absorb some 80 % of it. However, accessing this storage capacity requires that the CO_2 enters the deep ocean, which represents the greater volume and this is the rate-limiting step for ocean CO_2 uptake, since compared to this, the flux of CO_2 from the atmosphere to the ocean takes place relatively fast. The equilibration timescale between the upper ocean and atmosphere with respect to CO_2 perturbations, which depends on the air-sea flux (Eq. 8.1), is on the order of a year, while the equilibrium time scale between the upper and deep ocean is on the order of centuries to millennia. The relevant aspects while assessing the role of the Arctic Ocean for the global carbon cycle are the air-sea fluxes, and storage and transports of carbon, in particular in the vertical. We will treat both natural carbon and anthropogenic carbon, while trying to maintain a clear distinction between them. This is not easy, as the literature most often presents estimates of the flow and distribution of contemporary carbon, which is a combination of the two.

8.2.2 Arctic Ocean Storage and Transports of Carbon

The transports, air-sea fluxes, storage and transformations of carbon, constrain the Arctic Ocean carbon budget (Fig. 8.2). The transport of carbon, into and out of the Arctic Ocean occurs mainly through its four gateways, the Bering Strait, Canadian Archipelago, Fram Strait and the Barents Sea Opening, where the ocean currents that flow into and out of the Arctic carry large amounts of inorganic carbon. Using a combination of observed carbon concentrations and volume fluxes from a model-derived velocity field, MacGilchrist et al. (2014) suggested that more inorganic carbon leaves the Arctic with the ocean currents than enters it; the net transport of carbon through the gateways of the Arctic is -231 ± 49 Tg C year^{-1} (1 Tg, 10^{12} g, 0.001 GtC). Most of the net export occurs through the Canadian Archipelago ($-2{,}630 \pm 220$ Tg C year^{-1}) and the Fram Strait ($-1{,}350 \pm 490$ Tg C year^{-1}), while there is a net inflow of inorganic carbon through the Barents Sea Opening ($2{,}980 \pm 420$ Tg C year^{-1}) and the Bering Strait (775 ± 60 Tg C year^{-1}). Export of carbon included in sea ice accounts for the remaining 6 Tg C. The direction and net sum of these transports are not surprising. Firstly, the water that leaves the Arctic Ocean, does it via the Canadian Archipelago and deep flows through the Fram Strait, while the shallow Barents Sea and Bering Strait are regions where net inflow occurs. Secondly, since waters are cooled in the Arctic Ocean we expect them to absorb CO_2 from the atmosphere during their residence there, due to the increased CO_2 solubility with decreasing temperatures, *i.e.*, an air—to—sea flux of CO_2 will occur. The existing estimates of the current uptake of atmospheric CO_2 in the Arctic Ocean were recently reviewed by Bates and Mathis (2009), which allowed them to constrain the total uptake to between 66 and 199 Tg C year^{-1}. The large range reflects the localised nature of the observations. Thirdly, the great rivers that flow into the Arctic Ocean carry large amounts of carbon, which eventually exits the area

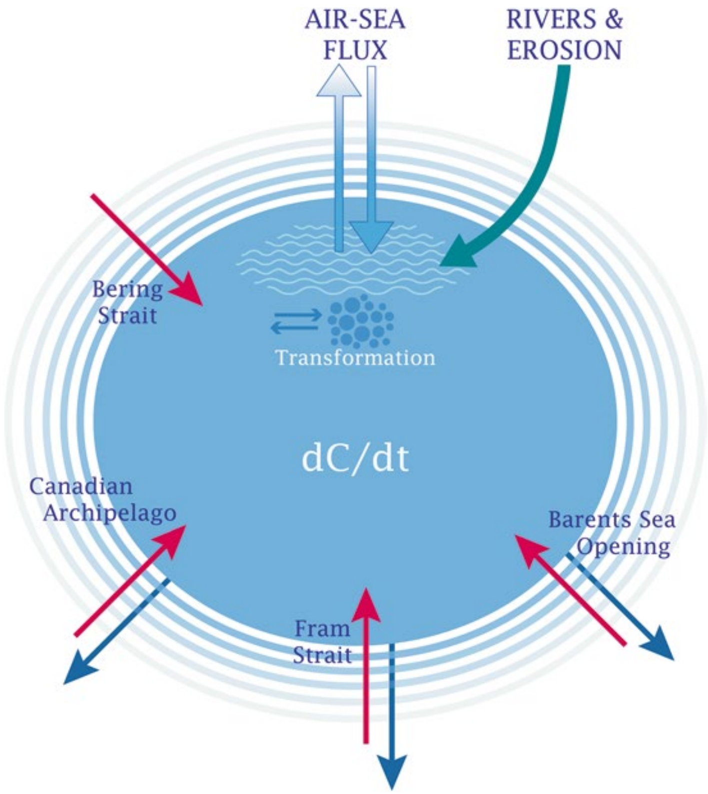

Fig. 8.2 A simplified representation of the Arctic Ocean with the terms defining its carbon budget: the transports in and out of its four gateways and from land (rivers and erosion), the air-sea fluxes, the transformation to and from organic matter and metal carbonates, and the storage (*dc/dt*) term

with the southbound ocean currents. This source corresponds to a total of 65 Tg inorganic carbon (Tank et al. 2012; MacGilchrist et al. 2014). Finally, since most of the carbon that is incorporated by phytoplankton (*i.e.*, the transformation term) in the Arctic Ocean is remineralised there as well (MacDonald et al. 2010), this does not represent a significant sink.

The numbers that have been presented apply to present-day carbon, no attempt has been made to separate the natural and anthropogenic components, and we have yet to discuss the storage term of the Arctic Ocean carbon budget. Tanhua et al. (2009) determined the inventory of C_{ant}, *i.e.*, the accumulated uptake since the pre-industrial era, in the Arctic Ocean to lie between 2,500 and 3,300 Tg C. We have used this to determine an annual storage rate in the mid 2000s of 55 ± 7 Tg C by assuming that a transient steady state (Gammon et al. 1982; Tanhua et al. 2007) applies. These numbers are comparable to the annual inventory increase of 26 ± 9 Tg C year^{-1} determined for 1991 by Anderson et al. (1998), in particular when considering that their estimate did not include water masses shallower than 500 m, which have the largest concentrations of C_{ant}.

Table 8.2 Arctic Ocean carbon budgets. Positive numbers represent fluxes into the AO

	Present day (Tg C $year^{-1}$)	Anthropogenic (Tg C $year^{-1}$)	Preindustrial (Tg C $year^{-1}$)
Net ocean transport	-231 ± 49[a]	~29[c]	~−202
Land & river sources	65 ± 6	0	65
Air-sea flux	133 ± 66[b]	~26[d]	~107
Storage	-55 ± 7[c]	-55 ± 7[c]	0
Transformation	~0	~0	0
Sum	-88 ± 83[e]		~−30

[a]From MacGilchrist et al. (2014)
[b]From Bates and Mathis (2009)
[c]Calculated in this contribution
[d]Determined as the difference between the net transport and storage terms. Any uncertainty in net transports has not been considered
[e]The root sum of square of stated uncertainties

The present-day Arctic Ocean carbon budget is summarised in Table 8.2. A closed budget is not achieved. More than anything else this illustrates that the uncertainties that are stated for each of the terms (and largely taken from the literature) are too low.

No estimates of the air-sea flux of anthropogenic carbon in the Arctic exits. The numbers presented above are for the present-day flux, which is a combination of the natural (pre-industrial flux) and its anthropogenic perturbation. Neither has anyone attempted to prepare a complete budget for transports of anthropogenic CO_2 through the gateways of the Arctic Ocean. In their budget for the Nordic Seas, Jeansson et al. (2011) determined the net fluxes of C_{ant} through the Barents Sea Opening and Fram Strait to 41 ± 8 Tg C $year^{-1}$ northbound and 1 ± 17 Tg C $year^{-1}$ southbound, respectively. As far as we are aware, no similar estimates exist for the Bering Strait and Canadian Archipelago gateways, so we will derive these here. Their uncertainties will not be formally established, but are certainly substantial, and are indicated in the following by using the tilde operator. The Pacific inflow though Bering Strait has anthropogenic CO_2 concentrations of 40–50 µmol kg^{-1} (Mathis et al. 2011). Combined with a water flow of 1 Sv (MacGilchrist et al. 2014), this gives an annual inflow of C_{ant} of ~18 Tg C $year^{-1}$. For the Canadian Archipelago, we use Davis Strait as the gateway. The two main flows are the southbound in the west, of approximately 4 Sv, and the northbound in the east of approximately 1 Sv (MacGilchrist et al. 2014; Curry et al. 2011). The southbound current is derived from the Canadian Basin Polar Mixed Layer and Upper Halocline (Azetsu-Scott et al. 2010), which has anthropogenic carbon concentrations of around 30 µmol kg^{-1} (derived from Fig. 5 of Tanhua et al. 2009); combined this gives an annual southbound C_{ant} flux of ~47 Tg C $year^{-1}$. The northbound current is derived from a mixture of East Greenland Current and Atlantic waters from the Irminger Sea. The C_{ant} concentration of these end-members is around 45 µmol kg^{-1} (Pérez et al. 2008; Olsen et al. 2010), which gives the inflow of C_{ant} through the Davis Strait of ~18 Tg C $year^{-1}$. Combining the transport estimates across the gateways gives us a net annual inflow of C_{ant} to the Arctic Ocean of ~29 Tg C $year^{-1}$, which accounts for ~52 % of the annual accumulation of C_{ant} estimated above.

The anthropogenic carbon budget for the Arctic Ocean is presented in Table 8.2, and we have also included the preindustrial carbon budget, calculated by backing out the anthropogenic components from the present-day budget. The large uncertainty is illustrated by the non-zero residual of the preindustrial carbon budget of −30 Tg C year^{-1}.

Taken together, our synthesis shows that the Arctic Ocean presently holds 1.5–1.9 % of the global ocean inventory of anthropogenic carbon (2.5–3.3 out of 155 Gt C, Tanhua et al. 2009). This inventory increases by some 0.055 ± 0.007 Gt C year^{-1}, which corresponds to 2.4 % of the annual global ocean C_{ant} uptake of 2.3 ± 0.7 Gt C year^{-1}. Approximately 50 % of this increase appears to be due to uptake of anthropogenic CO_2 from the atmosphere within the Arctic Ocean itself, while the other half has been taken up from the atmosphere in upstream regions, and enter the Arctic Ocean by the ocean currents (*i.e.*, it is the net transports). The Arctic Ocean makes up 1 % of the global ocean volume, and 2.6 % of the global ocean surface area. Hence the inventory and its annual increase is greater than expected from the volume, while the uptake of C_{ant} from the atmosphere (~0.026 Gt C year^{-1}) is smaller than expected from its surface area. This latter phenomenon is not surprising given that large areas of the Arctic are covered by seasonal and permanent ice-cover, which prohibits air-sea transfer of gases. The relatively large inventory size, on the other hand, is the result of the deep penetration of recently ventilated water masses in this area, due to deep mixing, which allows higher C_{ant} concentrations at depth than in most other regions of the global ocean.

We end this section with a brief assessment of the importance of the Arctic Ocean for vertical transports of anthropogenic carbon, important for sustaining the global ocean sink. Using a plume-entrainment model, Anderson et al. (1998), determined a transport of C_{ant} to the layers beneath 500 m of 0.026 Gt year^{-1} for 1991, corresponding to about 1 % of the global ocean uptake. Apparently, the Barents Sea is the most important conduit. Smedsrud et al. (2013) prepared a time series of surface-deep ocean transport of carbon and its anthropogenic component in the Barents Sea outflow, based on measured concentrations and modelled volume flows. In 1991 the waters exported from the Barents Sea carried with them some 0.016 Gt C, and in the early 2000s some 0.022 Gt C. The export of carbon *per se* (*i.e.*, the natural and anthropogenic components) is much greater, and varies between 0.6 and 1 Gt C year^{-1}, depending on the strength of the ocean currents. Whenever climate change starts affecting processes such as this, large disruptions of the Arctic Ocean carbon cycle may be expected. This is the subject of the next section.

8.3 Vulnerability of the Arctic Ocean Carbon Cycle

Environmental change in the Arctic is manifested in two major phenomena, the shrinking summer sea ice coverage and the increase of permafrost thawing. These are a result of an increase in energy input to the Arctic region, both by the atmosphere and by the ocean. Changes in the environment have impact on the carbon cycle through several processes, *e.g.*, by increasing the input of organic matter from land, by altering the biological primary productivity in the ocean and by modifying the circulation

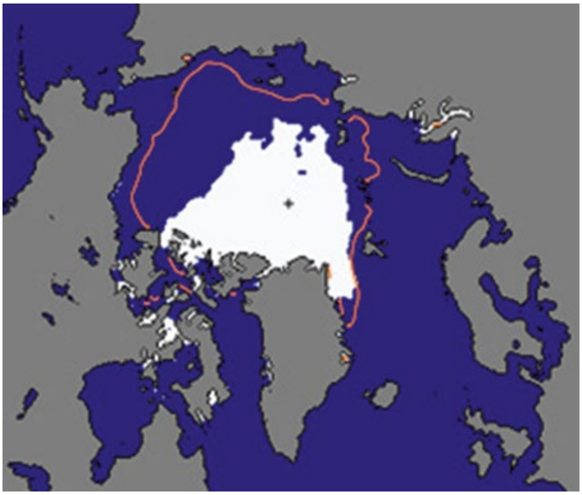

Fig. 8.3 Sea ice coverage at the 1st of September 2012, with the median for the period 1979–2000 noted by the line (Courtesy of the National Snow and Ice Data Center)

and deep water formation. In this chapter the potential impact of these processes will be discussed and plausible future scenarios will be presented.

In the past the central Arctic Ocean, as well as parts of the shelf seas, was covered by sea ice, often several years of age, but with open leads and cracks in between the ice floes. This was also the situation in summer until a few decades ago, while today large areas are ice free (Fig. 8.3). Furthermore, the ice that is present today has a much larger fraction of first year type relative to multiyear ice than in the past. A consequence of the increased extent of open waters in the summer is that more sea ice is formed during the winter season. This is because the heat loss from the ocean to the atmosphere and subsequent sea ice formation is much more efficient in ice free than in ice covered areas, as the ice insulates the ocean from the cold atmosphere. The maximum sea ice thickness that can be formed during one season is in the order of 1.5 m.

When sea ice is formed, salt is expelled from the ice crystals and concentrates as brine around them. As the ice ages, parts of the brine drain out and will sink down the water column while entraining surrounding water. If the sea ice is formed in shallow waters, the brine does not mix much with the underlying water before it reaches the bottom where it builds up a high-salinity bottom water layer. Such a high salinity water production has been shown to occur in Storfjorden, Svalbard, and also contributes to a carbon transport from the atmosphere to the deep sea (Anderson et al. 2004). The brine observed in the deep Storfjorden requires a formation of about three meters of sea ice, which is not unrealistic for this area during one season where a polynya prevails during much of the winter season. The associated carbon transport here equals 9 g C m^{-2}. To estimate the brine associated carbon transport in the entire Arctic we assume that typical dissolved inorganic carbon excess in the brine is the same as it was in Storfjorden in 2002, 10 μmol kg^{-1}, a typical ice production of 1 m $year^{-1}$, that in terms of volume brine production corresponds to 2/3 of ice production and that 10 % of the brine that is produced all through the Arctic Ocean contribute to a carbon flux below the surface mixed layer

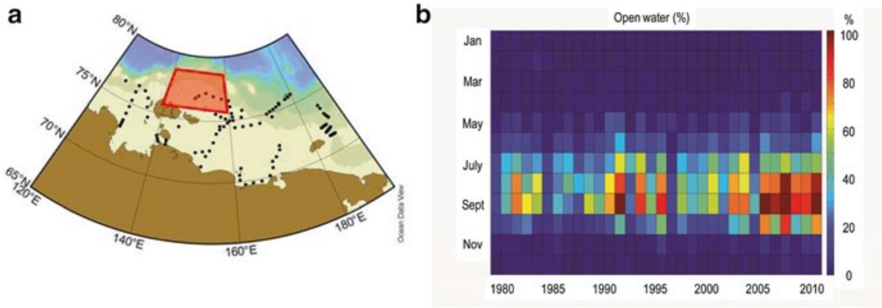

Fig. 8.4 (**a**) The Siberian shelf seas with locations of stations occupied during the ISSS-08 cruise and (**b**) the percent open water for each month from 1979 to 2011 in the region noted with red on the map

(Anderson et al. 2004). The total area of the Arctic Ocean including shelf seas, but excluding half of the Barents Sea (since ice is not forming in its southern half) is 8.6845×10^3 km^2, this gives a brine production of 0.18 Sv, and carbon export of 0.07×10^{12} gC year^{-1}. This computation is based on several assumptions, as stated, and thus only gives information on the order of magnitude of potential fluxes.

Increased brine production from more sea ice formation in open water could generate more intermediate and deep-water production, leading to enhanced vertical carbon transport. One example of such a change in sea ice coverage is the area north of the New Siberian Islands where the percentage of open water has increased substantially during the summer months over the last 20 years (Fig. 8.4).

The waters of the Chukchi and eastern East Siberian Seas receive much water from the Pacific Ocean, waters that have high concentrations of nutrients. Thus these waters support extensive primary productivity and because of the shallow bottom depth much of the organic matter that is produced ends up at the sediment surface, where it is degraded by bacteria. A consequence is that the brine enriched bottom waters on these shelves pick up the chemical signature from this degradation, *i.e.*, they are high in nutrients, partial pressure of carbon dioxide (pCO_2) and dissolved inorganic carbon, and low in oxygen and pH. This brine enriched water with its decay signature has in the past covered large areas of the Canadian Basin at a depth of about 150 m, centred around a salinity of 33.2 (*e.g.*, Jones and Anderson 1986). In the summer of 2008 the water with high nutrient and pCO_2, and low oxygen and pH was observed in deeper layers with salinities well over 34 (Fig. 8.5). This organic matter mineralization signature also coincides with a deficit in $\delta^{18}O$, which is a signature of brine contribution, thus confirming a shelf source (Anderson et al. 2013). Considering the flow pattern of the boundary current, which is from the west to the east, the most plausible source location of this high salinity nutrient maximum is north of the New Siberian Islands where the open water in summer has increased during the last 20 years. This might be the first observation of a change in the ventilation, with subsequent carbon transport, caused by the decreased summer sea ice coverage. If this process is to impact the very deep waters of the Arctic

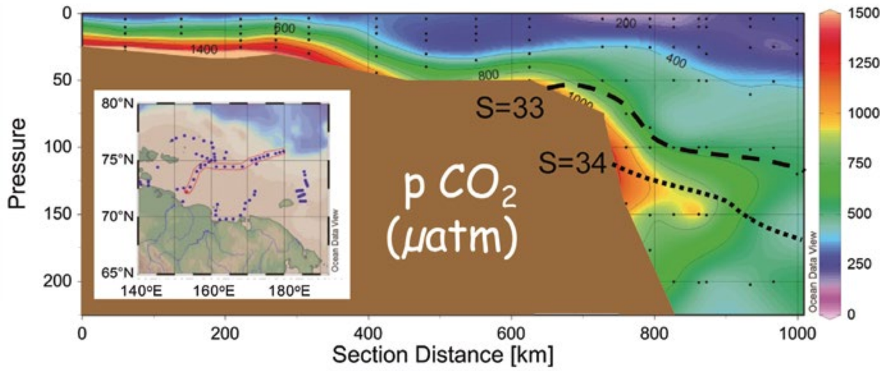

Fig. 8.5 Partial pressure of carbon dioxide (pCO$_2$) along a section from the coast of East Siberian Sea across the shelf break (exact location noted in the inserted map)

Ocean, it likely needs to have a higher initial surface salinity, as is the situation in the Barents Sea. On the other hand this area is largely ice free during summer and thus the effect of decreased summer sea ice coverage here is limited.

Primary production is dependent on light and nutrients as well as carbon. The latter is normally not a limiting factor in seawater but the first two usually are. As a consequence, primary production relies on the presence of a shallow, well illuminated surface mixed layer, with ample access to nutrients. Stratification that occurs when sea ice melts traps phytoplankton in this layer, but at the same time this impedes introduction of nutrients from below. Even without addition of new nutrients the production can sometimes be maintained; this is the so-called regenerated production. In this situation the nutrients and carbon are recycled within the upper water layer, and thus there is no net flux out of the photic zone. For primary production to have a significant impact on the carbon cycle over several years there is a need for the organic matter to sediment out of the surface mixed layer (export production) and into the intermediate and deep waters. The export production has up to now been extremely low in the central Arctic Ocean, most likely because of low productivity caused by both light limitation from the sea ice and low nutrient concentrations. This feature is confirmed by the very low organic matter content in the sediment and the lack of any signature of organic matter degradation in the water column. The latter is manifested by the nearly constant concentrations of nutrients and oxygen in the depth range from about 1 km depth to the bottom of up to 4 km depth.

Sedimentation of organic matter is amplified by production of large particles with a high sinking rate. An example of this are the algae attached to the underside of the sea ice. A recent investigation (Boetius et al. 2013) shows a large abundance of sea ice algae at the sediment surface of the Eurasian Basin and suggests this to be the result of increased production of ice algae in recent times. The explanation is that more first year sea ice is present that allows more penetration of light to its underside than does thicker multiyear sea ice. Better light conditions at the underside of sea ice are also achieved by a lack of snow on its top, a condition that is favoured by air temperatures above zero. As the sea ice drifts across the ocean in a different direction than the underlying water, the hanging sea ice algae can be exposed to fresh nutrients and thus might reach a substantial size before losing grip and sink to the bottom. If the sedimentation as observed by Boetius et al. (2013) is maintained during the coming years, a substantial amount of the nutrients added to the central Arctic Ocean will be consumed leading to the sequestration of CO_2 from the surface water, giving rise to increased uptake from the atmosphere.

A typical summer surface water phosphate concentration in the central Arctic Ocean is 0.4 μM and if all of this is consumed, followed by sedimentation of the organic matter, the sink of carbon equals 10 g m^{-2} or a total of 48 Tg C in the central Arctic Ocean, based on the classical P:C consumption ratio of 1:106. However, this sink cannot be maintained from year to year without input of new nutrients from the surrounding oceans and rivers. Taking reasonable values for the water transport to the surface layer and typical phosphate concentrations in these waters, the sustained maximum carbon sink is less than one percent of above sink when all the phosphate presently available is used up.

In a climate change situation the supply of nutrients might also be affected by altered current flow from the adjacent oceans or by altered supply of river runoff. There are indications that the river discharge increases under global warming (*e.g.*, Wu et al. 2005; Wagner et al. 2011), but to what degree this will impact the supply of nutrients is not known. Changes in current flow can come about by modification of winds, for instance caused by more open water that increases evaporation. To what degree this has an effect can be assessed by climate models, but as these processes are of small scales in the Arctic Ocean these studies are only starting.

One source of nutrients in a situation of less sea ice is increased upwelling of nutrient rich subsurface water, induced by strong winds along the shelf break when it is ice free (Carmack and Chapman 2003). However, the nutrients in the subsurface layer are produced by organic matter degradation, which also release carbon. During upwelling this will also be transported into the photic zone and more or less offset the carbon consumption caused by new primary production. There are some processes that can further affect the nutrient and carbon content of the subsurface waters, *e.g.*, denitrification that consumes nitrate, and calcium carbonate dissolution that decreases the carbon dioxide concentration. The importance of these processes varies among the geographic regions of the Arctic Ocean. Hence, whether the carbon supply associated with upwelling will offset the effect of the increased nutrient supply or not, will have to be evaluated for each specific region of the Arctic Ocean.

Except for nutrients Arctic rivers also supply organic matter, both particulate and dissolved. Material is also supplied by coastal erosion. Thawing of permafrost, together with the decrease in sea ice coverage, has likely increased this supply during the last decade(s). Absence of sea ice in the late summer/fall makes the waves from the storms erode the coastline much faster (Forbes 2011). The particulate matter ends up at the sediment surface where some is degraded by bacteria, some will re-suspend and be transported along the sea bed, and the rest will be buried at site.

Regardless, a fraction, yet not well known how large, is degraded and added to the inorganic carbon pool as CO_2. In the summer of 2008 the surface waters of large parts of the Laptev Sea and western East Siberian Sea were CO_2 supersaturated even though most nutrients had been consumed by marine primary production (Anderson et al. 2009). The only plausible explanation for this CO_2 supersaturation is degradation of terrestrial organic matter. In total the excess was in the order of 1 Tg C, an excess that potentially could be lost to the atmosphere during the summer in these shallow waters. Unfortunately there are too few data to draw any conclusions if this source of CO_2 is increasing as a result of permafrost thawing. A similar situation was observed in the East Siberian Sea in 2003 and 2004 (Pipko et al. 2011).

Thawing of permafrost also has another impact on the carbon cycle and that is the release of methane hydrates from the sediments of Arctic shelves. An estimate of the size of the methane content on the East Siberian Arctic shelf is ~540 Gt of CH_4 in the form of hydrates, with an additional two thirds (~360 Gt) trapped below as free methane gas. A substantial release from the sediment to the overlying water was found, resulting in about ten times supersaturation relative to equilibrium with the atmosphere (Shakhova et al. 2010a). In the water column oxidation of methane occurs, often mediated by bacteria, which convert methane to carbon dioxide. Oxidation by aerobic bacteria together with dissolved oxygen consumes most of the methane in the water column of the Arctic Ocean as long as it is dissolved, but if it is released as bubbles most of it will escape to the atmosphere (Biastoch et al. 2011). Fluxes of methane from the East Siberian Arctic shelf (total area of 2.1×10^6 km^2) showed a mean of 7.98 Tg C year^{-1} with the 95 % upper and lower confidence limits being 9.73 and 6.31, respectively (Shakhova et al. 2010b). Observed gradients of methane concentrations in air by Kort et al. (2012) gave an estimated efflux of about 2 mg C day^{-1} m^{-2} from the Arctic Ocean up to latitudes of 82°N.

Destabilisation of methane hydrates in areas of permafrost depends on the penetration of heat into the sediments. Several modelling studies on this have been performed, all suggesting slow penetration rates (both on land and at the shelf sediments). However, these modelling exercises are one-dimensional and do not reflect the dynamic conditions of the permafrost domain. There are several observations of sediment structures showing pockmarks from escaping gas, most likely methane. Seismic reflection profiles that penetrate the sediment also clearly show the variable conditions within the sediments, including structures of escaping gas. Plumes of gas seeping out of the sediment have also been observed in the Arctic water column, *e.g.*, along the West Spitsbergen continental margin (Westbrook et al. 2009) and within the East Siberian Sea (Shakhova et al. 2010b).

The global inventory of methane hydrates along the continental margins is several times larger than that on the shelves. Here the stabilization depends on the pressure and temperature. At a given bottom depth, typically around 500 m, the zone of stabilization is reached and little methane hydrates are found at shallower waters if no permafrost exists. Water of Atlantic origin, having temperatures above zero, are typically found in the depth range of 200 to 700 m with the maximum temperature between 300 and 400 m. There has been a substantial variability in the temperature of this source water during the last decades, also with some tendency of an increasing trend. If this signal penetrates all along the Arctic Ocean continental margin it can cause substantial dissociation of these hydrates and release methane to the water column and further into the atmosphere.

The overarching question, that is still to be answered, is whether the release of methane from Arctic sediments is a continuous process or if it has increased during the present warming or will increase with further warming? Both observations (Berndt et al. 2014) and modelling (Biastoch et al. 2011) indicate that no increase of methane release from the methane hydrates of the continental margins has occurred during the last decades. Modelling also suggests that there is little potential to increase this release during the coming century as the expected temperature increase in these layers of the Arctic Ocean water column will not be sufficient (Biastoch et al. 2011). However, there is a potential for a larger temperature increase on the Siberian shelves with an increased risk of an amplified methane efflux.

8.4 Ocean Acidification in the Arctic

Except for climate change, the increasing atmospheric carbon dioxide concentration also causes ocean acidification, *i.e.*, it tends to bring the water towards acidity without formally becoming acidic. When carbon dioxide dissolves in seawater it reacts with the carbonate ions to form bicarbonate (Eq. 8.2), where the latter is the more acidic species. The net result of ocean carbon uptake is thus lowered ocean pH and decreased concentration of carbonate ions. Carbonate ions are one of the building blocks of calcium carbonate, which is produced by many marine organisms, *e.g.*, corals, and plankton like pteropods and coccolithophorids, to form their shells.

The Arctic Ocean has by nature relatively low pH and calcium carbonate saturation state compared to other areas of the global ocean. This is because cold waters have higher CO_2 solubility than warmer waters, so the concentration of natural carbon dioxide is rather high in the Arctic. Due to this, surface waters in the Arctic are 100–200 % supersaturated with respect to calcium carbonate, compared to 300–400 % for tropical surface waters. Consequently not all that much additional CO_2 is required to cause the surface waters of the Arctic Ocean to become undersaturated, which can have severe effects on organisms that produce calcium carbonate shells. Producing and maintaining shells will cost more energy, and in the worst case the shells may start to dissolve. This may threaten many species. The situation is aggravated by the increased summer sea ice melt, as it further dilutes the concentration of carbonate as well as calcium ions. One result is that large areas of the Arctic surface ocean have already experienced calcium carbonate under-saturated conditions during the last decade. The situation is most unfavourable in the southern part of the Canadian Basin where the melting of sea ice has been most extensive (Yamamoto-Kawai et al. 2009).

Another area of low calcium carbonate saturation state is the river plumes, where the carbonate and calcium concentrations also are strongly diluted. Added to this there is extensive input of organic matter, which when degraded adds carbon dioxide to the water. This effect is largest just above the sediment surface, but can be substantial throughout the entire river plume when large amounts of dissolved organic carbon are present. From an ocean acidification point of view, addition of carbon dioxide from degrading organic matter is just as detrimental as the input of anthropogenic carbon dioxide from the atmosphere.

Coupled climate models predict substantial ocean acidification in the future Arctic Ocean, undersaturated waters may cover up to 50 % of its surface on an annual mean basis by the middle of this century (Steinacher et al. 2009). When the summer sea ice disappears from large parts of the central Arctic Ocean, the water will largely be under-saturated with respect to calcium carbonate. The main cause is the dilution effect, combined with the effect of increased uptake of CO_2 from the atmosphere. If primary production increases due to the better light regime, it will slightly offset this effect through the fixation of carbon dioxide, but to what degree this may occur is difficult to assess as many different processes are at play.

8.5 Terrestrial Carbon Cycle in the Arctic

In the following section, we give a brief outline of the northern high-latitude terrestrial carbon cycle for comparison with the ocean carbon cycle, which is the main focus in this chapter. In contrast to the marine carbon cycle, the carbon cycle on land is dominated by processes ultimately going back to biological activities, which can be nicely seen on combined primary productivity maps for the world ocean and the continents (Field et al. 1998). The spatial heterogeneity on land with many types of biome settings and changes in land use as well as forestry adds to the complexity of the land carbon cycle and budget estimates are associated with considerable uncertainties (Canadell et al. 2007). Carbon from the atmosphere is fixed in vegetation through primary production via photosynthesis and released to the atmosphere through respiration. In general, animals play a minor role in the CO_2 related carbon cycle as the land biosphere is strongly dominated by plant material in terms of standing stocks of biomass. Methane (CH_4) emissions, however, can be influenced significantly through termites and ruminating animals, especially cattle (Van Amstel 2012), though neither of these factors play any significant role in Arctic budgets. The land biosphere acts also as more long-term carbon sink through accumulation of biomass and peat formation (Yu et al. 2011). CO_2 and CH_4 sources/sinks on land are dependent on physical driving factors, especially light availability, temperature, and precipitation as well as soil properties (wetlands, soil temperature, drainage etc.). Perturbations of the land biosphere through human activity are considerable. In addition to land use for farming and clear cutting as well as afforestation (Hurtt et al. 2011), the addition of artificial reactive nitrogen from fertilisers and landfill practices has contributed to significant changes in carbon storage on land.

8.5.1 Seasonal Cycle

The Arctic region is marked by high seasonality with respect to light availability and temperature. The global atmospheric seasonal cycle of CO_2 is dominated by the seasonal growth and respiration of deciduous forests with maximum amplitudes in the Arctic (see Point Barrow, Alaska measurements and others worldwide in Keeling et al. 2008). Rising atmospheric CO_2 concentrations due to fossil fuel burning have a fertilising effect on plant growth (Woodward 1987). If changes in the ratio of deciduous to coniferous forests can be ruled out, the increasing amplitude of the Arctic seasonal atmospheric CO_2 concentration is supporting evidence that this fertilising effect is in progress. However, CO_2 fertilisation is influenced by many factors and its effects may be insignificant (*e.g.*, Oechel et al. 1994).

8.5.2 Vegetation Cover

The vegetation around the Arctic Ocean consists mostly of tundra and polar desert. Primary productivity rates are small (Jonasson et al. 2001). Stocks in above ground biomass are, therefore, smaller than in the forest rich areas of sub-polar Canada, Alaska, and Siberia. It is not straightforward to draw a clear boundary between Arctic ecosystems and more forest rich areas further south. Under warmer and wetter future climate conditions, a northward relocation of forests can be expected. This would on the one hand lead to an increase in biomass carbon. However, the associated reduction in albedo would give rise to a surface warming effect and hence a positive feedback to climate change (*e.g.*, Snyder and Liess 2014).

8.5.3 Soil Organic Carbon and Permafrost

Even though vegetation carbon stocks are low in Arctic ecosystems, total carbon stocks can be very large because of the organic carbon stored below ground in soils. Large areas of Arctic and sub-arctic soils consist of continuous permafrost (as larger areas of Siberia and Mongolia further south, Jonasson et al. 2001). Under warming conditions, melting of these organic-rich soils could temporarily lead to a considerable outgassing of CO_2 and CH_4 (*e.g.*, Schuur et al. 2009). Microbial activity is expected to increase under warming conditions. Melt water and intensifications of the hydrological cycles are expected to contribute to a further rise in CH_4 emissions from high latitude soils (*e.g.*, Fung et al. 1991).

8.5.4 Weathering and Erosion

Dry cold climates in the Arctic in conjunction with large seasonal temperature variations as well as freezing-thawing cycles promote erosion. Both rock weathering as well as transport of dissolved organic carbon through river systems can be significant. Beaulieu et al. (2012) demonstrate that in one key Arctic watershed, namely the Mackenzie River Basin, increased erosion of carbonate rocks due to enhanced hydrological cycling and increasing CO_2 acts as a negative feedback to rising atmospheric CO_2. Total organic carbon exports from Canada to the Arctic Ocean seem to be fairly minor. Siberian rivers, however, are able to transport large amounts of dissolved organic carbon into the Kara and Laptev Seas (*e.g.*, Kicklighter et al. 2013).

8.5.5 Source or Sink?

At present, the Arctic tundra may be a small overall carbon sink, but the uncertainties in the various methods are large (Table 8.3; McGuire et al. 2012). In future, the competing effects of biomass growth on the one hand and soil respiration (also as a consequence of permafrost melting) as well as wetland development on the other hand may compensate to some degree (Callaghan et al. 2005). It is, however, possible that at least for some time soil respiration may dominate over biomass production (Schuur et al. 2009) also when taking into account the still not conclusively established efficiency of the fertilisation effect under high CO_2 (Oechel et al. 1994). Present estimates for Arctic land biosphere carbon uptake rates and ocean uptake rates are of the same order of magnitude. In future, this sink may turn into a source. Unless large outgassing rates from sub-sea bed methane sources occur, the land biosphere is likely to account a larger contribution to an emerging carbon source for the atmosphere than the ocean.

Table 8.3 Carbon dioxide and methane associated carbon fluxes from Arctic tundra to the atmosphere, 2000–2006 (From McGuire et al. 2012). Positive numbers represent a source of CO_2 to the atmosphere

	CO_2 (Tg C year^{-1})	Uncertainty (Tg C year^{-1})	CH_4 (Tg C year^{-1})	Uncertainty (Tg C year^{-1})
Observations	−202	−628 to 224	20	−11 to 51
Regional process-based models	−187	−312 to −28	28	18 to 37
Global process-based models	−93	−222 to −1	–	–
Inversion models	−117	−439 to 243	–	–

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Chapter 9
Arctic Vegetation Cover: Patterns, Processes and Expected Change

Bruce C. Forbes

Abstract The tundra biome is characterized by strong gradients in temperature, precipitation and incoming solar radiation, which can vary significantly due to elevation, aspect and distance from the sea. Tundras and polar deserts exist as a relatively narrow strip of land up to 300 km wide around the margins of the Arctic Ocean. The biome is terrestrially disparate yet biotically united, characterized by floristic impoverishment and reduced productivity as one moves progressively north. Many of the plants and animals currently occupying the Arctic are ancient, even if their configuration is quite recent in geological terms. Initial views of the biome as 'simple' due to its relatively low biodiversity and homogenous structure have become more measured in recent decades as scientists now understand the importance of feedbacks and the nature of cyclic yet exceedingly slow processes. Our knowledge of tundra vegetation dynamics has advanced greatly since the 1970s due to the advent of experimental population and community ecology. Disturbance regimes encompass natural and cyclic phenomena, such as fires and insect outbreaks, but also anthropogenic forces like large-scale oil and gas extraction. In recent decades scientific and public attention has focused on the sensitivity of the biome to climate change. Research has shifted from focusing solely on movement of the treeline and the future species distributions, to more holistic treatments of encroachment coupled with *in situ* increases in trees and shrubs. Reindeer/caribou feature prominently throughout the Arctic and, especially in Eurasia, tundra areas are managed as rangelands. Future models will need to account for both vertebrate and invertebrate herbivory.

Keywords Tundra biome • Treeline • Climate change • Arctic greening • Shrub increases • Reindeer rangelands

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9.1 Introduction: Tundra Biome Past and Present

9.1.1 Evolution and Distribution

The tundra biome is the youngest on the planet, having developed its current structure and geography during the close of the Pleistocene glaciations roughly 10,000 years ago. Sources of the flora and fauna tend to be much older, with a high number of species deriving from the various mountain chains that ring the Arctic and stretch between the Far North and more temperate regions. During the middle Miocene (≈18–15 million yr BP), coniferous and mixed coniferous-deciduous forests were present in the uplands of what is now Alaska. However, climatic cooling and drying at the end of the Miocene drove remnants of the deciduous Arcto-Tertiary forest southward, leaving a relatively depauperate biota in the North, characterized by the coniferous boreal forest that spreads across Beringia.

The modern biome is characterized by strong gradients in temperature, precipitation and incoming solar radiation, which can vary significantly locally and regionally due to elevation, aspect and distance from the sea. Taken together, tundras and polar deserts exist as a relatively narrow strip of land 100–300 km wide around the margins of the Arctic Ocean. The 'Low Arctic' consists of mostly closed tundra vegetation types, in which exposed mineral soils are uncommon, and can extend as far south as about 58° N latitude along Hudson Bay in Canada. The polar deserts and semi-deserts of the 'High Arctic' comprise cold, dry habitats with sparse vegetation cover and low vascular plant and animal species diversity. Pronounced diversity among lichens and bryophytes and extremely high similarity among circumpolar plant and animal species is coupled with overall floristic impoverishment and reduced productivity as one moves progressively north. Together these factors contribute to the concept of the tundra biome that is terrestrially disparate yet biotically united. In recent decades scientific and public attention has focused on the perceived sensitivity of the biome to climate change and various forms of anthropogenic disturbance, such as extensive oil and gas development (Forbes 2013).

The Arctic tundra biome generally lies north of the latitudinal treeline and is characterized by low temperatures and precipitation, low biotic diversity, permafrost soils with limited nutrient availability, and short growing seasons and reproduction cycles. Vegetation structure is simple and monotonous relative to more temperate regions. In the Low Arctic the main, mostly closed vegetation types consist of mires and sedge-moss tundra on poorly drained substrates, erect deciduous shrubs like willows and alder in snow-protected habitats (Fig. 9.1), and dwarf-shrub heath on drier ground. The High Arctic features open polar deserts and semi-deserts with scattered cushion plants, a greater proportion of lichens and few woody taxa. Vertebrate herbivores are widespread and some, such as microtines and reindeer or caribou, can be extremely abundant albeit subject to large cyclic population oscillations (Forbes and Kumpula 2009; Olofsson et al. 2012).

Fig. 9.1 Tall willow (*Salix*) and alder (*Alnus*) shrubs characterize low arctic tundra in the foothills of the Polar Urals on southern Yamal Peninsula, West Siberia

9.1.2 Tundra Biome Concept and Phytogeography

The modern concept of a tundra biome developed in the 1960s with the advent of the International Biome Programme, or IBP. However, the recognition of a distinct terrestrial circumpolar flora dates back at least a century and a half (Hooker 1862). In a global context, the Arctic Floristic Province is the northern extension of the Circumboreal Region and is characterized by low diversity and endemism coupled with extreme floristic unity as one moves poleward. The IBP adopted 'tundra biome' as a convenient term for a broad range of high latitude and high altitude sites, while recognizing that they did not represent a discrete biome with clearly defined environmental or biological limits. Rather, the IBP synthesis stressed that the tundra biome consists of a series of gradients in climatic, soil and vegetation characteristics, albeit mainly those with extreme low temperatures and short growing seasons (Bliss et al. 1981). Since the IBP, arctic and alpine tundra have tended to be treated separately given the strong biophysical differences between them, even if they share many floristic elements. During the IBP tundra vegetation was divided into ten distinct plant growth forms, later referred to as plant functional types (see Shaver et al. 1997).

Most of the early research conducted in the tundra biome, through the first half of the twentieth century, consisted essentially of basic science, encompassing species composition, vegetation structure, distribution (phytogeography), and preliminary inquiries into mechanisms of succession, physiological ecology, primary production and plant litter decomposition. The initial view of the tundra biome as 'simple' due to its relatively low biodiversity and homogenous structure has become much more measured in recent decades as scientists have come to understand the importance of feedbacks and the nature of cyclic yet exceedingly slow processes. Recent work has brought modern genetics to bear on the questions of arctic biogeography raised by Hultén (1937) some 75 years ago (Abbott and Brochmann 2003; Alsos et al. 2007; Abbott 2008; Willerslev et al. 2014). Much effort still goes into understanding the extinct biome known as Beringia (Hoffecker et al. 2014). The discovery of oil at Prudhoe Bay, Alaska eventually spurred intensive investigations on a wide range of issues pertaining to vegetation cover, such as plant-animal interactions, experimental ecophysiology, disturbance ecology, and assisted revegetation.

Many of the plants and animals currently occupying the Arctic are ancient, even if the configuration of the tundra biome is quite recent in geological terms. Soviet and post-Soviet research in Russia has tended to focus on longitudinal variation or floristic zonation within the arctic flora, a distinctive factor commented on 150 years ago by Hooker (1862). An excellent example of this approach is the review by Yurtsev (1994). Among Western scientists, the emphasis has been on latitudinal variation or bioclimatic zonation in the North American Arctic. Walker et al. (2005) carry the concept to its ultimate end by developing a circumpolar map based on remote sensing data that anticipates needing to be updated if the northern climate continues to warm.

9.1.3 Ecosystem Processes and Disturbance

Our understanding of tundra vegetation dynamics has advanced greatly in recent decades, particularly in the West, due to the advent of experimental population and community ecology. Permanent plots came into vogue in the 1970s and now have proved their value since the 2007–2008 International Polar Year led to resurveying many of the oldest and most carefully sampled sites. In a recent review of circumpolar studies (Callaghan et al. 2011a), the majority of the plots were in the range of 40 years old, which encompasses the era of late twentieth century Arctic warming. Walker et al. (2006) provide a nice complement to the latter by focusing on population- and community-scale experimental warming trials, albeit of shorter duration, pointing to a future decline in tundra biodiversity. Shaver et al. (1997) do an admirable job of employing biogeochemical and growth form or 'plant functional type' approaches to understanding tundra ecosystem processes. Eviner and Chapin (2003) place these processes within a conceptual framework that emphasizes tools for managing and maintaining ecosystem services.

As an original tenet of ecology, studies of succession in tundra ecosystems date back to the early twentieth century. A key figure in biogeography, Charles Elton, was also one of the first to highlight the central role played by soil instability in arctic vegetation patterns. Others later expanded upon this theme, characterizing arctic vegetation as seasonally and perennially dynamic. As in more temperate regions, there were differences of opinion between adherents of Clements versus Gleason: By the IBP era, consensus had moved on from climax thinking (Clements) to the individualistic approach (Gleason), which would carry forth into the twenty-first century (Forbes 2013).

Disturbance ecology encompasses natural and cyclic phenomena, such as fires and insect outbreaks, but also anthropogenic forces like large-scale oil and gas extraction and introduced species. The rapid pace of human-mediated disturbance in recent decades has focused attention on natural regeneration (Forbes et al. 2001; Forbes and McKendrick 2002). The main limiting factor is that the further north one goes the fewer available vascular and bryophyte species there are capable of growing on either disturbed or undisturbed ground. A related issue is that viable seeds are absent for most ruderal species, with the result that clonal rhizomatous graminoids tend to dominate disturbed ground and larger patches regenerate on decadal times scales, if at all (Forbes and McKendrick 2002).

9.2 Predictions of Tundra Distribution

By the mid-1980s projected Arctic warming had become an issue of major concern within the scientific community. Public interest soared after the release of the Arctic Climate Impact Assessment (ACIA) Summary for Policy Makers in 2004 and was further galvanized by the anomalous contractions of late summer Arctic sea ice extent in 2007 and 2012. With regard to the bio-physical aspects of a warming tundra biome, the most relevant summaries in the past decade are those from ACIA (Callaghan et al. 2005), Snow, Water, Ice and Permafrost in the Arctic (SWIPA) (Callaghan et al. 2011b, c) and the Intergovernmental Panel on Climate Change (IPCC) (Larsen et al. 2014). Diminishment of the extent of the tundra biome is of strong interest given the huge potential loss of habitat for plants, animals and humans who depend on them, as well as potential positive feedbacks to climate change. Major terrestrial feedbacks are expected since: (1) northward migration of treeline would act to decrease Arctic albedo and further increase regional warming (Callaghan et al. 2005); (2) stores of greenhouse gases are believed to have considerable potential to accelerate climate change; and (3) the massive reservoirs of soil organic matter in the northern boreal and tundra biomes may be vulnerable both to permafrost thawing and warming (Schuur et al. 2008; Karhu et al. 2014) as well as to encroachment by plant communities which may accelerate decomposition and loss of soil carbon to the atmosphere (Hartley et al. 2012). However, more regional studies and multi-dimensional modeling remain to be done (see Chap. 8 by Olsen et al., this volume). This section of the chapter summarizes key processes, feedbacks and predictions concerning tundra distribution, with emphasis on potential treeline advancement and increased abundance of tundra shrubs, from ACIA, SWIPA and the IPCC Fifth Assessment Report.

The width of the tundra zone varies greatly in different parts of its circumpolar distribution. On average, it does not exceed 300 km, but in some regions (e.g. the lower reaches of the Kolyma River in eastern Siberia and the eastern portion of the Mackenzie River Delta in northwest Canada) the tundra zone extends only 60 km from treeline to the Arctic coast. In such areas, the tundra zone is potentially highly vulnerable to climate warming (Callaghan et al. 2005). As such, Arctic biota of the present day is relatively restricted in range and population size compared with their Quaternary history. When the treeline advanced northwards during the warming of the early Holocene, a lowered sea level allowed a belt of tundra to persist around the Arctic basin whereas any future northwards migration of the treeline will further restrict the area of tundra because sea level is expected to rise. Arctic ecosystems are known to be vulnerable to current disturbances and to have long recovery times (Forbes et al. 2001; Callaghan et al. 2005).

Evidence from the past indicates that Arctic species, especially larger vertebrates, are certain to be vulnerable to extinction if climate warms. The treeline will very probably advance, perhaps rapidly, into tundra areas of northern Eurasia, Canada and Alaska, as it did during the early Holocene, reducing the extent of tundra and contributing to the pressure upon species that may result in their extinction. Species that today have more southerly distributions will most likely extend their ranges northwards, displacing Arctic species, as in the past (Callaghan et al. 2005).

About 40 % of vascular plants (and a much higher percentage of mosses and lichens) are basically boreal species that now barely penetrate the Arctic. They currently occur close to the treeline or along large rivers that connect the sub-Arctic with the Arctic. These boreal species already present within the Arctic will probably be the primary boreal colonizers of the Arctic in future in the event of continued warming. Polyzonal (distributed in several zones), arctoboreal (in taiga and tundra zones) and hypoarctic (in the northern taiga and southern part of the tundra zone) species have even greater potential to widen their distribution and increase their abundance in a changing climate. The majority of cryptogams (non-vascular plants) have wide distributions all over the Holarctic. Such species may survive a changing climate, although their abundance can be reduced (Callaghan et al. 2005). The most vulnerable vascular plants are likely to be species that now have the largest abundance and widest ecological amplitude in the northernmost part of the tundra zone (the former) or in polar deserts (the latter). These groups of species are best adapted to the climate conditions of the high Arctic where they are distributed in a wide range of habitats where more competitive species of a general southerly distribution are absent.

The aforementioned latitudinal gradients (see *Phytogeography* above) suggest that Arctic plant diversity is strongly sensitive to climate. The number of vascular plant species declines five-fold from South to North on the Taymyr Peninsula in central Siberia. Summer temperature is the environmental variable that best predicts plant diversity in the Arctic. However, latitudinal gradients of species diversity are best described as several parallel gradients, each of which depends on summer heat, but which may differ from one geographic region to another. This fact has to be taken into consideration when predicting future changes in biodiversity. In general then, summer warmth, length of the growing season and winter temperatures all affect the growth, reproduction and survival of Arctic plants. Still, the relative importance of each of these varies from species to species, site to site and year to year.

Palaeorecords of vegetation change indicate that the northern treeline should extend upwards in elevation and northwards in latitude during future climate warming (Callaghan et al. 2005) based on the relationship between treeline and summer warmth discussed above. Although the treeline has moved northwards and upwards in many Arctic areas, it has not shown a general circumpolar expansion in recent decades. In some areas, the location of the treeline has not changed or has changed very slowly (Larsen et al. 2014). A global study by Harsch et al. (2009) showed that only 52 % of 166 global tree line sites studied had advanced over the past 100 years. In many cases the treeline has even retreated. At the small scale, the tree line has shown increase, decrease and stability in neighboring locations (Van Bogaert et al. 2011).

Model projections that suggest a displacement of between 11 and 50 % of tundra by forest by the year 2100 (Callaghan et al. 2005) and shifts upslope by 2–6 m per year and northwards by 7.4–20 km per year might be overestimating the rate of tree line advance by a factor of up to 2000 (Van Bogaert et al. 2011; Larsen et al. 2014). The fastest upslope shifts of treelines recorded during twentieth century warming are 1–2 m per year whereas the fastest so-far recorded northward-migrating tree line replaces tundra by taiga at a rate of 3–10 m per year (Larsen et al. 2014).

Water availability rather than temperature appears to be an increasingly limiting factor for the northward progression of the treeline, with previous trends of positive tree growth now appearing to be weaker, nonexistent, or even reversed as a result of temperature-induced drought (Wilmking et al. 2005). Thus, under warmer climatic conditions, the northern treeline would probably not advance uniformly into regions that were formerly too cold (as generally perceived), but would advance in a fragmented manner by occupying parts of the landscape with sufficient moisture, for example from snow accumulations (Callaghan et al. 2011b). At the same time, slightly drier soils along thermokarst banks promote the introduction of woody species as compared to adjacent tundra. Such processes may accompany a northward expansion of the treeline. Taken together, these observations imply that the treeline will advance over the course of this century in a non-uniform way, colonizing only those parts of the landscape where there is sufficient moisture (Callaghan et al. 2011c), or where it is prevented by paludification (Crawford et al. 2003).

Various changes in biodiversity will decrease albedo and increase the positive albedo feedback to the atmosphere (i.e., warming). These include more and taller shrubs in the tundra, expansion of boreal forest into regions now occupied by tundra, and the replacement of summer-green conifers (larch) and other deciduous treeline tree species by evergreen conifers such as pine and spruce. Feedbacks to climate from changing biodiversity also include sequestration of carbon from the air, which will help reduce air warming, and increased evapotranspiration that in turn leads to local cooling (Callaghan et al. 2011d), while some areas might serve as carbon sources (Hartley et al. 2012).

Interactions between snow and current and projected advances of shrubs and trees into the tundra are expected to amplify warming in the Arctic (Callaghan et al. 2011c).

There are complex interactions between permafrost soils and vegetation that affect soil temperature, surface albedo and even a region's sensitivity to fire. By trapping snow and directly insulating the ground with its foliage, plant communities can reduce soil temperatures by several degrees, and permafrost patches may therefore continue to exist beneath undisturbed vegetation despite rising air temperatures. Trees and shrubs have a much lower albedo than snow on tundra, and the conversion of northern landscapes to shrub tundra and forest is likely to cause increased heating; after snowmelt, however, increased evapotranspiration from vegetation can also cause local cooling. Finally, increased vegetation biomass combined with drier conditions is likely to increase the frequency of fires on the tundra, with additional impacts on permafrost stability and temperature (Callaghan et al. 2011c). Although increases in shrub advance in the Alaskan Arctic have not yet resulted in warming, it is predicted that an increase of shrubs could increase summer heating of the atmosphere by 3.7 W/m^2, which is equivalent to a doubling of CO_2 concentration or a 2 % increase in the solar constant (Chapin et al. 2005; Callaghan et al. 2011c).

To conclude, in recent decades the treeline has moved northward and upward in many, but not all, Arctic areas, and significant increases in tall shrubs and grasses have been observed in many places (Larsen et al. 2014). The latest assessment of changes in NDVI (Normalized Difference Vegetation Index, a proxy for plant productivity) from satellite observations between 1982 and 2012 shows that about a third of the Pan-Arctic has substantially greened, <4 % browned and >57 % did not change significantly (Xu et al. 2013). Even if the coniferous boreal forest zone does not march poleward as quickly as expected, the tundra in some places is already undergoing substantial changes in vegetation cover and structure (see Fig. 9.1).

9.3 Tundra as Habitat and Homeland: Reindeer/Caribou and Northern Residents

Reindeer and caribou (*Rangifer tarandus*) feature prominently in virtually all Arctic – as well as many northern boreal – social-ecological systems. The tundra biome and reindeer habitat are virtually synonymous (Fig. 9.2). Given this situation, no contemporary overview of Arctic vegetation cover can avoid the fact that even though the tundra zone is sparsely settled by humans relative to more temperate regions, Arctic rim nation states all manage their reindeer and caribou rangelands to a greater or lesser extent. Arctic nations, through governance regimes ranging from international to local to the household level, thereby exert a number of direct and indirect, conscious and unconscious influences on vegetation cover over time scales

Fig. 9.2 Heavily reindeer grazed and browsed wetland serving as summer pasture in the mountain birch forest zone along the Norwegian border in northernmost Finnish Lapland

from hours to millennia. This section of the chapter will therefore briefly address the relationship between reindeer management and tundra vegetation.

In addition to basic sustenance for large numbers of indigenous and non-indigenous Arctic residents, *Rangifer* spp. provide the basis for clothing, shelter, tools, transport, art, language, education, seasonal calendar, spiritual fulfillment, status and, not least, the maintenance of intra- and inter-household sociocultural relations though formal and informal codes of sharing and reciprocity. In other words, inter- action with reindeer (and caribou) is a key element of the social fabric of human societies throughout the circumpolar Arctic (Forbes and Kumpula 2009; Crate et al. 2010). Reindeer habitat ranges from open polar semi-deserts and so-called polar oases in the High Arctic, through the more closed shrub-dominated belt of circumpolar low arctic tundra, to patchy sub-Arctic fjells and vast swaths of northern boreal deciduous and lichen-rich coniferous forests in North America and Eurasia (Forbes 2010; Ims et al. 2013). Given all this, it is clear that territories occupied seasonally or year-round by semi-domestic or wild reindeer function as both ancestral and modern homelands for nearly all Arctic peoples, including western Greenland. For better or worse, these same territories encompass a wide variety of land uses, including forestry, mining, hydro- and wind-power, hunting, fishing, gathering and all types of tourism. As a result, the vegetation cover of reindeer rangeland is perennially subject to powerful socio-economic and cultural interests and its management is fraught with political agendas and imperatives that often clash, sometimes ferociously (Forbes 2006, 2010).

In Fennoscandia and Russia, carrying capacity models are generally employed by the respective nations to manage nearly two million semi-domestic animals in relation to state-sponsored scientific assessments of range conditions. Strongly linked to this is the concept of 'overgrazing', and that, due to high animal densities sustained over several decades, many rangelands across northern Eurasia are considered to be in poor condition, the key metrics for which tend to be lichen biomass on winter pastures and average slaughter weights for yearling calves in autumn (Forbes and Kumpula 2009). Some of the most interesting work in recent years concerns rethinking traditional concepts of herbivory, which has important implications for the use of tundra as rangelands. Mysterud (2006) challenges the assumptions underlying carrying capacity models while van der Wal (2006) makes a highly complementary critique around alternative stable states driven by grazing and concludes that habitat 'degradation' is immensely subjective. In other words, transitions between different vegetation cover types in space and time are to be expected. Trying to maintain an administratively 'preferred' stable state in the face of dynamic animal populations, competition among land users, and rapidly changing climatic conditions is unrealistic.

At the deciduous treeline in Fennoscandia (Fig. 9.2), reindeer grazing has potentially two opposing effects on forest expansion. The removal of lichen may allow birch seeds to germinate and sprout successfully, while reindeer grazing on birch seedlings, shoots, and leaves may hinder the advance of the treeline (Hovelsrud et al. 2011). Within the tundra zone, repeated grazing and trampling on summer ranges may lead to a significant increase in graminoid cover. However, heavy grazing and trampling on drier ground or skeletal soils typically leads to significant reductions in total plant cover and increases in organic and mineral soil erosion (Forbes and Kumpula 2009). It is unclear whether such changes persist over the long-term, but preliminary findings indicate that damage is ephemeral (Tømmervik et al. 2012; Bernes et al. 2013). Contrary to the 'overgrazing' narrative, there is some evidence that biodiversity hot spots of Arctic-alpine plants in the Scandinavian high mountains that depend on disturbance from grazing are enhanced by reindeer trampling and grazing (Olofsson and Oksanen 2005; Caballero et al. 2007). Thus, the traditional role of reindeer herding could be reinterpreted as a stewardship of the landscape by using reindeer to retard the advance of shrubs and trees and the disappearance of valued flora and fauna (Callaghan et al. 2011b).

Recent changes and results of climate change simulation experiments in the field have shown that there are considerable uncertainties in the projected rates of Arctic vegetation change. Furthermore, the models do not yet include vertebrate and invertebrate herbivory, extreme events such as tundra fire and extreme winter warming damage or changes in land use that either reduce the rate of vegetation change or open up niches for rapid change (Larsen et al. 2014). Future modeling efforts will therefore need to better account for herbivory by reindeer, as well as other herbivores that affect extensive areas, including microtine rodents in peak years (Olofsson et al. 2012) and geometrid moths (Larsen et al. 2014).

9.4 Trees in the Tundra: Northward Migration or Shrub-Woodland Transformations *in Situ*?

The science of climate warming in the Arctic has developed rapidly in an attempt to keep pace with the rate of change (see Sect. 9.2). The result is that the more general scenarios initially proposed have come to be informed by more and better quality empirical data. For example, at the time of ACIA a decade ago, and the previous IPCC assessment in 2007, expectations were that the coniferous treeline would migrate northward relatively quickly, yet the evidence indicates this has not been the case so far in most locations. The predicted expansion of the boreal zone northward would result in the extinction of significant elements of the tundra flora, particularly in the High Arctic. However, a more critical review of this process by Crawford (2008), published since ACIA and the previous (fourth) IPCC Assessment Report, foresees the survival of arctic and alpine flora in a rapidly warming tundra biome.

Gradually over the past decade, attention has shifted from focusing solely on movement of the treeline and the future distribution of tree species, to more holistic treatments of tree encroachment and *in situ* shrub increases (Tape et al. 2006; Forbes et al. 2010; Myers-Smith et al. 2011). Shrubs have been increasing in several places across the Arctic (Myers-Smith et al. 2011), as well as globally (Naito and Cairns 2011). Shrub encroachment is important to account for because of its ability – like trees – to influence surface albedo, with additional feedbacks to the cryosphere (Fig. 9.3). The enhanced growth of Arctic shrubs in response to warming increases

Fig. 9.3 In addition to northward and upward migration of the coniferous treeline, *in situ* shifts of low erect shrubs into tree-size individuals have strong potential to affect tundra albedo, with feedbacks to climate, permafrost and snow cover

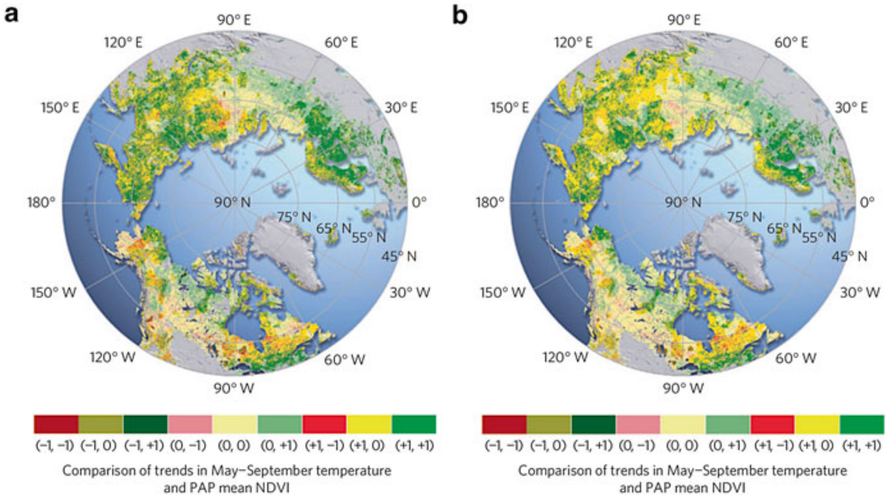

Fig. 9.4 Seasonality changes across the Arctic expressed as changes in temperature versus vegetation seasonality

the potential for local increases of snow cover accumulation independent of increases in precipitation within the tundra zone. Increased shrubbiness is expected to change snowpack properties and melt dynamics that, in turn, will have implications for the soil thermal regime, permafrost and hydrology (Blok et al. 2010). Overall, it is likely that over the next few decades shifting treeline position and shrub growth combined will exhibit many different responses throughout the circumpolar North according to different degrees of warming associated with various changes in precipitation, permafrost dynamics, land use and tree species' migration potential (Larsen et al. 2014).

Mechanisms for increased shrub growth can vary from place to place. Different drivers may include increased summer air temperatures, changing snow duration and depth, and release from strong herbivory pressure (Myers-Smith et al. 2011). In general, circumpolar seasonality has diminished in recent decades as air temperatures have risen (Xu et al. 2013) (Fig. 9.4), with the result that phenology has advanced in key regions where shrub growth has increased, such as West Siberia (Zeng et al. 2013). It is important to note that treeline advance may be delayed or prevented in regions already occupied by clonal deciduous shrubs whose *in situ* growth has increased significantly in recent decades (Macias-Fauria et al. 2012). The presumed 'blanket' trigger for tundra vegetation change has been sea ice decline (Bhatt et al. 2010). However, detailed empirical analysis of shrub growth in relation to sea ice cover in northwest Eurasia has questioned this direct link (Macias-Fauria et al. 2012). At the same time, Macias-Fauria et al. (2012) note that while a decline in sea ice may not be the direct trigger for increasing tundra productivity in recent decades, if the current trend continues the circumpolar Arctic is likely to experience a level of 'greening' that has already been observed in northwest Eurasia (see also Walker et al. 2011; Epstein et al. 2013). Recent research also suggests that herbivory may serve to check increases in tundra shrubs, at least when they remain below the reindeer browse limit of ca. 1.5 m (Olofsson et al. 2009). The previous section reviewed the extent and profound ecological importance of reindeer throughout the Arctic. The bottom line is that understanding Arctic vegetation cover in the past, present and future requires a multitude of approaches that consider together linked climatic, geomorphic and social-ecological drivers and processes.

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Chapter 10
Human Development in the New Arctic

Joan Nymand Larsen and Andrey Petrov

Abstract In the decades ahead global change will have major consequences for the Arctic natural environment and human populations. In this chapter we reflect on the state of human development in the new Arctic and some of the key components of human wellbeing, including the basic sources of change. We address the importance of data and monitoring as ways forward to track changes in human development. The speed of Arctic change, its complexity, and the uncertainty about future directions, makes it increasingly important to understand how human development is changing, and precisely what and how individual aspects are changing. Rapid change in the Arctic has increased the emphasis placed on devising indicators for monitoring and measuring change in human development and quality of life. The Arctic Social Indicators (ASI) framework and method for monitoring and tracking change in human development is briefly discussed, and an application to the case of Nunavut, Canada, is presented.

Keywords Human development • Wellbeing • Arctic change • Indicators • Monitoring

10.1 Introduction

The Arctic is witnessing profound changes in the region's state of human development, in the livelihoods and wellbeing of peoples, cultures and societies, and the very processes for enlarging the capabilities, opportunities, and overall well-being of Arctic residents. The ongoing and emerging changes describe critical aspects of the new Arctic and are central in discussions of possible pathways forward to a more sustainable Arctic future.

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There is wide consensus on the multiple changes, challenges and opportunities facing the Arctic and its peoples, and the long term impacts for human development in the region (Larsen et al. 2014b; Huskey 2005; Larsen and Fondahl 2014; AMAP 2011). Understanding these changes and their consequences is important in seeking answers to questions of sustainable human development. Human development refers to a process of expanding the choices and freedoms available to people and societies to improve their wellbeing in terms of material needs, health, education, culture, and security. To many people sustainable human development remains the foremost desirable development paradigm that can offer robust solutions to the many converging economic, environmental and climate challenges the region is facing.

Among the often cited drivers of change in the Arctic are climate change, the world economy, and the growing demand for natural resources and increased world prices of minerals (Larsen and Fondahl 2014; Huskey 2010; Glomsröd et al. 2009). In addition, a number of more regional drivers, such as the rate of exploration of natural resources, measures undertaken to protect the environment, the introduction of new forms of governance, and innovative systems for managing the region's natural resources are increasing in importance. These global and regional drivers affect Arctic change and the very pillars of our human systems, with potentially far reaching consequences for Arctic livelihoods (Arctic Resource Development 2012). At the same time, broad variations continue to characterize the impacts between and within regions, between indigenous and non-indigenous populations, and between smaller and more remote settlements and central or urban localities.

In the decades ahead global change will have major consequences for the Arctic natural environment and human populations (Rasmussen 2011; Heininen and Southcott 2010). Change in the Arctic transcends the physical, biological, and social systems in complex ways and will continue to produce outcomes with costs or benefits for Arctic populations and local communities. While medium and long-term impacts remain largely uncertain, scientific evidence suggests that for many local communities the observed and projected changes to sea ice, permafrost, storm surges and increased coastal erosion will have direct consequences at many levels, including for subsistence livelihoods, travel on ice, the ability to engage in cultural pursuits, and for community infrastructure and housing (AMAP 2011; Krupnik and Jolly 2002; Forbes 2011; IPCC 2014). This in turn presents critical challenges for human development and individual wellbeing.

In this chapter we reflect on the state of human development in the new Arctic and some of the key components of human wellbeing, including the basic sources of change. We address the importance of data and monitoring as ways forward to track changes in human development.

10.2 Arctic Human Development and the New Arctic

Human development is a process that goes far beyond merely realizing increased economic growth and development. Because of the unique character of the Arctic region, including small size, and the remoteness and lack of accessibility of many communities, the consequences of change in terms of its impact on culture, society and economy may be relatively more pronounced than in regions beyond the Arctic. Arctic societies are facing an unprecedented combination of rapid and stressful changes, both bio-physical and socio-economic, with the rate, magnitude and complexity of these changes becoming a growing factor of concern and uncertainty. In fact, the discourse on Arctic change, human development, and adaptation to change, is becoming increasingly focused on these complex interactions, the notion of a transformative change, and the heightened degree of uncertainty. We can increase our choices – realize improvements in human development – by expanding a range of human capabilities in terms of what we can do or be. Among central capabilities in any society would be good health, access to education, and access to employment and economic opportunities. The range of capabilities we have access to in turn helps determine outcomes in human development and life fulfillment in general. As in the world at large this also applies to the Arctic, and indeed the new Arctic (Larsen et al. 2010; Rasmussen and Larsen 2009).

The state of Arctic human development is undergoing change and transformation into the new Arctic. Some basic facts are telling of the challenges and opportunities that lie ahead. The Arctic is relatively sparsely populated; there are about four million people who live in the Arctic, of which about 10 % are indigenous. Yet, the Arctic demography is highly diverse, with different areas characterized by varying shares of indigenous, settler and transient populations, with differing levels of urbanization, rates of population growth or contraction (Bogoyavlenskiy and Siggner 2004). The Arctic population is also an aging population, but tends to be younger than that of the national averages. Some areas are characterized by high levels of out-migration, which tends to involve a larger number of females than males, and a stream of migration from smaller settlements towards larger centers and urban areas. At the same time, an influx of skilled and unskilled workers from as far as Southeast Asia to Arctic resource projects also contributes to transforming the ethnic and demographic portrait of Arctic communities. Other characteristics include the present gap in educational attainment between indigenous and non-indigenous people, and the increasing political and economic empowerment of the region's indigenous population (AHDR 2004; Larsen and Fondahl 2014).

In northern economies, local as well as regional, material wellbeing provided by the formal, informal and transfer sectors is central to understanding migration patterns and changes in livelihoods. These economies have a number of common characteristics that set them apart from economies outside the region. While the formal economy of the North is characterized by resource extraction and the increasing role and presence of large-scale capital and skill-intensive industrial resource production, local economies can be described as mixed economies where market and non-market activities all play an important role in supporting community livelihoods. Wage employment, traditional pursuits – hunting, trapping, fishing, and gathering – and transfer income from government all provide important sources of income and help support individual and community wellbeing. The relative size and importance of the market, non-market, and transfer sector vary throughout the North (Larsen and Huskey 2010; Huskey 2010; Huskey et al. 2014; Duhaime 2005; Aslaksen et al. 2009, 2006).

The Arctic region faces several distinct challenges related to economic development and large-scale resource extraction activities. With rising global demand, and a growing desire for stable and secure resource supplies in world markets, industrial resource extraction activities will likely continue to expand. Arctic residents have witnessed the effects of a changing market economy. In some cases this has involved a greater focus on short-term gains with positive economic net-benefits to industry, local firms or local community residents, rather than long term sustainability and community viability, with the protection of the environment and local resource base for next generations. This has also meant that the North has been exposed to potentially destructive cycles of resource exploitation that may put Arctic species and local communities at risk. Resource development may inevitably represent trade-offs between a healthy environment and economic growth, with possible consequences for human wellbeing. This classic dilemma in the industrial world is becoming a growing challenge in the new Arctic. The classic trade-off remains, but is now increasingly amplified by a new challenge created by the rate and extent of Arctic change, including the effects of new and complex interactions between bio-physical and human systems (Larsen 2010a, b).

The vast majority of Arctic natural resources are destined for world markets, and this places the circumpolar north firmly in the world system. Life in the Arctic is increasingly shaped or influenced by events, decisions and activities happening elsewhere. Strategies for sustainable development and Arctic environmental protection need to take into consideration the economic, social and environmental linkages between the Arctic and other regions of the globe, and processes of globalization. The future of the Arctic will be influenced by other, non-Arctic regional, social, political and economic interests. Viability of modern communities increasingly requires the maintenance of economic relations with the outside. Yet, the strength of these economic relations and the linkages between different sectors differ significantly due to variations in physical, natural, financial and human resources.

Among the most formidable challenges are permafrost and sea ice, remoteness and lack of accessibility of Northern communities, the high cost of production in the North, the shortage of human resources for large-scale industrial projects, the fragility of eco-systems and environmental impacts, and the negative spill-over effects of industrial activity for local and indigenous communities.

In the last several decades most Arctic countries have begun to require socio-economic impacts assessment (SEIA) as a part of any resource development process. Some jurisdictions have introduced mandatory SEIAs, usually as a part of a larger environmental impacts assessment framework. Many have recommended or mandated the domains that are assessed, although a few have developed specific measurement criteria for assessment.

As the volume of development in the Arctic is growing, the complexity and scope of SEIAs is increasing as well. Collaboration among proponents, multiple levels of government, and local communities to create comprehensive, structured, transparent and clear frameworks and processes for socio-economic impacts assessments is promising. However, by taking a piecemeal approach this may fail to adequately present the overarching conditions of peoples' wellbeing in the Arctic, such as the level of human development. Often assessment are modeled and tested in the South, and may apply indicators that have limited meaning in the Arctic while omitting key Arctic-relevant variables. Therefore, further development of Arctic specific indicators systems that reflect local needs and characteristics is a related research goal that has become a key necessity not only from the standpoint of our understanding of changing human conditions in the Arctic, but also from the standpoint of practical necessities associated with regional development (Larsen 2009).

Alongside the advancement of Arctic-oriented wellbeing and human development measurement systems and the establishment of community-based observation systems, more holistic yet simple indicator frameworks will guarantee the sensitivity of SEIAs to the socio-economic characteristics, vulnerabilities, and needs and concerns of Arctic communities.

10.3 Monitoring Change in Arctic Human Development

The speed of Arctic change, its complexity, and the uncertainty about future directions, makes it increasingly important to understand how human development is changing, and precisely what and how individual aspects are changing. Rapid change in the Arctic has increased the emphasis placed on devising indicators for monitoring and measuring change in human development and quality of life. There is a growing need for monitoring the transforming socio-economic systems in the new Arctic (ASI 2010; Forbes 2011).

A method for monitoring and tracking change in human development was first discussed as part of the process of producing the first Arctic Human Development Report, AHDR (2004), and was then further developed during the years of the Arctic Social Indicators projects (ASI-I and ASI-II), culminating with a full suite of Arctic specific social indicators from each of a set of chosen domain areas, and then followed by recommendations for an ASI monitoring system (ASI 2010).

The AHDR team in consultation with indigenous representatives– during the process of developing the first AHDR – arrived at a set of domains of human development, which as a collective would provide a holistic picture of what to most Arctic residents would be considered important for wellbeing and human development. In particular, this process emphasized that beyond the more general aspects of human development – those employed by the United Nations in its construction of the Human Development Index (HDI), namely material wellbeing, health, and education – there are additional components that are considered unique to the Arctic – components of human development that residents of the Arctic have emphasized as being prominent aspects of what they consider important to human development and the fulfillment of their lives. These are: cultural wellbeing, closeness to nature, and fate control (AHDR 2004; ASI 2010; Young 2010). The overarching framework of measuring human development in the Arctic mapped by the first AHDR in 2004 and developed by Arctic Social Indicators (ASI 2010; Larsen et al. 2014a), provide general guidance regarding the domains and indicators to be used in Arctic regions, while community-based indicators ensure adequacy and relevance of the chosen variables.

Indicators of living conditions are useful in monitoring social change, and some indicators are common for worldwide comparisons. Standard and globally accepted measures such as educational attainment and gross domestic product are important in evaluating human capacities. Knowledge about indicators such as these is important in understanding the character, direction and prospects of changes taking place in the North. In addition, however, differences between the Arctic and the surrounding world are reflected in a set of unique attributes of human development which have not been captured adequately by universal standard indicators. This has been a point of departure for the construction of ASI indicators.

Many areas of the Arctic and especially the more remote regions with substantial indigenous populations do not achieve high scores on the UN HDI (AHDR 2004; ASI 2010). But this does not necessarily mean that human development and wellbeing is lower in the Arctic. The critical challenge is to identify the relevant domains, i.e. domains that reflect what the Arctic population considers important aspects of human development. For example, many Arctic communities do not rank high in terms of life expectancy, particularly among indigenous peoples where suicide rates and accidental-death rates are high (Young and Einarsson 2004). Also, GDP per capita is often deceptive as a measure of wellbeing in the Arctic. Much of the income associated with extractive industries flows out of the Arctic and into the income streams of large multinational corporations. Nonetheless, many individuals in this region exhibit a strong sense of wellbeing (Young 2010). In response to this, the Arctic Social Indicators (ASI) project has constructed indicators that reflect the unique aspects of what residents of the north view as prominent features of human development.

In the ASI (2010) report indicators were devised for six domains; material wellbeing, education, human health and population, cultural wellbeing, contact with nature, and fate control. Three of these domains are of particular interest. Arctic residents have indicated that the viability of their communities relies on having control over their own fate, sustaining contact with nature, and retaining their cultural identity, and hence, the construction of Arctic social indicators is based on these three domain areas articulated by residents of the north as being particularly prominent features of human development. These three aspects of Arctic human development are relevant to all Arctic residents, indigenous as well as non-indigenous populations. In some regions of the Arctic the identified domains may be more relevant to indigenous livelihoods just as geographical and other factors, such as self-government arrangements and the importance of large scale resource projects, may affect their importance.

Cultural vitality – which is a matter of being surrounded by and able to interact regularly with others who share belief systems, norms, and a common history – is a value of great significance to many of the Arctic's residents and particularly to indigenous peoples, even under conditions of rapid social change. ASI recommended the measurement of ***cultural wellbeing and cultural vitality*** using a composite indicator which incorporates cultural autonomy (an indicator of institutional arrangements for cultural self-determination), language retention and "belonging" (measured in terms of engagement in traditional subsistence activities) (Schweitzer et al. 2010).

C*ontact with nature* or the opportunity to interact with the natural world constitutes yet another supplementary dimension of human development. Many Arctic residents come into contact with nature on a day-to-day basis as they go about their routine activities (ASI 2010). For ***contact with nature***, the recommended ASI indicator was the consumption and/or harvest of traditional foods, with the rationale being the centrality of country food consumption to Arctic cultures and peoples, the availability of data and ability of communities across the Arctic to collect those data, as well as the generalizability of the concept across Arctic regions, for indigenous and non-indigenous people, for rural and urban residents, and for women and men (Crate et al. 2010).

Fate control is about being in control of and having the ability to guide one's own destiny. It refers to the *collective* control of fate which seems of critical concern to Arctic residents. To measure *fate control*, ASI included measures for political power, economic self-reliance, cultural empowerment and control over land. Two exact measures suggested in the ASI report, namely the percent of public expenses paid from locally generated funds (economic control) and the percent of people speaking their mother tongue (knowledge construction/human rights), can be estimated using proxies or direct measures from Census data (Dahl et al. 2010).

The ASI work on devising Arctic specific indicators presented a small suite of indicators. This suite includes: infant mortality, net-migration, consumption/harvest of local foods, per capita household income; ratio of students successfully completing post-secondary education; language retention; and fate control index (ASI 2010; Larsen et al. 2014a). Among these, ***per capita household income***, for example, is as a core indicator of material wellbeing. It provides a more accurate estimate of income in the North than does the standard measure of GDP. A major limitation with the income indicator, however, is that it ignores both direct services purchased with public transfers and also production in the traditional economy (Larsen and Huskey 2010). In terms of ***education***, ASI recommended three indicators, all of which are based on post-secondary educational attendance (the proportion of students pursuing or completing post-secondary education) or retention of educated people in a community (within 10 years after graduation). Post-secondary education encompasses all forms of educational attainment at an advanced level, including the development of vocational, technical and subsistence skills and expertise as well as the completion of certificate and degree programs. Some case studies that implemented Arctic Social indicators opted to use educational attainment (the characteristics of the level of education attained by residents) as more readily available information (Rasmussen et al. 2010). As for population and human health, infant mortality was chosen as the best indicator for *health* because it relates directly to quality of life and people's sense of well-being, and integrates a wide range of health-relevant conditions including health infrastructure, sanitation, nutrition, behavior, social problems and disease (Hamilton et al. 2010).

In general, the ASI set of indicators is robust and will likely remain valid over time and in the new Arctic. The Arctic human development components listed by the ASI domain are all impacted by the Arctic change. For example, material wellbeing is increasing, but a growing share of material wellbeing in the new Arctic will be made up by formal sector activity, moving away from the traditional subsistence economy; cultural wellbeing in the new Arctic is also changing, and this is reflected in changes in language vitality and in the importance of country food; for demographics, there is an increasing out-migration from local communities in the new Arctic along with transformation of population structures and community characteristics; also, there is increasing fate control, with more local ownership of key industry, resources and political institutions; closeness to nature is decreasing with the escalating urbanization and outmigration from smaller communities; and educational gaps are slowly closing but remaining high in the new Arctic, while traditional knowledge is becoming increasingly integrated into school curricula (Larsen and Fondahl 2014).

10.4 ASI Applied to the Case of Nunavut, Canada

Until 1999 Nunavut was a part of the NWT. The new territory was created based on the provisions of the Nunavut Land Claims Agreement (1993) and became the first and only Canadian province or territory with a predominantly Aboriginal population. The largest city and capital of Nunavut is Iqaluit (population 6,699). Other large communities include Arviat, Rankin Inlet, Baker Lake, and Cambridge Bay.

Four ASI domains of human development have been considered for Nunavut: fate control, material wellbeing, education and cultural vitality. The indicators were developed based on the Canadian census of 2006, and thus were adjusted to meet the definition used in Canadian census and other surveys (Larsen et al. 2014a). As seen on the maps (Fig. 10.1) there is a considerable differentiation in human development among places included in this analysis. Most Nunavut communities demonstrate a high level of fate control (FCI is 3.77 out of a possible 4.0 for Clyde River) reflecting high levels of language retention and decision-making control among Aboriginal peoples in Nunavut. This reflects the existence of the Comprehensive Land Claim Agreement and strong participation of Aboriginal people in government structures. At the same time, in Iqaluit, less than 41 % of leadership (government and managerial) occupations are held by Aboriginal people, a sign of a known challenge associated with ensuring an appropriate representation of Aboriginal residents in territorial and federal administrations (Petrov et al. 2014).

Many Nunavut settlements have rather low levels of material wellbeing (Fig. 10.2) with high dependency on income subsidies. This situation is typical in remote communities throughout the Arctic region. This, however, must be interpreted with caution since the data fails to properly capture the value of the traditional economy, which constitutes a considerable proportion of the Arctic mixed economy (ASI 2010; Bone 2012). In contrast to the majority of outlying communities, privileged places, such as the Nunavut capital and regional centers, exhibit a much different picture. The per capita household income in the capital city of Iqaluit is more than double the average for Nunavut as a whole.

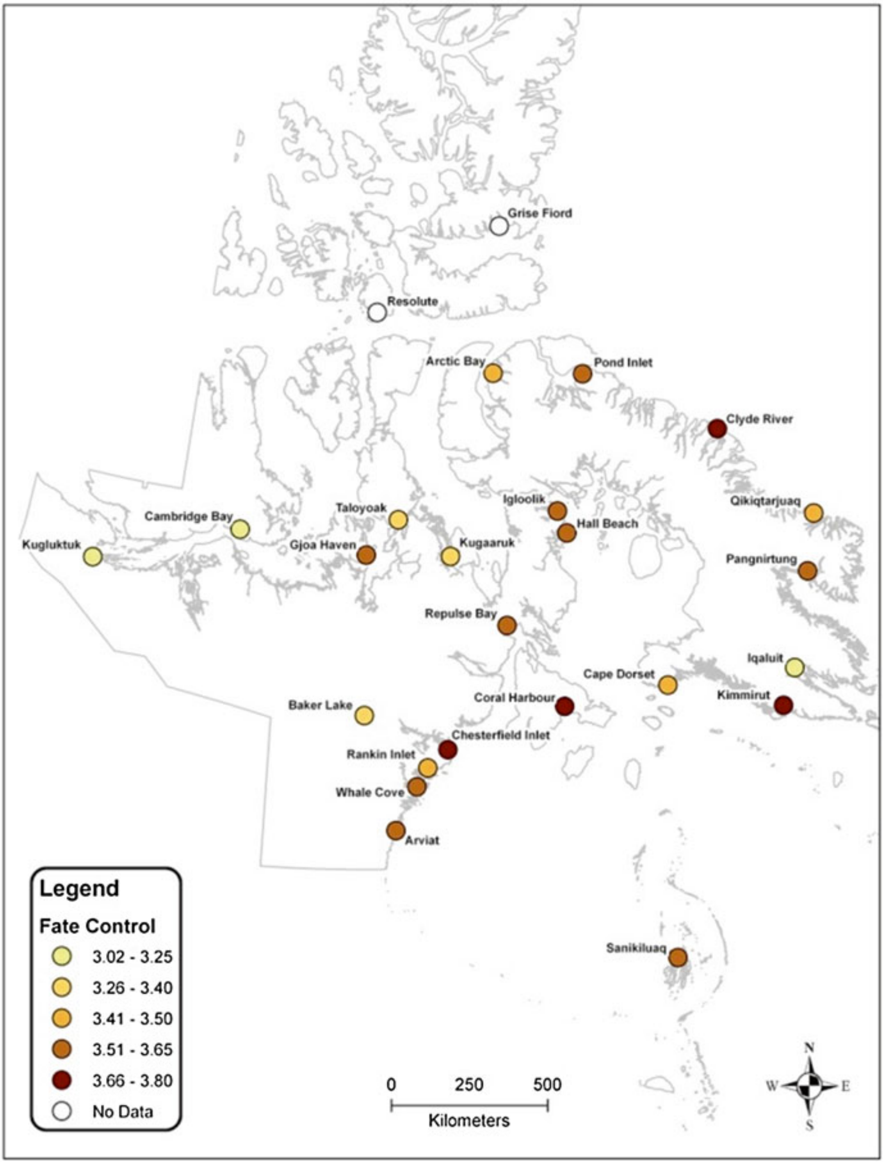

Fig. 10.1 Fate control

A similar pattern emerges in respect to post-secondary and tertiary education: the percent of residents with bachelor's degree or higher ranges from 12.7 % in Iqaluit to 2.2 % in Coral Harbour. Both, however, are lower than the Canadian average. These indicators, however, reflect only the level of formal educational attainment and do not take into account an informal learning, including local and traditional knowledge, which is an important component of the educational experience in the Arctic (Petrov et al. 2014; Larsen and Fondahl 2014).

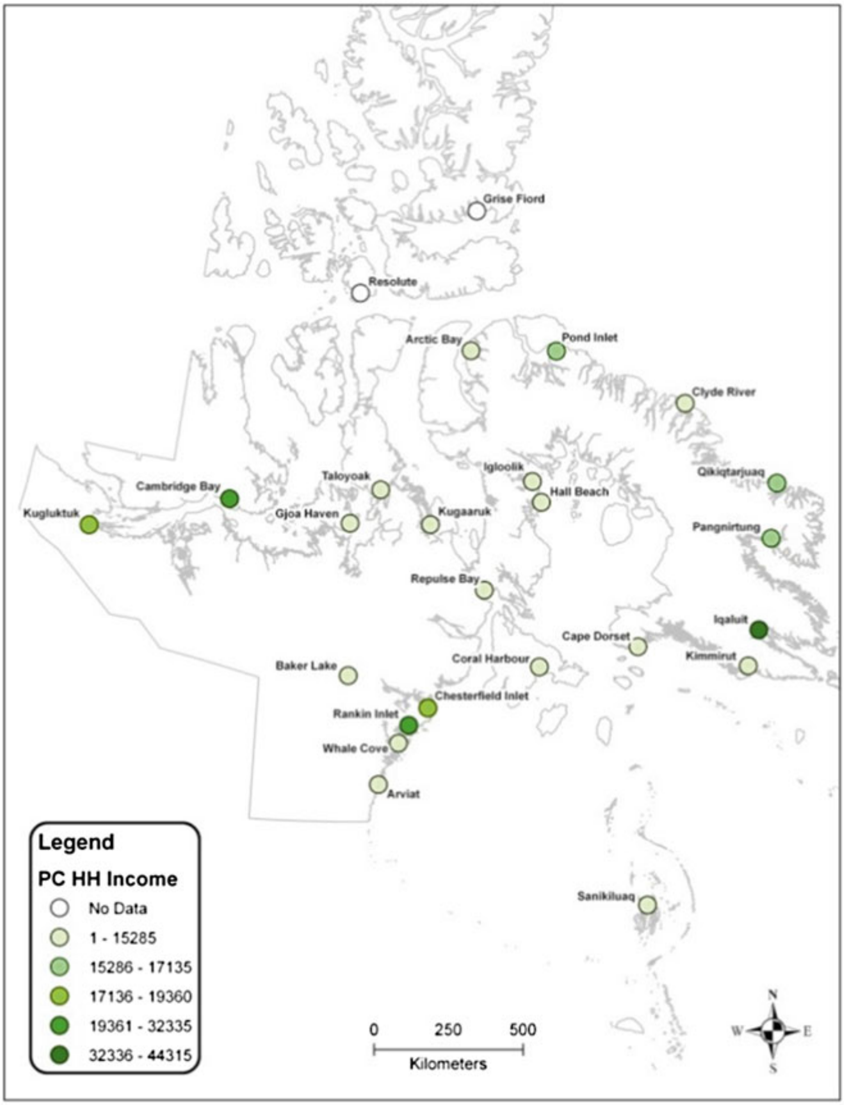

Fig. 10.2 Per capita household income

Cultural vitality (as measured by the language retention rate) is noticeably higher in Nunavut than in the other Canadian northern territories with most Nunavut communities posting Aboriginal language retention rates in the 80–90 % range (Fig. 10.3). This indicates the strength of local Aboriginal culture and society and relates back to the elevated levels of fate control exhibited by Nunavut communities (Petrov et al. 2014).

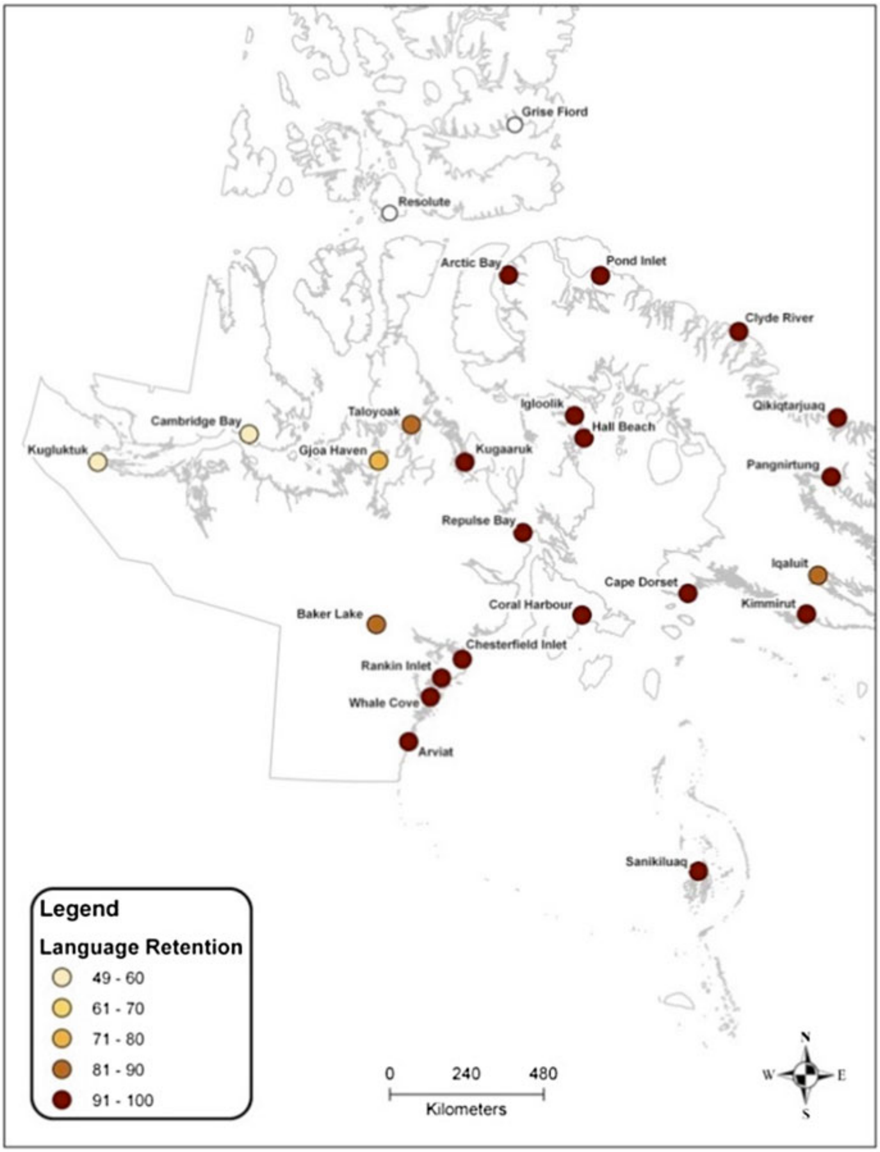

Fig. 10.3 Language retention

These snapshots demonstrate the applicability of ASI, and its strength in making comparisons across places.

10.5 Concluding Comments

In the new Arctic – with the multifaceted and interlinked bio-physical and social changes – it will become increasingly important to adjust existing human based indicators and develop a more integrated monitoring system that captures the impact of bio-physical changes on human wellbeing and development. The analysis of the temporal dynamics of human wellbeing brings its own data challenges, both in terms of availability and comparability, which needs to be addressed. Researchers are faced with major issues as data collection agencies change definitions and survey content, conduct data collection unsystematically (e.g. occasional surveys) or abruptly modify or shorten census questionnaires, so that a reliable multiyear analysis is impossible. Consistent and systematic data collection is a key prerequisite for a successful Arctic social indicators monitoring system.

In light of the speed and complexity of change, the sense of urgency among the scientific community, policy makers and Arctic stakeholders is not only one of gaining a more complete understanding of human development and of finding ways to capture and project the emerging and future trends, but also one of implementing effective monitoring for measuring and tracking this change. The development of cost-effective monitoring networks will be a challenge in the Arctic, just as the high cost of primary data collection to enable measurement of social indicators and the assessment of human impacts presents significant challenges.

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Chapter 11
Issues in Arctic Tourism

Dieter K. Müller

Abstract Arctic tourism has recently experienced considerable growth. However, it is not a single form of tourism; different physical preconditions, but also not least varying socio-economic, institutional and geopolitical preconditions, imply that Arctic tourism has to be seen in the context of its setting in marginal regions. This chapter aims to provide an overview of recent Arctic tourism and tourism research, and reports mainly from a research project conducted in Northern Sweden, the Nenets region in Russia and Canada's Yukon. It is argued that, along with some differences, there are also common traits in recent development. Tourism is most often seen as an opportunity, but weaknesses in institutional arrangements appear to hinder development. Moreover, increasing competition for land use and climate change are forcing tourism providers to adapt to quickly changing conditions, even affecting their businesses. It is concluded that there is a struggle for development in the North, but a vision of what development is desirable and how this should be achieved varies across Arctic nations as well as within them.

Keywords Arctic tourism • Accessibility • Institutions • Geopolitics • Tourism entrepreneurs • Adaptation

11.1 Introduction

Tourism in the Arctic has recently become a hot topic. This is not only because of growing tourist numbers, but is also owing to the increased attention caused by climate change and geopolitics (Hall and Saarinen 2010b; Lemelin et al. 2010; Timothy 2010; Huijbens and Alessio 2015). The relatively prominent role of tourism in the Arctic also needs to be seen in the context of the Arctic regions' relative remoteness in relation to population centers further south and the peripheral region characteristics that go along with the location (Müller 2011). Accordingly, small populations and longtime economic dependency on extractive industries have

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created a situation whereby few alternatives are available to make a livelihood in Arctic communities (Müller 2013a, b, c). Tourism is certainly one of them, and indeed, the idea that peripheral areas should cater to the touristic needs of southern populations was already highlighted by Christaller in 1964.

The recent attention has resulted in increasing scientific activity and, hence, in recent years several research publications have highlighted various aspects of Arctic and Antarctic tourism (Sahlberg 2001; Hall and Saarinen 2010a, b; Lück et al. 2010; Stonehouse and Snyder 2010; Grenier and Müller 2011; Maher et al. 2011b; Lemelin et al. 2013; Müller et al. 2013). Moreover, the formation of the dedicated International Polar Tourism Research Network (IPTRN) further intensified academic endeavors into Arctic tourism. Still, in this context it becomes obvious that Arctic tourism is not a single form of tourism but, indeed, many. In analogy with the definition of polar tourism suggested by Maher et al. (2011a), it can be claimed that Arctic tourism is: tourism to the Arctic; tourism to places outside the Arctic that interpret the history and environment of the Arctic, for example the Fram Museum in Oslo; and tourism for the sake of the Arctic, for example participation in scientific and industry meetings.

The definition of the Arctic further complicates the spatial definition of Arctic tourism (Müller 2013c). While the application of physical boundaries like the tree line creates a homogenous region but disregards human aspects, other definitions, such as that applied in the Arctic Human Development Report (AHDR), provide preconditions for acknowledging the heterogeneity of Arctic societies but create a concept that conflates different types of tourism in boreal forests, mountain regions, tundra and marine environments. These all feature different conditions, making Arctic tourism a category of interest owing to its economic-political dimensions rather than because it delimits a distinct set of tourism forms. Even Keskitalo et al. (2013) point at the fact that current imaginations of the Arctic are stereotypical and tend to marginalize the fact that Arctic societies can indeed be modern and very well interlinked with global networks. However, as Müller (2013c) points out, this is mainly an academic problem. The tourist industry and tourists themselves create their own imaginations of the Arctic, sometimes far from insights gained in academic discourse.

Against this background, this chapter aims to highlight some recent issues of Arctic tourism as identified within the research program, "From Resource Hinterland to Global Pleasure Periphery? Assessing the Role of Tourism for Sustainable Development in Arctic Communities", funded by the Swedish Foundation for Strategic Environmental Research (MISTRA). The purpose of this research program was to assess the role of tourism in changing Arctic societies. To accomplish this the program focused on three Arctic areas, namely (1) the Nenets region in Russia: an example for an emerging destination; (2) Swedish Lapland: a mature and very accessible European destination; and (3) the Yukon: a remote North American destination. Within the program a variety of methods were applied. The insights presented here have been gained through interviews and survey instruments mainly but also by reviewing public statistics on labor market and tourism. Though mainly based on the outcomes of the research program, the following presentation also refers to findings of other research in order to put results into perspective.

11.2 Accessibility to the Arctic

Tourism in the Arctic is no new phenomenon. Traveling in the footsteps of explorers and adventurers has lured people toward the poles for a long time. Indeed, tourism along the Norwegian coastline and to the northern parts of the Scandinavian mountain range has taken place for over a 100 years. Not least Hurtigruten, the Norwegian coastal steamer, and the Swedish railway system provided early access to northernmost Scandinavia (Lundgren 1995, 2001; Sletvold 1997). After WW II, car ownership and a consecutive improvement in road infrastructure further provided improved accessibility to the North Calottes and made the area a destination for an increasing number of tourists. Nevertheless, tourism numbers stayed at relatively low levels despite this improved accessibility (Lundgren 2001).

In contrast, in North America the northern periphery has not yet achieved the accessibility level of the European Arctic. Though the infrastructure spread northward even here, lower population numbers in the North did not justify an improvement like that in Europe. Hence, the Alaska Highway, constructed during WW II, was the first road connection stretching north, and until the 1970s remained (at least partly) only a gravel road. Furthermore, the construction of the Dalton Highway as a supply road for the Trans-Alaska Pipeline in 1974 was the first road crossing of the Arctic Circle on the American continent. Despite these improvements, many places are still today isolated and reliant on access by boat or airplane. Nevertheless, tourism figures in Alaska are high not least because of cruise ship tourism (Munroe and Gill 2006). This form of tourism, with cruises departing from Vancouver and Seattle, has been a successful product for a century, and makes Alaska one of the world's top four cruise destinations.

Most places remained isolated in the Russian North as well, though even here the extraction of natural resources and geopolitical considerations justified investments in various infrastructures that can be co-used by tourists. It should be noted, however, that military considerations still today constrain the development of tourism in northern Russia (Pashkevich and Stjernström 2014).

Still, it should be noted that the Arctic is not a remote destination. It is in fact surrounded by major demand markets in North America and Europe, and is in fact much closer to these markets than other popular destinations like Southeast Asia and Australia. Hence, it is not the physical distance that makes the area remote, but rather the cognitive perception of a different climate and ecosystem. Still, traveling in the Arctic can be expensive, but this is a consequence of limited market demand rather than physical distance.

Owing to different statistical measures, it is difficult to create a comprehensive picture of Arctic tourism (Fig. 11.1). However, it is obvious that Alaska, with close to two million visitors annually implying approximately ten million guest nights is

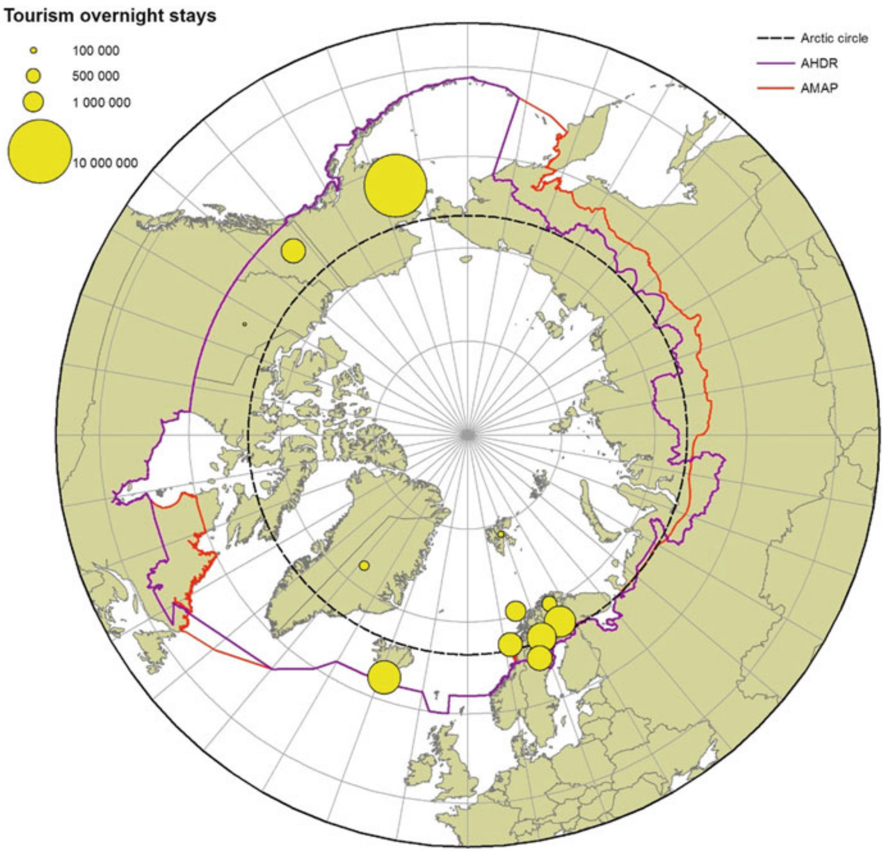

Fig. 11.1 Estimated number of overnight tourism stays in the Arctic (Sources State of Alaska (2014), (calculated values for 2013: visitor numbers × 5). Yukon Government (2014), (calculated values for 2012/2013: visitor numbers × 5). Government of the Northwest Territories (2013), (calculated values for 2010/2011). Statistics Finland (2014). Statistics Greenland (2014). Statistics Iceland (2014). Statistics Norway (2014). Statistics Sweden (2014))

the prime destination within the Arctic. Cruise ships and private yachts further add more than 1.5 million passengers annually to this number (Munroe and Gill 2006). In comparison, Finnish Lapland and Norrbotten, Sweden, the largest destinations in the European Arctic with prime attractions such as the Santa Park, Rovaniemi and the Ice Hotel, respectively reach only over two million guest nights annually. Altogether, the European mainland regions within the Arctic record about nine million guest nights annually, which roughly corresponds to the figure that can be estimated for Alaska. Iceland records 2.7 million overnight stays annually, while other destinations like the Yukon, Nunavut, Greenland and Svalbard are secondary destinations only. Figures for Russia are not easily available, but even here figures are expected to be very low, except for the Kola Peninsula. The estimated figure for the

Arctic is thus a total of 25–30 million guest nights annually, which indicates a substantial number of tourists in relation to the region's total population of four million (AHDR 2004).

Interest in Arctic tourism is growing (Hall and Saarinen 2010b), and the area offers some major tourist attractions that have been successfully positioned in the global marketplace. Furthermore, it is argued that climate change and the related media attention are redirecting interest and tourist flows toward the North as a form of "last chance" tourism (Lemelin et al. 2010). This tends to amplify interest not least among groups with latent interest in the Arctic. But despite recent growth, it should be noted that tourism is highly concentrated to certain spots, often easily accessible by air or cruise ship, while vast parts of the region still remain unvisited.

In a recent review, Stewart et al. (2005) identified a number of areas in which research on Arctic tourism is clustered, namely tourism patterns, tourism impacts, tourism policy and management issues, and tourism development. However, they state that the knowledge about Arctic tourism suffers from a lack of empirical studies and a closer relation to mainstream tourism theory. Hence, they claim that new clusters of knowledge should be developed within the fields of tourism experiences and global-regional nexus, highlighting the interrelationship of Arctic tourism with global changes and large-scale influences. The remainder of the text summarizes some of the findings from this research project, which focused geographically on Northern Sweden, the Yukon and the Nenets okrug in Russia.

11.3 From Resource Hinterland to Global Pleasure Periphery

The point of departure for assessing the role of tourism in Arctic development is the notion of great expectations regarding its potential to change current development paths in the North (Hall 2007). Theoretically, at least the asset for tourism development in peripheral areas is the availability of pristine nature; but on the downside, a remote location implies a limited flow of people owing to the constraints caused by distance (time, costs, ease). This implies that livelihoods based on tourism require high-quality products since income has to be gained from a limited number of people. Only in places where access is easier can businesses base their business idea on quantity. Good examples of this are the Ice Hotel or the Santa tourism. However, the insight that tourism cannot develop everywhere in the Arctic as it does in Kiruna and Rovaniemi is not embraced everywhere in the industry, as a review of tourism offers in Sweden has demonstrated. Instead, there seems to be an oversupply of offers in the northern parts of the country (Lundmark and Müller 2010). Hence, even though several places have managed to develop a successful tourism product, others have failed to deliver.

11.3.1 Tourism as Opportunity or Problem?

Against this background, a question is whether tourism development is perceived as a possibility or a problem. Several studies within the research program indicated that the overwhelming answer to this question was that tourism is largely seen as an opportunity. Particularly the potential of the tourism industry to create employment has been seen as advantageous in Arctic Sweden (Robertsson 2014; Müller and Brouder 2014). The opportunity to diversify the local economy and labor market was particularly highlighted, but tourism was also seen as a place-based activity enabling people to make a livelihood locally without leaving the area. Similarly in Russia tourism development has been identified as a tool for sustaining northern communities and labor markets (Pashkevich 2013). Since the 1970s, numerous attractions have been available to domestic tourists in not least the European part of the Russian Arctic. Today, adventure tourism and science tourism provide the opportunity for a limited number of people to work in tourism. Regional governmental bodies are all involved in tourism development, which however suffers from poor coordination and communication within the region.

Nevertheless, though this has been the dominant perception of tourism in the North, it is not shared by everyone. In Russia, particularly the competition of different land uses has been identified as a constraint to tourism development (Pashkevich 2013). Also, geopolitical and military considerations seem to be higher on the agenda, for example, ranking over the co-use of the military infrastructure readily available in the area (Pashkevich and Stjernström 2014). In Sweden as elsewhere in the North (see Jóhannesson and Hujibens 2010), it appeared that a tourism growth discourse often occurred in times of recession in staple industries like mining and forestry (Müller 2013a).

The tourism industry thus appeared to be mainly a sector utilized as buffer for periods of industrial decline. Traditional staple industries were preferable, owing to not only higher salaries but also greater tax revenue, and hence development in many peripheral places seems to be path-dependent on and locked in to traditional structures. This makes tourism development difficult, though it is suggested by politicians both within and outside the periphery as a solution to periphery problems such as unemployment and out-migration. Müller (2013a) argues that this situation occurs partly because tourism is only weakly interlinked to other areas of the local economies. Without firm embeddedness in local structures, it is easy to adopt as a strategy in times of crisis but also easy to abandon when it is no longer needed. Moreover, the often seasonal characteristics of the industry as well as its low salaries imply that tourism is not a very attractive industry to work in (Müller and Brouder 2014). Instead, it has been shown that the tourism industry competes with other low-salary industries for employment (Byström and Müller 2014). Relatively well-off Arctic areas like the Norwegian North may also choose not to develop tourism further simply because it fails to meet local needs (Viken 2010).

Another positive aspect of tourism development was mentioned in interviews by Sami tourism stakeholders. Tourism was framed as a “soft” way of utilizing natural resources. Not least indigenous populations seized tourism as an alternative to mining and an opportunity to disseminate knowledge about their contested situation. Moreover, tourism was seen as a way of disseminating cultural knowledge about this indigenous group to a global group of tourists (Hoppstadius 2012). In this sense, it could be argued that the globalization of tourism in the North also created a shortcut for indigenous groups to gain a global audience. This is not only applicable to the Sami, however. As Viken (2010) points out, Arctic areas may not be as peripheral as they are often perceived or constructed. Instead, for numerous forms of economic activity they may be hotspots and very well interlinked with nodes of these activities. Thus, even tourism development should not be seen as a solution to all northern problems and challenges. Places in the Arctic may be very well off even without tourism. Nevertheless, they may suffer from collateral marginality, which implies that they are seen as backward and contested because of a stereotypical perception of the Arctic and because they are surrounded by areas that appear to be this way (Müller 2011).

11.3.2 Institutional and Political Conditions

Against this background, an important question is how institutional and political conditions framing tourism development in the Arctic do influence possible development paths. Obviously, a majority of stakeholders are pro-tourism, but there is a core-periphery conflict as well. This became visible in discourse analysis of media content, not least in relation to nature protection (Müller 2013b). In the case of a proposed national park in Northern Sweden, local resistance to the plans could mainly be explained as a distrust of national policy and governmental institutions. Hence, local stakeholders feared that the proposed protection would be *from* people rather than *for* them. However, even southern media displayed negative opinions regarding the trustworthiness of northerners and their ability to manage the environment properly.

Diverging visions among local and national stakeholders regarding future development were also pertinent regarding tourism development in general. For example, an interview survey among local citizens in Jokkmokk, Sweden, viewed the recent tourism development as a success despite decreasing commercial overnight stays and a development that did not mirror the relatively positive development in the region (Müller and Brouder 2014). This indicates how the current Swedish growth discourse is not adopted in the local arena, where other goals more related to quality of life continue to dominate.

Moreover, as mentioned above, tourism obviously suffers from being less prioritized than other industries (de la Barre 2013). Hence, tourism entrepreneurs in Pajala, a new mining area in Northern Sweden, indicated that they feared that support for tourism would fade because of the newly opened mine. There is thus a distrust of local politicians' ability to facilitate a more diversified development through tourism. However, from a local and national perspective the current focus on mines may be understandable, since they generate tax income to the municipality that cannot be attained through tourism (Müller 2013a). Owing to resource demand cycles, this one-sided development focus tends to create a truncated development whereby local diversification only occurs temporarily and in a very limited scope (Gunton 2003).

In the very different setting of the Russian Arctic, a similar hierarchy of development options could be spotted. Here, geopolitical interest limited the possibility to develop tourism (Pashkevich 2013; Pashkevich and Stjernström 2014). Nevertheless, the major challenge was the lack of functioning institutions, resulting in additional obstacles to locally desired tourism development.

In Sweden, however, unclear responsibilities among different stakeholders created confusion and a lack of commonality in envisioning future development (Robertsson 2014). In a survey among destination organizations, tourist offices and municipalities, it became obvious that they lacked a common understanding of the strengths and weaknesses within the destination. Even among adjacent destinations very different features were highlighted. The resulting pattern is best described as chaotic, and although there have been attempts to organize tourism (de la Barre 2013), it appears to have been challenging owing to short-term funding and the application of public-private partnership approaches. The latter implied that the public sector increasingly acted as entrepreneur, which affected tourist organizations' ability to support the factual needs of the industry.

Among indigenous and non-indigenous enterprises, different visions of the touristic future in Northern Sweden were detected. For example, while non-indigenous stakeholders rejected the establishment of a national park owing to potential constraints to their businesses, Sami entrepreneurs embraced the initiative as compatible with their business ideas and reindeer herding in general (Müller 2013b). However, the interaction between indigenous and non-indigenous stakeholders was not frequent.

11.3.3 Adaptation

Another important question in the research program referred to how tourism stakeholders like local communities, indigenous groups and industry adapt to global changes in environment and industry. Two major challenges were focused on, i.e. climate change and resource extraction. Indeed, except for Sami tourism entrepreneurs, stakeholders did not usually consider climate change a major challenge (Hoppstadius 2012; Robertsson 2014). Instead, climate change was also seen as an opportunity to bring tourism to the North.

Current changes in the North caused by renewed interest in resources have forced different stakeholders to adapt. In Northern Sweden, recovering mining and forestry industries successfully compete for the available workforce and public attention, leaving tourism as only a secondary option. Still, tourism was embraced as a way to create attractive communities and hence be a tool for sustaining settlements in the North. Most tourism entrepreneurs accepted resource extraction, too, since they were aware of the limited ability of tourism to create employment and support infrastructure development. In contrast, indigenous populations in Sweden did not share this perception, instead seeing resource extraction as an intrusion on their land use rights and their livelihoods and culture (Hoppstadius 2012). In Canada, the Yukon case illustrates changes to the resource extraction sector that are due to the increasing indigenous capacity to activate self-government. Here, the nature/culture discussion internally intersects with the economic empowerment goals of self-government. The way these internal discussions occur depends highly on the specificities of the mine (e.g., location, history) and the First Nation's evolving capacity to negotiate the benefits they want, be they economic or environmental.

11.4 Arctic Tourism Futures

There is obviously a struggle over development in the North, but a vision for what development is desirable and how this should be achieved varies across Arctic nations and within them. Interest in northern resources has redirected attention away from tourism, but the discourse on this development cannot be characterized as a core-periphery conflict only. Instead, core and local interests often overlap, and sometimes collide, not least when indigenous populations are involved. Experience from previous resource cycles should be a reminder that boom is followed by bust; hence, tourism should be considered an important option for future development since it will be there when southern interest in natural resources fades. However, while people in the North are largely aware of the need for a diversified economy, the nature of small-scale communities, a still pervasive reliance on traditional economic growth models, an inability to integrate broadly defined community and regional goals into policy frameworks and development planning, all continue to present major challenges to economic diversification mandates, which still include a tendency to privilege industry monostructure, be it mining or tourism.

In summary it is nonetheless important to remember that even though tourists and media may define the Arctic as one destination (Müller 2013c), from a social and economic perspective the Arctic is not a single homogenous region. Instead, it is a conglomerate of different biomes, political systems, cultures and economies. Areas of touristic success are accompanied by areas with touristic failure, even within a single region. It would thus be wrong to diagnose common challenges for Arctic tourism development. In fact, in some cases, like Northern Norway, the tourism development is satisfactory to the stakeholders involved (Viken 2010). Meanwhile, in other Arctic areas tourism is still desired by some and rejected by others. Hence, the Arctic can be both, a resource hinterland and a pleasure periphery at the same time and sometimes even in the same place. This situation is not unique for the Arctic. Regions all over the world face similar questions. Still, the geographical features of the Arctic such as climate, accessibility, settlement patterns, and length of seasons, tend to amplify the challenges. And hence, the increasing integration into global systems of production and consumption creates a new and complex playground that is sometimes difficult to tackle for small communities and tourism businesses in the North.

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Chapter 12
The Arctic Economy in a Global Context

Joan Nymand Larsen and Lee Huskey

Abstract Change has been a characteristic of the Arctic economy since its early history. Today the pattern of change differs from the past in its magnitude, its rate of change, and the complexity of Arctic changes. The differences reflect a number of sources – climate warming, increased accessibility, and economic integration with global markets. This new pattern of change will produce significant impacts on the economies of the Arctic region, from main centers to smaller local communities. In this chapter we consider a number of sources of change, and reflect on the impacts for the new Arctic. We conclude that while the new Arctic will hold many promises and opportunities for formal and informal economies across the region, there are critical challenges to be addressed as the economy becomes an increasingly important player in the global context.

Keywords Resource Extraction • Resource Development • Subsistence • Migration • Climate Change

12.1 Introduction

The new Arctic economy will experience increased economic integration across national borders as well as economic growth. Along with economic growth the new Arctic will continue to be characterized by uncertainty and economic volatility. For Arctic residents, the heightened pressure to adapt to a changing environment will increase. For some this change represents increased threats and challenges to daily livelihoods and economic wellbeing, while for others the new Arctic presents new economic opportunities.

Change has been a characteristic of the Arctic economy since its early history. Today the pattern of change differs from the past in its magnitude, its rate of change,

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and the complexity of Arctic changes. The differences reflect a number of sources – climate warming, increased accessibility, and economic integration with global markets. This new pattern of change will produce multifaceted social change with cascading effects on the economies of the Arctic region, from main centers to smaller local communities.

Rapid change and transformation increases the future uncertainty for local and regional economies in the North. Human settlements in the North range from small isolated and scattered communities to larger urban and industrial centers, with variation in the relative importance of formal and informal economies across the Arctic (Larsen and Huskey 2010; Huskey 2010). No matter their size or locality, northern economies are feeling the impacts of global change. Their futures are tied to success in achieving sustainable resource and economic development.

Communities in the North may face both socio-economic challenges and resource constraints that limit their economic prospects and lower their speed of adjustment to economic change. These may include: a narrow and climate sensitive resource base in combination with weak or underdeveloped infrastructure and institutions; a small and scattered population base; geographical isolation and long distances to markets. A community's economic vulnerability and adaptive capacity will vary with factors such as, national economic wealth, available technology, monitoring of potential hardships, availability of income support programs, and the extent of local human and financial resources (Larsen 2010a, b).

Globalization and the transformation of the world economy to a post industrial and knowledge based economy will be reflected in the North. As described by Southcott (2010) the economic transformation of the Canadian North is characterized by communities having moved "from an economy based almost entirely on subsistence and fishing, to an economy dominated by the industrial exploitation of natural resources, to an uncertain future in a world increasingly dominated by a knowledge-based post-industrial culture" (p. 73). However, while change is significant for the Arctic, there is also much that remains the same. Economic outcomes and the industrial structure, conduct and performance will continue to be affected by smallness and remoteness of scattered towns and villages, high costs of production, long distances to markets, and continued high levels of economic uncertainty.

The new Arctic economy will experience increased economic integration across national borders as well as economic growth. Along with economic growth the new Arctic will continue to be characterized by uncertainty and economic volatility. For Arctic residents, the heightened pressure to adapt to a changing environment will increase. For some this change represents increased threats and challenges to daily livelihoods and economic wellbeing, while for others the new Arctic presents new economic opportunities. While economic and political autonomy is growing, many of the region's narrowly resource-based local and regional economies are facing increasing pressures from global change impacts, with these impacts being felt on economic and employment opportunities, distribution of income and wealth, and the allocation of resources between different users (Larsen 2010b; Rasmussen and Larsen 2009).

12.2 Recent Trends in the New Arctic

The Arctic economy is composed of three parts: the formal and market based sector, the traditional and non-market sector, and the transfer sector (Larsen et al. 2010b). The size and relative share of each of these component sectors varies across regions of the North. Each sector will be affected by the economic changes facing the Arctic. The formal market-based part of the Arctic economy has experienced rapid growth at 3.5 % annually over the past decade, with growth rates surpassing that of Arctic nations overall. The Arctic per capita disposable income is estimated at 21,900 USD, with per capita Gross Regional Product (GRP) at 45,400 USD (Huskey et al. 2014).

The Arctic economy is not a single integrated economy but a set of independent economies linked by their similarity of environment and location. These northern economies are, for the most part, remote and sparsely settled and distant from major markets. The money economy of these regions depends primarily on public spending and natural resource production. Even though the regions of the north differ in history, institutions, and culture they are influenced by similar forces. During the first decade of the twenty-first century these forces were changing world markets for natural resources and the liberalization of the development process (Duhaime 2005).

In terms of the value of Gross Regional Product, GRP, the Arctic economy experienced relatively rapid growth between 2000 and 2010. The Arctic economy grew almost twice as fast as the economies of the eight Arctic nations. The primary driver in this growth was increasing demand for commodities and associated rising commodity prices during this period. Expectations of a future of higher resource prices helped to open up the North's storehouse of natural resources to exploration and development. The role of world markets as driver of the Arctic economy could be seen in the slowdown in Arctic economic growth that accompanied the world economic downturn after 2006 (Huskey et al. 2014).

While the value of the Arctic's economic output is significant it is not evenly distributed throughout the north. The Russian Arctic dominates production primarily because of the high value of its petroleum and other mineral resources. Output is also unevenly distributed within each country's Arctic region. This reflects the uneven distribution of natural resources and cities throughout the north. The distribution of output may change in the future as development follows exploration in new areas such as Greenland and the Canadian Arctic (Huskey et al. 2014).

While the Arctic's GRP is significant, the share of regional income in GRP is only about 48.3 %. A large proportion of income generated in the region does not remain in the region but leaves in the form of income, profits, and rents, due to ownership and control of resource development resting in the hands of external actors. Because of the significant outflows of income from the Arctic to pay for various resources used in production, GRP becomes an inadequate measure of what in real terms is available for investment and consumption locally. In addition, as described by Larsen et al. (2010b), the Arctic GRP does not take into account the contribution to income made by the informal and transfer sectors. These caveats mean that the size of the Arctic economy can be underestimated (when informal sector activity is excluded from calculations) and overestimated (when income and payments flow out of the region).

Problems with measures of economic performance in the Arctic complicate the task of assessing the contribution to local areas of engaging in resource development. In many parts of the Arctic large scale resource development projects may contribute little to the local and regional economy where they are located. The creation of economic linkages may be limited or non-existent and economic activity may be partly or fully decoupled from the local economy. The current picture does not show signs of this changing in the near future.

Though it may be underrepresented in economic data the traditional or subsistence economic harvesting continues as an important sector of many local economies throughout the circumpolar north (Larsen et al. 2010b; Megatrends 2011; Poppel 2006). The importance of cash in subsistence harvesting links the traditional and modern economies in the north. Conflicts over resource use between industrial and traditional users provide another link between these two economies (Aslaksen et al. 2009).

Large scale resource development in the Arctic has the potential to make some local and indigenous communities worse off. The appropriation or degradation of the very assets that are critical to local livelihood strategies may leave some local communities more vulnerable and with increased risk of being without sufficient resources to support their living. Long established cultural values and practices that make local residents more resilient are at risk of being eroded by the increasing rate of social change. There is a growing awareness of the potential disruptive effects of large scale development and the need to balance the economic benefits of development with the protection of the natural assets communities depend on economically, to secure peoples' access to them, and to ensure future sustainability.

12.3 Changes in the Institutions of Resource Development

Decision-making about the development of the North's natural resources is complicated. Historically, national governments have been the North's natural resource owners. Governments decide not only whether particular resources should be developed but also how they will be developed. Government decisions involve a wide range of interested parties. Since the costs and benefits of resource development aren't evenly shared among these affected groups, it is difficult to arrive at a satisfying compromise. Conflict results when groups suffering significant costs are not compensated from the benefits of a project. This is more likely to happen when affected groups aren't involved in the decision making.

In most Arctic nations, the development and production of natural resources is done by international resource firms seeking a profit. Firms weigh the expected benefits of development against the uncertainties of exploration and the cost of development in the North before they decide to participate in development. Resource development will not happen unless governments and resource producers reach accord on how resources will be produced and benefits will be shared.

When national governments make resource decisions there is no guarantee that residents near the development will gain more than they lose. Local residents could suffer costs from the disruption of local environments and disruption of traditional economic activities. Historically, revenues have gone to national and regional governments through taxes and to international companies through profits. Local resistance to resource development reflected this imbalance between local benefits and costs.

In the last part of the twentieth century significant changes in the relationship between local residents and local resource production were introduced around the North. These institutional changes increased the role of local residents in the decision-making as well as the local share of development benefits. There have been three types of institutional changes which have brought more local control over resource production decisions to residents of the North (Caulfield 2004). Each of these is discussed below:

12.3.1 Self-government

Local majority controlled government allows residents to influence the way resources are developed, to collect tax revenue from resource production, and, in some cases, to act as an owner of local resources. The creation of the State of Alaska in 1959 is an early example of this institutional change in the North. Alaska's North Slope Borough and Northwest Arctic Borough and Canada's Nunavut are examples of local governments established in regions with majority indigenous populations (Fox 2005a, b). The country of Finnmark in the Norwegian north was recently granted greater control over decisions about resource use within its borders (Grimsatd and Sevatdal 2007). Greenland is a majority Inuit government which has had limited self-government since 1979 and in 2008 received greater control over its resources.

12.3.2 Local Ownership

Beginning with the 1971 Alaska Native Land Claims Settlement Act (ANCSA), the federal governments in the US and Canada have negotiated a series of settlements with indigenous groups providing these groups with land ownership and control of resources. One motivation for these settlements was the recognition that uncertain indigenous land claims could hold up resource development. Alaska Natives received ownerships shares in 12 profit making regional corporations and over 200 village corporations which were created to receive and manage the resources (Colt 2001). Canadian settlements were achieved through negotiations with specific aboriginal groups; 26 comprehensive land claims agreement have been settled since 1973. The Canadian settlements provide for participation in land and resource management decisions and governmental control in addition to land ownership and money (Fox 2005a). Outside of North America indigenous groups have not been as successful establishing rights to local resources. Ownership of resources valued in the international market allows indigenous groups to decide when and how to develop resources and to benefit directly when resources are produced.

12.3.3 Acting Like Owners

New institutional arrangements have been introduced which allow residents and local resource users to assume some of the roles of owners without actual ownership. Co-management schemes for subsistence resources, individual fishing quotas, and Impact and Benefit Agreements (IBA) all provide local people with direct say in resource use decisions. Co-management schemes allow local users of traditional resources to share both information and power with government officials to reach collective agreement on the use of these resources. Co-management schemes have been used in Russia, the US, and Canada. Individual Fishing Quotas (IFQ) have been introduced in Alaska, Iceland, and the Faroe Islands. IFQs provide owners with a share of the catch quota set by the government (National Research Council 1999). Quota owners make the decisions about how and when to fish their shares. The Canadian Supreme Court affirmed that is was the duty of mining companies to consult with indigenous groups who may be affected by mining on or near their traditional homelands (Fraser Institute 2012). The IBA consultation allows local communities, like owners, to negotiate contracts which spell out the roles and responsibilities of developer and local aboriginal communities in development of particular properties.

In the Circumpolar North, the national government has historically been the most important institution for making resource production decisions. Over the last half century important changes to northern institutions have been made increasing the rights of ownership and control of northern residents and resource users. This has primarily been a North American phenomenon. These institutional changes have provided mechanisms for reaching positive local outcomes from resource development in the North.

12.4 Migration and the Northern Economy

The North's economic performance is linked to its migration history. The many regions of the circumpolar north are demographically distinct (Bogoyavlenskiy and Siggner 2004; Huskey and Southcott 2010). The northern population density in Russia is 50 times the density of Greenland and Canada. The Russian north is also the most urban; all but one of the eleven northern cities of Russia have populations over 250,000. The importance of the indigenous population also differs across the North; over 80 % of the population of Greenland and Northern Canada but only 10 % of the population in the Nordic countries is indigenous.

As in most places, the pattern of net migration partly reflects the economic health of the region and its communities. People generally move from places with relatively limited economic opportunities to places with better opportunities. However, migration will also influence the economy of communities in the North. The population of a community will influence its economic opportunities.

Most parts of the circumpolar north share a similar migration experience. The North is generally a sending region. Recently, more people have moved out of the region than have moved into the region. This has not always been the case; in all parts of the circumpolar North there have been historic periods of positive net migration. This is not the case for all places in the North; government and service centers and university towns are examples of communities that have attracted migrants. This doesn't mean that population has everywhere declined; high birth rates in the North American North mean that these regions have experienced population growth.

While people move for a variety of reasons, research in northern Sweden, Alaska, Russia and Canada has found that relative economic opportunities help explain the direction of migration (Westerlund 2010; Huskey et al. 2004; Heleniak 2010; Petrov 2007). People choose to move when they expect the move will make them better off. The strength of this economic effect was found to vary by age, education, gender and family status. In some parts of the north, economic opportunities are defined not just by market work but also by traditional or subsistence opportunities. Participation in traditional activities limits migration from northern places because the skills used in traditional activities are not easily transferable.

Migration responding to economic opportunity is also limited by the cost of moving. The social cost of moving away from family and culture limits migration between places with very different cultures. Social costs are one of the explanations for the stepwise pattern of migration found in Alaska. Costs involve the physical costs of moving which is influenced by transportation infrastructure and distances. These differences are reflected in different migration patterns between villages and cities in northern Canada and Alaska. Both social and transport costs are higher in the more sparsely settled North American North than in the more densely settled Nordic North, so we would expect different rates of migration in these regions.

The new technology of resource development limits the connection between a northern region's economy and its population growth. Development of mines or petroleum resources often takes place at sites distant from local communities. The skills required for modern capital intensive resource development often have to be imported. These skilled workers will not move to the region if development follows a "fly-in-fly-out" arrangement with workers isolated in enclaves from local communities (Storey 2010). This unique character of the northern job market results in out migration from communities even in regions experiencing economic growth.

Migration affects a local economy through its effect on a community's scale, which in turn determines the size of the local market and the cost of producing goods and services. If out migration causes population decline, this will reduce the market for goods and services and increase the cost of local production. This affects the provision of public services as well as the private market. The public sector provides a number of services throughout the north including transportation, housing, and energy. Since economic well-being is influenced by the local provision of goods and services, the link between migration and scale creates a vicious cycle leading to continued population decline.

The 'brain drain' creates an additional link between migration and the local economy. The brain drain occurs when the most productive residents move away. The more educated have been found to be more likely to move from small to larger places or rural to urban places in Russia, Sweden and Alaska. A similar migration pattern is found for the young (Heleniak 1999). The young are attracted to the work and study opportunities and the bright lights of larger places. The out-migration of the young explains the aging found in the Nordic North (Megatrends 2011).

In some Northern communities return migration provides a counter to the brain drain and its negative effect on local economies. Survey data showed that as much as a quarter of the indigenous population in Arctic communities in Alaska, Greenland and Chukotka returned to the community after migrating away (Martin 2010). High rates of churning or cross flows of migration have been found in the Arctic regions of Alaska. These return migrants bring skills learned both through schooling and experience and add to the human capital available in Arctic communities.

12.5 The New Industries in the North

In the first Arctic Human Development Report (2004) the economy of the Arctic was described as combining large scale natural resource production with public sector production and transfers. These sectors accounted for over half of the value of output in the north of six of the eight Arctic nations (Huskey et al. 2014). While this is the general pattern, the economies of the Arctic nations fall into two different groups; the less resource depended European north (including Iceland) and the Russian and North American (including Greenland) north's which are more dependent on resources and public spending. Across the north there are examples of new industries that are not directly related to the production of natural resources.

Tourism is an old Northern industry that is growing in importance. For example, the number of tourists visiting Alaska between 1990 and 2006 more than doubled to almost 1.6 million (Goldsmith 2008). Northern tourism follows the more general trend towards the increased popularity of nature-based tourism throughout the world. An increased navigation season resulting from climate change is one factor which could promote further increases. Predictions are that both land based and vessels based tourism will increase. Reduction in sea ice may open up opportunities for increased expansion of cruise traffic, which is already experiencing rapid growth (Stewart et al. 2010). Cruise tourism has been increasing throughout Greenland, Norway, Alaska and Canada because of decreasing sea ice extent (Larsen et al. 2014b).

There have also been increases in other industries with no direct connection to the extraction of northern resources. Anchorage, Alaska has developed as a major center for handling international air cargo. Geography and air carriers desire to carry heavier payloads and less fuel made Anchorage a likely stop for refueling on international cargo flights, and several carriers sort packages and move consolidated cargo for different destinations (Goldsmith 2008). A second, though less successful, example of the growth of this type of industry was the development of the financial industry in the Iceland. Iceland's financial industry accumulated foreign assets and experienced dramatic growth until its collapse in 2008 (Matthiasson 2009). Each of these illustrates the expansion of industries which are not necessarily northern in the processes, skills, talents or connections used.

The same conditions might also be said for the new types of manufacturing recently introduced to the North. Arctic Finland has a highly developed manufacturing sector which processes natural resources especially timber. During the first decade of this century Arctic Finland experienced the growth of an electronics manufacturing sector located primarily in Oulu. Around the world this sector has experienced dramatic changes which have affected the size and structure of the industry in northern Finland. Even with these changes the sector remains important in the Finnish north (Glomsrød et al. 2009).

The Circumpolar North has become an urbanized region. The region is not simply made up of villages and resource enclaves, but also towns and cities of significant size. While this is not uniform throughout the North, the most recent population growth in the North has been in urban centers leading to a growing urban concentration of the northern population (Megatrends 2011). These urban areas are centers of industrial activities, service provision, and government activities. The concentration of population provides opportunities for new types of activities. The bigger concentrated market allows local producers to compete with importation of goods and services from outside the north.

The importance of knowledge or human capital to the growth of most developed economies is much discussed. With natural resource extraction as its economic driver, the Arctic may seem the last place where the knowledge economy would have an impact. However, the northern knowledge economy is reflected in the development of both the Icelandic finance industry and the electronics industry in Finland. The petroleum and other resource sectors have advanced in high cost, and remote regions through the use of new technology. The Arctic nations have recognized the importance of creating this northern human capital with the creation of a series of northern universities and colleges to train northerners and developed regional expertise (Megatrends 2011; Hirshberg and Petrov 2014).

12.6 Economic Volatility and Uncertainty

Resource extraction and export markets have a long history in the Arctic, and have been seen as key drivers of growth and development throughout much of northern history. In theory, improved utilization of factors of production, expanded factor endowments, and the creation of economic linkage effects are well-known potential benefits that may follow a strategy of large scale resource development and export trade. However, in reality northern strategies of primary export trade in renewable and non-renewable resources may be largely ineffective for many localities. Some of the explanations are that weaknesses may result when markets for primary products grow slowly, when earnings are unstable due to price fluctuations, and when expected economic diversification around an export industry is nonexistent or limited. Furthermore, significant instability and fluctuations in earnings may result if production is concentrated in one or a few products, and if the destinations for exports include only a few external markets. This may result in a country or region remaining heavily dependent on imports of both final and intermediate products, as well as imported personnel, and in turn, opportunities for generating value added locally may be lost. This describes a scenario not unfamiliar to many northern regions (Larsen 2010b).

The narrow and natural resource base is a central characteristic of the formal and market based economy in the Arctic. It is also a key source of instability and increases the economic vulnerability to climate change, as most of the natural resources of the Arctic are climate sensitive. The degree of volatility in local economies is unlikely to disappear anytime soon. Economic fluctuations are undesireable not least because they tend to trigger fluctuations in other variables such as government revenue and investment, which may have impact on short run economic stability and long run economic development. While regularly reversing deviations are less problematic – as income can fluctuate over time and yet be known in advance with some certainty – it is the sporadic elements of deviations from some normal level of earnings that are likely to be the greater cause of concern. Events that are predictable or certain do not necessarily have adverse consequences, since regularly reversing fluctuations make it easier to predict the level of exports and income each year and to judge the correct timing for implementing possible stabilization policies. Still, in the Arctic, the scope for corrective action in response to economic deviations may be more limited in some regions due to a range of resource constraints including lack of economic and political autonomy in many places. Local and regional governments may therefore be less able to undertake effective offsetting policies to minimize shock effects, even if they could predict the future accurately (Larsen 2003).

While the Arctic has witnessed an increase in economic and political autonomy, and also a growing focus on resource development throughout much of the Arctic, many regions and localities remain in a state of economic dependency, such as for example seen in the case of Greenland and Nunavut, and many Russian northern regions. These dependent economies can be described by their economic structures having relatively few and weak relationships between different economic sectors with only limited local production serving as inputs into other sectors of the domestic or local economy. Also, resource use in these "dependent economies" tends to be less flexible than what may characterize more advanced or diversified economies, with limited ability to adapt to the effects of economic shocks and disturbances. Their economic growth tends to be highly dependent on external factors and markets, and external demand is an important factor in the ability to make full use of productive capacity as well as justifying and financing large-scale investment to expand capacity. Larsen (2003) found that in the case of Greenland the economy is characterized by a high degree of economic dependence, and this has led to instability and dampened the rate of economic growth and development. Southcott (2010) argues that in the case of Canada, the dominance of a dependent economy controlled by large resource corporations is likely to continue into the future as diamond mining and oil and gas development increase in importance. Similarly, large scale natural resource development projects in the North have often meant that economic goals in the Arctic have been elevated over environmental or social goals.

What is efficient and profitable for the individual or a particular company, may not be so for society, but rather may have significant societal consequences. The Arctic provides examples of economic growth having been sought through unsustainable use of natural resources and levels of consumption. With the increasing importance of change, environmental and social problems in the Arctic are becoming ever more visible, and there is increasing pressures placed on finding sustainable and more recilient pathways forward.

Global perceptions of the Arctic as an area of new potential for resource exploitation and intercontinental shipping is one result of the increased awareness of climate change (e.g. Arctic Council 2009). Warming will open up Arctic seas providing new shipping lanes and increasing the accessibility to Arctic natural resources. Increased accessibility is expected to reduce the cost of producing the North's resources for the world market. When lower production costs from global climate change are combined with an increased world demand for resources from the emerging economies, the distant and once uneconomic resources of the far north will be linked to global markets and play an increased role in the world economy. However, while climate change and globalization can be expected to alter the composition and stock and flow of resources, the nature and extent of their effects is highly uncertain, including the impacts for the environment and the marine sectors.

12.7 Climate Change Impacts

Climate change and increased world demand for Arctic resources are likely to have both positive and negative effects on the economic production and welfare of the Arctic's residents. Reductions in sea ice extent, duration, and thickness will likely increase human presence and economic activities in the Arctic in the near to long-term (Forbes 2011; AMAP 2011; IPCC 2007, 2014). Impacts from increased shipping include not only pollution but also potential increases in marine invasive species through ballast water and vessel hulls which present important ecological challenges for ecosystems and economic and cultural livelihoods in the Arctic (Lassuy and Lewis 2013; Arctic Resource Development 2012). Longer ice free seasons and reduced ice coverage will not only increase Arctic shipping (Stephenson et al. 2011; Arctic Council 2009; Prowse et al. 2009; Larsen 2010a, b), but also introduce new threats to food security and quality of life in the region. For many local communities, continued access to traditional harvested resources is linked closely to livelihoods and overall wellbeing and closely tied to cultural survival (Larsen et al. 2010a, 2014a; Larsen and Fondahl 2014).

ACIA (2005), AMAP (2011) and IPCC (2014) describe the range of possible costs and benefits from the observed and projected impacts of a changing climate. In the marine ecological system and fisheries sector, for example, expected impacts may include changes in stock and species, alteration of fish migraton routes, changes to harvesting costs, and increased stock productivity and yield, with some commercial fish species becoming both more plentiful and an engines of economic growth, while others – such as shrimp around Greenland – may migrate further north or disappear altogether from commercial harvesting. At the same time, reports suggest that increased maritime activity could in the worst case scenario lead to potentially devastating oil spills, the pollution of commercial fishing grounds and endangerment of key species, thereby adding considerable stress to Arctic economies and livelihoods.

Climate warming may also present additional challenges for northern development and infrastructure design from the impacts associated with ground disturbance and construction. The impacts of changing climate will become increasingly significant over longer time scales (Prowse et al. 2009). In the case of the Canadian oil and gas sector, thawing permafrost and changes in snow cover will necessitate an increased focus on low-impact vehicles and/or changes in seasonal scheduling of exploration activities (Ibid.). The unpredictability of the winter season and the winter ice road system will necessitate greater flexibility in scheduling of exploration and extraction activities. Winter roads are temporary roads on frozen ground, that enable the transport of equipment and cargo for resource development and construction projects, and resupply to remote communities that would otherwise be uneconomic using permanent roads or aircraft (Stephenson et al. 2011). Winter roads provide critical transportation infrastructure in Alaska, Finland, Russia, Norway, Sweden, and Canada. Projections suggest there will be a broad pattern of declining winter road accessibility potential on land and rising ship accessibility potential in the Arctic Ocean by year 2045–2059 (Ibid.).

Projected changes in air temperature, snow accumulation, and sea ice directly alter travel times by restricting or enabling transportation modes in land (e.g. winter/ice roads) and ship speeds at sea. Projections suggest significant changes in annually averaged inland and maritime transportation accessibility by mid century (2045–2059) versus the baseline of year 2000–2014: e.g. change in inland transportation for Iceland in terms of square km is projected to be minus 82 %, for Finland −41 %, Norway (−51 %), Sweden (−46 %), Greenland (−11 %), Russia (−13 %), Alaska, USA (−29 %). Whereas for maritime-accessibility, the increase in ocean area (square km) is projected to be 19 % for Canada, Greenland (28 %), Russia (16 %), USA (5 %), while for Iceland and Norway it is projected to be only negligible, and for Finland there is no change (Ibid.). Thus, inland transportation will likely become more challenging, whereas maritime transportation will become more accessible, and hence the impact of climate change on resource development will depend in part on whether extraction is on or off shore, and the type of transportation used for moving resources to markets.

Resource development and production in the Arctic must increasingly consider the effects of climate change on permafrost and ground stability. Mining, energy and timber industries will face shorter time windows for ground transport of equipment and risk becoming uneconomic in some areas. Costly mitigation efforts will therefore need to be factored in and may include building permanent roads, as in e.g. Nunavut, Canada. At the same time, there are other factors than sea ice that affects Arctic shipping and transportation, such as e.g. economics in general, existence of port infrastructure, tariffs etc., which will continue to be part of cost benefit analyses in evaluating the feasibility of resource projects in the new Arctic.

Climate change and social change present new challenges for institutions in the north to be more flexible, resilient and robust, and to find ways of increasing the ability to cope with rapid change in biological systems. Climate change and its consequences for natural resources is an additional factor in raising the level of economic vulnerability in the new Arctic. There is risk associated with all human activity in the Arctic, and this has been the case since the early history of extractive industries in the North. Questions remain however of how to manage the increasing level of risk associated with these industries, and how to reduce it to a level that is acceptable to most stakeholders. Indigenous inhabitants of the Arctic whose livelihoods are intimately connected to the land might have a much lower tolerance for risk (Arctic Resource Development 2012). This raises important questions of who defines what the acceptable level of risk should be, and how to address the potentially diverse range of values and goals, and in turn, how to solve conflicts of interest over resource use between the many different stakeholders in the new Arctic. The future of the Arctic economy will necessitate increased attention to risk management. Managing risk is about managing the combination of hazards, vulnerability, and exposure. This suggests that future approaches to managing Arctic environmental- and economic change must be firmly based on principles that take into account the fragile and vulnerable Arctic environment and the increasing social and environmental risks associated with human activities. Finding effective ways of internalizing environmental externalities originating from large scale resource development in the Arctic will increase in importance.

12.8 Concluding Comments

A number of challenges beyond climate will persist in developing strategies to realize long-run sustained growth in the new Arctic, including the existing limits on resource flexibility, the constraints on entering into new and foreign markets and the difficulties associated with a very small and scattered population base which presents barriers to achieving economies of scale in domestic markets.

Future studies on the Northern economy must acknowledge the growing complexity and interconnections between different human and bio-physical systems. A classic dilemma in our industrial world and the new Arctic is presented by the tendency of resource development to inevitably represent some sort of tradeoff between a healthy environment and economic growth. While this may be coined a classic trade-off, in the new Arctic it can be described as a new and growing challenge involving an increasing rate and magnitude of climate change along side the ongoing social, cultural and economic changes, and the seemingly converging challenges of climate, environment, economy and human development in the Arctic. While the new Arctic will hold many promises and opportunities for formal and informal economies across the region, there are critical challenges to be addressed as the economy becomes an increasingly important player in the global context. In addressing issues of economic growth and development the consideration of impacts on human development is essential, including analyses of questions related to the possible divergence or convergence between economic outcomes and the overall wellbeing of Arctic residents.

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Chapter 13
Globalization of the "Arctic"

E. Carina H. Keskitalo and Mark Nuttall

Abstract The Arctic has long been subject to the effects and influences of increasing globalization. Yet while globalization is a commonly used term to account for and explain dramatic and wide-reaching changes and transformations, it is also a commonly misapplied one, evoking a range of meanings, from negative impacts to positive trends in the contemporary world. In this chapter, we cast light on globalization processes in the Arctic and then sharpen our focus on the diversity of identities in the region. In this way, we illustrate a complex reality that contradicts the logic of previous nationalizing state developments and current ethnopolitical movements that describe resources and people, communities and wider regional populations in certain and often very prescribed ways.

Keywords Globalization • Mobilities • Identities • Resource use

13.1 Introduction

Like anywhere else in the world, the Arctic has long been subject to the effects and influences of increasing globalization. Yet while globalization is a commonly used term to account for and explain dramatic and wide-reaching changes and transformations, it is also a commonly misapplied one, evoking a range of meanings, from negative impacts to positive trends in the contemporary world. A conventional understanding of globalization is that it is a process of international integration, with the term often used in the form of what we may consider to be a convenient shorthand for this complex phenomenon in order to explain and characterize current and emerging international trends and processes. As such, one of its central features is that contemporary social, cultural and economic issues cannot be understood at the level of the nation-state, but need to be seen within the context of transnational

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relations and movement (Sklair 2000). In this sense, economic systems, social relations, social structures and cultural processes can often only be explained or understood by looking beyond the boundaries of a single society or country.

To think of globalization as something related to modernity in the late twentieth and early twenty-first centuries is thus to ignore the histories of the processes that influence, mould or shape societies that have long been global, and are often (indeed, increasingly) detached from what we understand to be locally, or nationally specific. One fundamental aspect of globalization is a continuation and intensification of those processes, especially in relation to mobility and communication around the globe. Yet globalization is far from a being a relatively new phenomenon—something synonymous with the "modern" world—as migration has always taken place, ideas and influences have flowed across borders, regions and cultures, and people have always been mobile throughout human history, forging and shaping social life: in that way, societies and cultures have always merged and conflicted, diverse cultural forms have arisen, and social life has continually been reshaped.

This chapter is not an assessment of the impacts of globalization on the Arctic (assuming that such a task is possible in the first place). Rather, we aim to cast light on globalization processes in the Arctic and then sharpen our focus on the diversity of identities in the region. In this way, we illustrate a complex reality that contradicts the logic of previous nationalizing state developments and current ethnopolitical movements that describe resources and people, communities and wider regional populations in certain and often very prescribed ways. We highlight these developments and movements which follow the logic of nation-building in that you are either fully or not at all their targeted identity, as well as Arctic literature that applies mainly historically-derived and limited descriptions of northern circumpolar worlds to what is today both a geographically larger and increasingly more diverse area.

13.2 Understanding Globalization

Contemporary political, cultural and economics discourses often take it for granted that, not only is globalization occurring, it is a powerful worldwide force. Yet beyond its actual perceived or real impacts, one problem in understanding globalization is that not all who use the term define it or distinguish it clearly enough from internationalization, with many writers and commentators on the process using the terms interchangeably. More accurately, we should understand globalization as the multiplicity of linkages and interconnections between the states and societies which make up the modern world system, as well as the flows of ideas and the less tangible and immaterial aspects of such interrelatedness that occur at different spatial and temporal scales. But globalization is seldom defined, analyzed or interrogated against evidence, and this is especially the case in the Arctic where there are considerable gaps in the kind of social science research that aims to identify and study these global influences, forces, processes and institutions.

Despite the best intentions of researchers who attempt to understand the complex inter-linkages between local-scale and global-scale processes, apart from a few relatively recent studies (e.g., Crate 2006; Keskitalo 2008; Heininen and Southcott 2010), detailed empirical documentation of globalization trends and processes in the Arctic is severely lacking in comparison with a burgeoning literature on globalization elsewhere in the world (see also Keskitalo and Southcott 2014). Here, we thus draw upon existing literature not because it describes "globalization" by utilizing this term, but rather because it describes features that are notable both with regard to how the region has often been described in more static terms and that are under change with globalization. In particular, we place the focus in particular on the image of resource use as local or traditional and on the image of northern population that moves us away for a moment from a largely predominant concern with indigenous peoples. However, what we also describe is how these features were never static: the diverse regions that make up what we know and understand as the "Arctic" were in fact never only the "local" nor "indigenous" units of today; rather they have developed and taken shape through interaction, migration, and the flow of ideas.

Our understanding of globalization targets it as a continuation and intensification of mobility and communication around the globe, one that involves both an intermingling of, and friction between, societies and cultures. However, what has resulted in more static descriptions of population is that the Westphalian basis of the contemporary state system targeted *nations* to construe and construct themselves as states, thereby allowing them to create administrations and express sovereignty over their territories. However, this focus on nations as states also led to the conclusion that each nation should have a state, and that each state should only have one nation – a postulate that increasingly became more of a fiction over time. This is because it necessitated the continuous nationalization of those who exhibited traits other than those declared national, despite the realities that these were increasingly challenged as migration continued (Anderson 1983).

The increasingly diverse conditions in which we find ourselves today are to a large extent a result of the breakdown of this system, after nationalization policies perhaps peaked around the Second World War (partly, perhaps, following the war, and partly as a result of a situation in which the increasing power of corporations no longer necessitated national sovereignty in order to appropriate resources). As Christopher Tilley has remarked, "The partial disjuncture between state and resource sovereignty opened for the large revival of previously submerged identities, some of which united in ethnopolitical movements" (Tilley 2006). However, at the same time, it also made many question the strong claims of unity and similarity among enthnopolitical movements. For instance, Tilley points to how Hobsbawm and Ranger (1983) "made a strong claim for the 'invention of tradition'. Many traditions which appear old are quite recent in origin and often invented. The contact thus claimed with the past is essentially spurious. … All traditions have to start somewhere, and at some time, and therefore may be said to be invented" (Tilley 2006).

In the Arctic Council – itself a result of these complex globalizing developments – a focus was given not only to states but also to some of these ethnopolitical movements with an aim to represent both state and non-state actors. However, despite an explicit focus on "the north", no representation was accorded to sub-regional governments or administrations. A focus on "nation" as the complementary category to "state" has lingered. The understanding of the Arctic that constitutes the basis for the Arctic Council, however, has also been criticized: rather than constituting a focus for the different varying sub-regions recognizing their different pre-requisites, much literature on the "Arctic" has targeted those concepts historically imagined as part of a pristine natural area, from the viewpoint of a constructed nature-culture dichotomy. The "Arctic" has often been seen as a pure environment, inhabited mainly by indigenous people and with a large focus on subsistence practices, rather than a dynamic and diverse place in which the modern and globalizing developments that increasingly come to characterize the region play out (Keskitalo 2004). Thus, not only the indigenous nation as the complementary category, but also to some extent from the viewpoint of emphasizing (at least partly imagined) tradition, became the focus.

The view of the "Arctic" as an eight-state, unified region for which such traits would be relevant thus itself follows rather than challenges the logic of previous nation-building developments – it attempts to erect one singular identity for highly varying regions (Anderson 1983). Most notably illustrating this imagined character, it also includes areas which were politically convenient at the time of institutionalization, but which are not historically included in "Arctic" areas, such as northern mainland Norway, Sweden, Finland and Iceland (Keskitalo 2004; see also Keskitalo et al. 2013 for a focus on Sweden).

In addition to its recently invented region-building character, the areas are also not clearly distinguishable in relation only to the relatively environmental and indigenous characteristics which are often the focus of Arctic studies (e.g., Keskitalo 2004). Rather, the broader world has reached into and influenced what is now seen as the "Arctic" for centuries. The fur trade, for example, is documented back to the ninth century in the Eurasian North, and brought northern peoples into contact with traders from regions to the south. Also in the ninth century and later in the tenth, the Norse sailed west from Norway and the British Isles across the North Atlantic to Iceland, and then to Greenland, and soon the northern North Atlantic, from Greenland across to northern Norway, was linked through extensive trade routes throughout Scandinavia, Europe, Russia, and Greece, and with Arab traders from further east, but also from Spain and North Africa. In the North Pacific, until Europeans disrupted Native trade, Alaska was part of an extensive trade network with Siberia and diverse cultures and economies were linked in a network that stretched a vast geographical distance, across Siberia and south to Korea, China and Japan. In Alaska, archaeologists have found ornamental objects from Asia, trade beads, and tea, and evidence of Chinese influence in art – stretching back some 2,000 years. Later, from the sixteenth century onwards, voyages to the far north were made in search for shorter maritime routes across northern Canada and Russia to access the riches of the Orient, and then later to exploit the resources, such as whales, of these northern areas themselves. These encounters often gave rise to new forms of society, hybridity, mobility and migration and the emergence and articulation of particular and distinctive identities. Today, people and institutions continue to move in and around the circumpolar North, contributing to the continuous shaping of this lively high latitude human world.

13.3 Example: Globalization in the Marine Resource Sector

Arctic fisheries represent a good example of how the effects and influences of global processes are increasingly felt in all aspects of social, economic and cultural life in the Arctic or north today. Viewed in relation to the relatively sparse population in the region, fisheries is one of the major economic sectors and export earners of the Arctic. In a number of northern regions it is the mainstay of local economies, yet fisheries dependent communities have been undergoing significant changes over the last few decades. The social and economic situations of many contemporary Arctic coastal communities can be attributed in part to the global restructuring of fisheries, the balance of competition between different species and different fishing areas, the globalization of the sourcing of supplies for processing plants and retail markets, changing consumption trends and market demands, and the redistribution of wealth from traditional actors, such as local fishers and local processors, to powerful global players in the form of transnational corporations that own and control large fishing fleets (Symes 1998). Eythorsson (1998: 42) argued that such conditions in fisheries worldwide can be characterized "as an accelerating process of disembedding and globalisation", seen most markedly in resource management models and in the transition from fish as common resources to private property. In this way, fisheries have been undergoing a process of transformation from industries or what we may call ways of life subject to the control and regulation of local, regional and national authorities, to a global enterprise dominated by a handful of transnational companies, with considerable consequences for social identity, coastal community dynamics and demographic change.

Yet, the local and regional economies of the Arctic are not – and many have never really been – isolated or insulated from global markets and trade networks, making us question the contemporary discourse of what is exactly meant by the "new Arctic". Today, global interests are focused on the Arctic for a number of reasons, however, but securing access to northern resources appears to be a major concern for many non-Arctic states and business interests. Countries such as China, Japan, Korea and European Union member states, for instance, constitute valuable markets for Arctic or northern resources, thus placing the circumpolar north even more firmly within the contemporary global economic system. The economic futures of many northern communities and regions are tied increasingly to distant markets, as well as the development of trade within and between the various regions of the circumpolar north. However, this interaction and entanglement with the global economy has long been the case as well. Greenland's largest single source of export income, for example, is deep-water shrimp, marketed in Europe, North America, and Japan. Oil from Alaska's North Slope meets 25 % of total US demand,

and provides considerable tax revenues for the North Slope Borough's Iñupiat residents. As Caulfield (2000: 497–8) wrote some years ago,

> Renewable resources are a part of this global dynamic: salmon from Alaska's Bering Sea is found in fashionable restaurants of Boston and Los Angeles within hours of being caught; Japanese technicians advise Greenlanders about how to produce specialized shrimp products ("fantails") for Tokyo markets; wealthy European and North American hunters pursue polar bear in northern Canada for trophies; wilderness enthusiasts in places like Alaska's Denali National Park seek wildlife experiences where subsistence hunting by indigenous peoples is banned; and animal rights activists lobby to keep Inuit hunters from selling seal skins on the European market, no matter how justifiable the practice on biological grounds.

Changes in world energy markets and technology have led to major and rapid expansion of oil and gas exploration and development in several regions of the Arctic during the past 30 years. Most activity to date involves oil onshore along the North Slope of Alaska and in western Siberia, and offshore in the Barents and Beaufort Seas. However, the Alaskan North Slope, Canada's Mackenzie Delta, the Yamal Peninsula of Russia, and their adjacent offshore areas hold enormous natural gas deposits that are projected to be developed during the next decade (Nuttall 2010). Furthermore, seismic exploration continues off west Greenland and in the Canadian parts of Baffin Bay. Current development and further exploration will likely continue as reductions in sea ice open new sea and river routes and reduce development and transportation costs. In addition to direct effects and impacts on marine ecosystems offshore oil and gas development has many cumulative effects on traditional resources use practices and on the well-being of local, including indigenous, communities. Global changes in politics, corporate structure, resource demands and energy needs strongly influence the patterns and rates of resource extraction at high latitudes. For example much of the projected oil and gas development in northern Canada will take place to satisfy market demand in the United States, although many other countries are looking to Canada for their energy needs (e.g., China has recently invested in Alberta's oil sands) and new pipeline projects, along with large harbours to accommodate ocean-going tanker vessels, such as the Northern Gateway project are being designed with this in mind (Nuttall 2014). All this entails its own processes of movement, of equipment, capital, and people, giving rise to different perspectives on the Arctic as place and space, and to new forms of social and economic life.

13.4 Example: Globalisation and the Multi-cultural Society

In accordance with this broader and shifting nature of change, we should also be careful in assuming that globalization will necessarily lead to cultural disorientation, tension and conflict in local societies in the Arctic, or seeing people as being on the receiving end of social change and modernity, making them passive victims of impersonal global processes. The ongoing changes offer opportunities to understand and reflect further on the relationship between global complexity and everyday life in local settings, and the examples of social identity and grass-roots reactions to rapid social and environmental change (e.g., Lynge 1992) serve to illustrate local responses to modernity. As we have already noted, the different groups in the "Arctic" have been implicated in and affected by global economic and cultural processes for several centuries in some cases. Today, as in the past, people have to negotiate work out, and manage for themselves identities that take account of these global complexities in daily local life (e.g., Dorais 1997).

This diversity – historic, present and future – needs to be a part of a coherent and richer description of northern areas. While "'[h]eritage' landscapes become memorious of a nation's past and the need to root and maintain that identity in the land as a counterpoint to the flux of modernity, to arrest time and change and provide something traditionally 'authentic'" (Tilley 2006; see also Viken 2006), much literature – although less included in "Arctic" research – challenges assumptions that places are to be described as having clear-cut identities. To travel in the Arctic today is to encounter diversity – the Thai population in Greenland's capital Nuuk, or the growing Muslim population of northern Canadian towns such as Yellowknife and Inuvik are but two examples. Yet researchers often essentialize the region and its societies. True, indigenous issues are vital in contemporary Arctic politics, but descriptions of the regions of the Arctic as indigenous homelands only ignores a different kind of dynamic at play.

For instance, with reference to a Norwegian case, Viken notes that cultural hybridity is a characteristic of contemporary society. "In this society identities can have elements that are immanent and fixed, but for many the most predominant parts will be a matter of reflection, choice and change. The choice may even be regarded as an obligation. … [T]here seems to be layers of identities, some being more profound and stable than others, but that these identities can be of different types and have different origins" (Viken 2006: 10–11). Similarly, Tuulentie notes in a paper on northern Finland that ["t]he more tradition loses its hold, and the more daily life is reconstituted in terms of the dialectical interplay of the local and the global, the more individuals are forced to negotiate lifestyle choices among a diversity of options" (Tuulentie 2006: 27–28).

In a constructivist understanding, all identities are constructed over time. This can be illustrated both historically and in a contemporary setting: Olsen takes the example of how one single official Saami identity was developed from multiple groups as a process of aboriginalization and to some extent development of Saami institutions (Olsen 2006, 2003; cf. Eidheim 1997). Similar processes are underlined as components of all nation-building as well as region-building processes (e.g., Paasi 1996; Neumann 1999), and are used to highlight and unify specific groups, necessarily by making them distinct from other groups. The ways in which groups are made distinct from each other has often drawn upon historically developed images of difference, for instance where a modern "civilization" has been counterposed to an indigenous society, which has thereby also been related to tradition, subsistence and nature (in particular to frontier-based understandings applied in the United States and Canada; Keskitalo 2004; Nuttall 2010). However, through globalization and increasing homogenization, international trade and communication, such distinct group differences are no longer a given (if they ever were): also the "indigenous" person can be a traveler in and through other societies, exhibiting middle class values and norms. Limited conceptions of identity, what Olsen calls "emblematic" conceptions, thus constrain necessarily complex realities. For instance, on one such indigenous group, Olsen notes that "Sámi culture is displayed in an 'emblematic' form that promotes an idea of the Sámi as traditional and radically different from modern Norwegian culture. This touristic way of exhibiting culture is also found in other fields than tourism, and is in danger of reinforcing clear-cut ethnic boundaries in an area that should rather be understood by concepts such as hybridity" (Olsen 2003: 3). This imagined, emblematic view of identity and culture – drawn from the logic of separating nature and culture that is characteristic of frontier thinking in the development of North America – may fundamentally constitute an issue in multicultural globalizing societies. As Olsen continues, "In many ways these concepts [indigenous and modern] might be looked upon as asymmetrical counterconcepts, where a difference in value excludes the one from the other. By this I mean that it is difficult, if not impossible, to appear as both modern and traditional or modern and indigenous in most contexts" (Olsen 2003: 5).

Here, in particular northern Fennoscandia (or the region that is also commonly called "North Calotte", comprising what is currently northern Norway, Sweden and Finland) constitutes an area where cultural mixing has been the norm. Pietikäinen et al. (2010) note that "[f]rom the point of view of majority communities, the North Calotte area was a politically undefined region until the early nineteenth century". The borders between Norway and Sweden, and Norway and Russia, respectively, were only determined in 1751 and 1826, with Sweden and Finland separating in 1808 (although "early" from the perspective of the much more compressed North American state history). Linguistic identities here include not only the national languages Norwegian, Finnish and Swedish but nine distinct languages in the Saami family, as well as Kven, and Meänkieli/Torne Valley Finnish. For instance, Lane (2009) notes that "Northern Norway has been multilingual [in Norwegian, Kven and different Sámi languages] for as long as historical records have been available". As Pietikäinen et al. describe it:

> "Approximately half of the Sámi people (c. 70,000–100,000) speak one or several of the nine Sami languages … and none of those speaking Sámi language are monolingual. As related to more specific numbers of Sámi languages [it can be estimated]… 30,000 speakers for Northern Sámi and an estimated 350 for Inari Sámi and 300 for Skolt Sámi. … The estimations given to numbers of speakers of Meänkieli and Kven vary considerably as well … the estimated number of Meänkieli speakers is 50,000 … [and] the estimated number of Kven speakers is 5,000–7,000" (Pietikäinen et al. 2010).

This integration as well as diversity in these areas, and the consequences as formal borders developed and shifted can be illustrated by impacts not only on Saami but on Kven and Meänkieli speakers. Meänkieli, a language close to Finnish and spoken on both sides of the Tornio river – the current border between Sweden and Finland – was following the separation of Sweden and Finland "long considered a 'foreign language'" in Sweden, although it is now recognized as a national minority language in Sweden and considered a regional dialect in Finland. In Norway, similar processes led to Kven – a language variety spoken by groups that early on migrated from what is currently northern Finland to northernmost Norway, before the borders were drawn – becoming recognized as a minority language in Norway in 2005 (Pietikäinen et al. 2010). Here, “[w]ritten sources from the eighteenth century … [refer to] both the Kven and the Sámi … as ‘nations’” (Lane 2009). However, as for Meänkieli, the language was for a long time seen as foreign in light of an assumption of a state as monolingual:

> “There are two sides to this story; first, it tells us about how the Kven are labelled as foreign, second, it reveals how difficult it is to be included as ‘Norwegian’ in public discourse. If a group of people, recognized as a national minority, with a historical continuous presence of more than 300 years, having settled before the borders were established, is still categorized as immigrants” (Lane 2009: 218–219).

Studies also illustrate further problems that result at the local level due to ethnopolitical, both state and other nation, attempts to define an area in terms of only one nation. Many statements in published literature on these areas indicate the fluid and chosen identities of family members where many can – if forced to – choose from several different identities. For instance, “during the last two centuries it has been rather common that some members of the same family are reckoned as Sámi, whereas others are not, depending on personal carriers and situations, and contexts constituted by politics and metatrends” (Viken 2006: 12–13). Viken exemplifies that this view of either having a split identity or having to choose only one identity is rejected by many: “[a] young person maintained that he was not a half person, protesting against the notion ‘half Sámi, half Norwegian’: ‘I am at the same time fully Sámi and fully Norwegian’, he said” (Viken 2006: 15). Thus, resistances exist not only against state identity but also against choosing a specific ethnopolitical identity. Olsen similarly notes that the:

> “Status as an indigenous people is important if one wants to claim political rights, but the distinction between indigenous and modern does not easily fit into everyday life in a multicultural area like northern Norway. Many people might trace their descent to many ethnic groups; people have what might be labelled hybrid identities … Such an image of the Sámi as a folk with clear-cut boundaries to a Norwegian population that is often found in a national discourse, can easily be contested by Norwegians with a similar way of living and a descent that can be labelled Sámi as well as Norwegian, Kven, or Russian” (Olsen 2003: 5).

Similarly, Olsen explains that “[m]any of the local people live and have grown up in communities where the local culture is not, and has not been, inscribed as Sámi but as local, as Finnmark culture, or as Norwegian” (Olsen 2003: 14). At the same time, the markers that have been used to claim ethnopolitical identity or to describe a group – such as traditional or a distinctive relation to nature – can also be seen as either imposed or as fading among many in the group. He notes that “[F]or the Sámi it is an increasing problem that everyday life does not fit the idea about indigenous people, and this is a problem not only found in tourism, but also in other realms” (Olsen 2003: 7). It may thus not only be ethnopolitical or nationalistic labels that do not fit the variety within the regions – in addition, the characteristics traditionally associated with these also do not fit. Rather, people have multiplicities of experiences and thus also multiplicities of identity.

A number of quotes from published literature can be used to underscore this point. Tuulentie writes on the requirement to define one's self in a certain way or in relation to certain characteristics in a paragraph worth citing at length:

> One interviewee in the female group explained that she was born in the Southernmost Lapland, but her roots are from her mother's side in the Utsjoki fell Sámi community and from her father's side in a Skolt Sámi community. She has lived in Inari municipality from the age of nine, but still she defined herself somehow as a tourist, or an explorer, in this terrain of her ancestors. … Another of the Inari interviewees positioned herself to Norway as well as to Finland since her mother came from Guovdageainnu. An important dimension for the third interviewee, in turn, was that her mother comes from Southern Finland and was the first ethnically Finnish woman who married a Sámi man in their village. This Finnishness becomes even more important than the Sáminess since outsiders often consider her as a Finnish person … Although regarding herself as a real Sámi, this interviewee feels the need to evaluate her Sáminess since the outsiders do not see it and since she has spent a long period outside the context of the Sámi culture. Because of the politicization of the Sámi identity in the last decades, every Sámi seems to be forced to work out his or her own position, and, thus, the assurances of genuine Sáminess are naturally offered to the audience. Through the life courses of the interviewees, it becomes clear that many of them have lived in different parts of their own country and also abroad (Tuulentie 2006: 29–30).

Kim, in a master's thesis focused on northern Norway, also pointedly illustrates these characteristics through interview material. Kim writes: "one lady who I interviewed said: 'I am a Northern Norwegian, my grandparents on my mother's side were from Finland and my grandparents on my father's side were both Norwegian and Sami. I was born in Norway and grew up here. … Almost everybody here has a background like me'" (Kim 2010).

Thus, the connection between one place and one identity may not be given: it is both constructed and dependent on the points in relation to which it is constructed. As Tilley notes: "Places are both spatial and temporal. They are intimately connected to history, the past, and hold out the promise of a desired future. As such they are in flux rather than static nodes or points in a landscape, and their qualities and character can only be understood relationally, with reference to other places, and on different scales like a series of Chinese boxes" (Tilley 2006). As we see it, a variety of places may be seen as existing, making up the politically constructed "Arctic" but they are not being accurately described by their inclusion into this meta-container. Rather, the variety of sub-regions and localities are imagined and constructed in relation to the many other places to which they are so increasingly connected –and which may be local or further away.

Based on her material, Tuulentie concludes that "Sámi, or other indigenous people as well, have often been regarded as totally local people and, thus, as an opposite to the tourists and the phenomena of tourism. The identity politics of the Sámi often underline this feature since it has been politically wise to underline the Sáminess as an indigenous identity that is bound to the specific Sámi region. However, the focus group interviews in the three Nordic countries show that the global and the local, the tourists and the Sámi, are not such opposites anymore – if they ever have been. The cultural figure 'native' should not be replaced by the intercultural figure 'traveller' but they should be seen as mediated in many ways" (Tuulentie 2006: 34).

Finally, in a statement that speaks strongly to the concurrent construction of areas by not only identities that have historically existed in the regions, Lane (2009) provides an example of the increasingly mixed characteristics of the state under globalization. She writes on an initiative:

> 'Agenda X have taken the initiative to make the exhibition Find the Norwegian. They are looking for a broader term where there is room for the feeling of belonging, for them to see opportunities, participate in and contribute to the community. They are looking for a Norwegianness which includes instead of excluding. They are looking for the opportunity to choose identity according to need and situation' (my translation, Norwegian original). The exhibition was set up with several portrait photographs of youth of various ethnic backgrounds and their comments about identity and Norwegianness. Two of these portraits can be seen below.
>
> Norway is what I'm used to! For Christmas I eat porridge with almond, and I dress nicely on the 17th of May.
> But in Norway I'll always be the Kenyan
> In Kenya, I'll always be Mzungu (the White)
> Judy
> (Norway and Kenya)
>
> I was born here and I speak Norwegian
> I just look a little different from the average Viking
> Welcome to the future!
> Samantha
> (Norway and Ghana) (Lane 2009: 222).

13.5 Discussion and Conclusion

In this chapter we have shown that, neither with regard to population nor with regard to resource use (such as in the case of marine resources), globalization cannot be considered a distinctly new process. Rather, globalization has intensified through recent changes and increasingly global processes of communications, technologies and mobilities. The "Arctic" has never been one thing or one given region: in some assessments it is defined as being over a tenth of the world's area, and it is more diverse and more interlinked with "non-Arctic" places than what is often recognized in Arctic literature. This diversity needs to be increasingly moved into focus.

While the "new Arctic" is not "new" with regard to globalization, a view of it as "new" or changing may thus be more of a testament to many earlier, simplifying descriptions that were based only on certain features of northernness to the exclusion of others. To us, it seems that both the focus on local resource use and the local environment in "Arctic" literature, and the focus on recognized indigenous peoples as the one northern group (and often ascribed traditional characteristics), are illusions. Complexity and multiculturalism are defining characteristics of the North – historically as well as today – and it diminishes our understanding of northern places and societies to describe them merely with labels such as national spaces, ethnopolitical regions, traditional cultures, and so on. Groups may be "characterized" only by their variety, by many kinds of movement and mobility, and, even if now situated at any particular place which has gained any particular description, as being in flux rather than being static, just like the Chinese boxes Tilley refers to. As Tiley notes:

> One of the paradoxes of contemporary modernity is that on the one hand traditional ways of life are perceived to be under threat yet local traditions (culinary, dress, arts and crafts, dance, music and so on) are everywhere being emphasized. … We sit in front of TVs and computer screens in which there is a simultaneous logic of excessive information and excessive space in which new forms of solitude and interaction replace face to face personal encounters. These may increasingly foster new virtual shared communities of taste, interest, consumption patterns and notions of shared identities among people who may never meet each other. Identity, when it becomes deterritorialized through migrations and diasporas, almost inevitably becomes located between places rather than bound to particular places or homelands (Tilley 2006).

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Chapter 14
Race to Resources in the Arctic: Have We Progressed in Our Understanding of What Takes Place in the Arctic?

Timo Koivurova

Abstract This article examines how we have progressed in our understanding of what is unfolding in the Arctic in regard to non-renewable natural resource exploitation. It first demonstrates how the Arctic expert community developed its understanding of what is happening in the offshore Arctic, as regards oil and gas exploitation. The aim is to enquire over the way the expert community has progressed in its analysis of what is driving natural resource development, and in what manner. It is shown that because of this learning process taking place in the expert community, we can nowadays ask more nuanced questions in regard to the operation of extractive industries in the Arctic. The final part of the article focuses especially on the main drivers of mining activity in the Arctic, and studies the kind of questions we can ask about how mining can be undertaken in a sustainable manner.

Keywords Arctic • Continental shelf • Race to resources • Geopolitics • Law

Arctic policy and legal issues have become hot topics in recent years. This is undoubtedly due to the actual changes in the region, the increased economic activities in the region, and climate change emerging as a major challenge. Yet, this is not the whole story. Why Arctic issues are “hot” is also very much due to the media coverage of what is unfolding in the region. It can be argued that the media have often dramatized and distorted what is actually taking place in the region; the way in which the media informs us of what is happening in the region has a deep impact on policy development. After all, most decision-makers and the general public have to rely on the media to keep abreast of what is taking place in the region – a region

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which very few ever visit and that has served as a place of public imagination for a long time.

It is argued that initially, it was perceived realities that dominated the way Arctic policy experts analyzed what was happening in the region. It seemed that especially after the Russian flag planting event in August 2007 (discussed below), the expert community perceived that a type of 'race to resources' was going on between the Arctic Ocean coastal states in the region. The underlying concept was that climate change was revealing the hydrocarbon riches of the Arctic Ocean by melting the sea ice, and this triggered a competition between states as to who gets to occupy most of the sea floor. This crude understanding of why states are mapping their continental shelves had to give way when scholars realized that international legal rules also played a part in continental shelf activity. However, this explanation also seemed to only partially capture an accurate view of what was happening, thus opening the door to the development of even more nuanced – and thus better – understandings.

This paper looks to outline the way we have progressed in our understanding of what is unfolding in the Arctic in regard to natural resource exploitation, in particular that of non-renewable resources. It first demonstrates how the expert community developed its understanding of what is happening in the offshore Arctic, as regards oil and gas exploitation. It seems obvious that the expert community's understanding has differed (and continues to differ) with how the media depicts what is taking place in the region. This is due to the different ways in which Arctic experts relate to the region, compared to that of the media and the general public, both of whom have little interest in whether the development that takes place in the region is sustainable or not.[1]

The aim is to demonstrate the way the expert community has progressed in its analysis of what is driving natural resource development, and in what manner. It is shown that because of this learning process taking place in the expert community, we can nowadays ask more nuanced questions in regard to the operation of extractive industries in the Arctic. This final part focuses especially on the main drivers of mining activity in the Arctic, and examines the kind of questions we can ask about how mining can be undertaken in a sustainable manner.

14.1 How Has the Expert Community Understood Continental Shelf Activity in the Arctic?

There was a high degree of consternation when Russian submarines planted their country's flag underneath the North Pole on the Lomonosov Ridge in August 2007. The Canadian Minister for Foreign Affairs stated to the media that "[t]his isn't the

[1] For a theoretical examination of why and how continental shelf activity has been interpreted in different ways, the mechanisms which have influenced the expert community's understanding, and why the media keeps relying on simplistic views of what is unfolding in the Arctic – see: Koivurova (2013).

15th century. You can't go around the world and just plant flags to claim territory."[2] Other Arctic Ocean coastal states also reacted to the Russian move. The United States officially criticized many aspects of the Russian claim, especially Russia's attempt to assert sovereign rights over the Lomonosov Ridge that runs through the Central Arctic Ocean Basin. According to the US, the Lomonosov Ridge "is an oceanic part of the Arctic Ocean basin and not a natural component of the continental margins of either Russia or of any State."[3]

The Russian flag planting – and the almost simultaneous reports of the dramatic loss of sea ice in the Arctic Ocean in September 2007 – consolidated the view that a race to resources had started. With this race between states underway and the decreasing levels of sea ice, a new ocean containing vast quantities of hydrocarbons was seen to be opening up.

There seemed to be no doubt that climate change was melting the Arctic Ocean sea ice, since satellite information collected from 1979 to this day demonstrated this to be the case. In general, since ice and snow are the first natural materials to react to global warming, it has been estimated that the Arctic has already been impacted by climate change, and the changes seen in the region will be twice as intense as those seen in other regions of the world. Indeed, it seems to be one of the consequences of climate change that previously inaccessible regions will be opened up to resource development, and it could therefore be argued that there are certainly several compelling reasons why the world should make use of the vast reserves of hydrocarbons contained in the seabed of the Arctic waters.

First of all, despite growing international demands for the development of renewable energy sources, fossil fuels still seem to have a future in the energy markets. The International Energy Agency (IEA) has recently estimated that despite efforts by the climate regime to convert our energy use to renewable sources, with present energy development scenarios, our dependence on fossil fuels will grow even more by 2030.[4] The Arctic hydrocarbon resources seem tempting from two perspectives: they are estimated to be plentiful and are generally considered to be safe, as they are located in areas with no on-going political conflicts. It can thus be concluded that the effect of climate change and also interests in exploiting hydrocarbons in the Arctic could likely provide an explanation as to why the Russians started to "occupy" the sea floor in 2007.

It was also evident to the media that the Arctic Ocean coastal states were out to occupy as much of the seafloor as possible. For example, in 2001 the Russians staked a claim to much of the Central Arctic Ocean seafloor. Since then other countries have followed Russia's lead. The Norwegians made their official claim in 2006,[5] and Canada made a partial submission in 2013.[6] Denmark (Greenland) made

[2] Struck (2007).

[3] Commission on the Limits of the Continental Shelf (2002).

[4] See, e.g., World Nuclear Association (2014).

[5] United Nations Convention on the Law of the Sea (UNCLOS) (1982, 2006).

[6] Canada made a partial submission in 2013, and stated that it will make the submission on the Arctic Ocean at a later date, see Government of Canada (2013).

partial submissions in regard to areas north of the Faroe Islands,[7] the Faroe-Rockall Plateau Region,[8] the Southern Continental Shelf of Greenland,[9] and the North-Eastern Continental Shelf of Greenland[10] – the last of which took place on 26 November 2013. The United States has also announced their intention to make claims. This overall development seemed to carry with it the possibility that states' interests would run counter to each other, and thus tensions or even military conflicts could ensue.

This drama provoked swift political and legal action in 2007, first from the 'foreign minister' of the European Union (EU), who argued in releasing the Commission's report on climate change and international security, that some type of international treaty was needed to contain the geopolitical struggle unfolding in the region. As much or even more was suggested by Scott G. Borgerson. A Fellow at the Council on Foreign Relations and a former Lieutenant Commander in the US Coast Guard, Borgerson argued in 2007 that even a military conflict of some sort may be possible, due to the conflicting claims and lack of legislation covering these areas.[11]

At the time, it seemed beyond any serious discussion that what is referred to here as a "race to resources", explained the behaviour of the states involved. In this storyline, unprecedented and rapid climate change opens the Arctic as a terrain for power politics over who is able to first stake claim to the hydrocarbon resources of the Arctic Ocean sea-bed. Yet, despite the fact that it convinced most of the Arctic governance expert community at the time, it was clearly an erroneous account of events, and fairly soon abandoned by these experts as not explaining what is actually taking

[7] See http://www.un.org/Depts/los/clcs_new/submissions_files/submission_dnk_28_2009.htm. Accessed 05 May 2014.

[8] See http://www.un.org/Depts/los/clcs_new/submissions_files/submission_dnk_54_2010.htm. Accessed 05 May 2014.

[9] See http://www.un.org/Depts/los/clcs_new/submissions_files/submission_dnk_61_2012.htm. Accessed 05 May 2014.

[10] See http://www.un.org/Depts/los/clcs_new/submissions_files/submission_dnk_68_2013.htm. Accessed 05 May 2014.

[11] Borgerson, at the time argued e.g. that: "The situation is especially dangerous because there are currently no overarching political or legal structures that can provide for the orderly development of the region or mediate political disagreements over Arctic resources or sea-lanes. The Arctic has always been frozen; as ice turns to water, it is not clear which rules should apply. The rapid melt is also rekindling numerous interstate rivalries and attracting energy-hungry newcomers, such as China, to the region. The Arctic powers are fast approaching diplomatic gridlock, and that could eventually lead to the sort of armed brinkmanship that plagues other territories, such as the desolate but resource-rich Spratly Islands, where multiple states claim sovereignty but no clear picture of ownership exists". Borgerson (2008). Recently, in 2013, Borgerson has revisited his views, with his new article in Foreign Affairs arguing e.g. that: "…a funny thing happened on the way to Arctic anarchy. Rather than harden positions, the possibility of increased tensions has spurred the countries concerned to work out their differences peacefully. A shared interest in profit has trumped the instinct to compete over territory. Proving the pessimists wrong, the Arctic countries have given up on saber rattling and engaged in various impressive feats of cooperation". Borgerson (2013).

place in the region. A better explanation seemed to be what may be referred to as "orderly development."

14.2 Orderly Development

Soon it was suggested that the Arctic Ocean coastal states are, in fact, following the rules of an international treaty – the United Nations Convention on the Law of the Sea (UNCLOS).[12] As a collective, we legal professionals were able to tell to the rest of the world (as we did in the first polar law symposium held in 2008 in Akureyri Iceland), that states are just following the rules and procedures of the law of the sea and UNCLOS. When we drafted our media release, colleagues from other disciplines of the Arctic governance knowledge community were curious as to how something like international law can explain what is happening. Many in the fields of geography or international relations were unaware of UNCLOS (or the customary law of the sea as mostly codified by UNCLOS), so there was a lot of discussion involving how such rules had come into being and to which procedures states are legally bound.

The rules applying to the continental shelf evolved in a particular manner. Before World War II, coastal states enjoyed sovereignty over only a narrow strip of territorial seas, extending three to four nautical miles from their shorelines. This was changed dramatically after the war, with the 1945 Truman Proclamation by the US, declaring that the natural resources of the subsoil and sea bed of the continental shelf beneath the high seas, but contiguous to the coasts of the United States are subject to the jurisdiction and control of the country. This initiated the era of creeping coastal state jurisdiction, especially in regard to the sea bed, the outer limit of which was defined in Article 1 of the 1958 Continental Shelf Convention in a way that permitted the possibility for coastal states to claim larger sea bed resources with the development of technology, to the extent that even ocean floors could be divided between coastal states.[13] A counterforce for this trajectory came from the Maltese ambassador Arvid Pardo, who in 1967 proposed in the UN General Assembly that the ocean floor be designated as a common heritage of mankind. Pardo argued that it should be administered and overseen by an international governance mechanism, whereby the economic benefits of the ocean floor riches could be shared equitably between developing and developed states.

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[12] See the Convention text at http://www.un.org/depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm. Accessed 05 May 2014.

[13] For the purpose of this article, the term "continental shelf" is used to refer: (a) to the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea to a depth of 200 m, or beyond that limit, to where the depth of the superjacent waters permits the exploitation of the natural resources of the said areas; (b) to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands.

The Convention was negotiated over an extended period of time – from 1973 to 1982 – as a package deal, permitting no reservations to the Convention. UNCLOS was able to achieve a compromise between various groupings of states with differing kinds of interests related to the sea bed. For instance, broad continental margin states were able to have rules accepted which allowed the whole continental margin to be subjected to the sovereign rights of coastal states. Geologically disadvantaged states – those whose continental margin was minimal – managed to push for an Exclusive Economic Zone that entitles all states (also) to a minimum of 200 nautical miles along the continental shelf, meaning that these states effectively exercise powers over the ocean floor as well. UNCLOS was also successful in defining more clearly the outer limit of the continental shelf than its 1958 predecessor convention, and in designating the ocean floor as part of the common heritage of mankind and under the governance of International Sea-Bed Authority (ISBA).

Although during the negotiations, broad continental margin states were able to extend the outer limit of the continental shelf to cover the whole geophysical continental margin (and in some exceptional cases beyond), they also had to make compromises. For example, they had to submit to rules requiring them to transfer some of the revenues from offshore hydrocarbon exploitation in their extended continental shelf to developing states via the ISBA, and, more importantly they had to document and "prove" the extent of their continental shelf scientifically to the Commission on the Limits of the Continental Shelf (CLCS or Commission), a scientific body with 21 members. The submission must be made by a coastal state if it perceives that its continental margin exceeds 200 nautical miles within 10 years from the date when it became a party to the UNCLOS.[14] The Commission can only make recommendations, but these recommendations are legally influential because the continental shelf's outer limits become final and binding only when they have been enacted on the basis of the recommendations.[15] The deadline for such submissions is fairly tight, given that states need to provide the Commission with vast amounts of scientific and technical data. However, it was seen as necessary to define the outer limits of continental shelves as quickly as possible, since only after knowing these limits is it possible to know where the boundary between states' continental shelves and the Area which comes under the jurisdiction of the ISBA lies.

Was it possible to reliably support our argument that states were only following their UNCLOS duties? Russia was the first country to make a submission to the CLCS in 2001, and was also the first country to which the Commission issued recommendations, requiring it to revise its submission regarding the Central Arctic

[14] UNCLOS, Annex II art. 4. This date was postponed by the parties to UNCLOS for those states that had become parties before May 1999, thus extending their submission deadline to May 2009.

[15] See an important study made by the Committee of the International Law Association (ILA) (2004).

Ocean Basin.[16] Whatever symbolic importance the Russian flag planting event may have had for its domestic policy, Russia has not argued that this would have any international legal effect. The Russians have insisted that they will make the revised submission to the Commission within the foreseeable future, which is now due to take place in 2015.[17] Norway made a submission in 2006 for three separate areas of its North East Atlantic and Arctic continental shelves. The CLCS has now made recommendations to Norway as to how to draw the outermost limits of its continental shelf.[18] According to news sources, the US has also started to develop its continental shelf submission, even though it is not a party to UNCLOS. The Clinton and Bush administrations have already tried to become party to UNCLOS, but without result. The current Obama administration continues with this struggle.

To articulate to the world that what they were doing was only in keeping with the law of the sea, the Arctic Ocean coastal states had convened a preparatory meeting as early as the end of 2007, and organized a political level meeting in Greenland in May 2008, wherein they issued what is known as the Ilulissat Declaration.[19] In the Declaration, they made it clear that there is already a comprehensive legal regime in place in the Arctic, namely, the law of the sea. In other words, there is no race to resources over the Arctic Ocean seabed, but simply an orderly development that proceeds on the basis of the law of the sea. Among other issues, coastal states stated that "…the law of the sea provides for important rights and obligations concerning the delineation of the outer limits of the continental shelf…",[20] and that they "remain committed to this legal framework and to the orderly settlement of any possible overlapping claims."[21] States also committed themselves to co-operating in the resource-intensive scientific work required to make a submission to the CLCS, and this has occurred between many Arctic Ocean coastal states.

In this light, it seemed evident that it was in fact the law of the sea that explained the continental shelf activity of the Arctic Ocean coastal states, and not the storyline referred to here as a "race to resources." Not only were the coastal states following the procedures set out by UNCLOS, but they also explicitly committed themselves to the orderly settlement of any possible disputes over where their continental shelf boundary would lie. Thus it seemed that the law of the sea can explain what is happening as pertaining to states' continental shelf activity.

[16] See UN General Assembly (2002). "As regards the Central Arctic Ocean, the Commission recommended that the Russian Federation make a revised submission in respect of its extended continental shelf in that area based on the findings contained in the recommendations."

[17] A Barents Observer news release from 7 Apr. 2014, states that this will take place in 2015, see: Barents Observer (2014).

[18] Commission on the Limits of the Continental Shelf (2009).

[19] See The Ilulissat Declaration (2009).

[20] Ibid.

[21] Ibid.

14.3 More Nuanced Explanations Arrive

Gradually, difficult questions started to arise over the role of the law of the sea as a simple explanation of what had motivated state actions in the area. Many started to question whether indeed the Arctic Ocean coastal states were only innocently following the rules of the law of the sea and UNCLOS. It seemed natural to assume that if states follow rules, then they do so for their own self-interest. The question then arose as to why states follow the continental shelf rules. The reason for this can be found in the negotiations which lead up to the conclusion of UNCLOS.

When states were negotiating the rules on where the limits of the outer continental shelf should lie, those with a broad continental margin made sure that UNCLOS would codify rules that would maximize their hydrocarbon interests. The practical consequence of this is that Article 76, which regulates the maximum outer limits of continental shelf, is now so flexible that it is almost certain that hydrocarbons will be found within the states' continental shelves. Hence, when the rules were negotiated during the 1970s, these hydrocarbon interests were in fact secured for coastal states. However, these rules are also beneficial for states for other reasons. By processing their submissions via the CLCS, states will maximize the final boundaries of their continental shelf limits. Within this fairly secretive process, states will receive guidance on how to enact their outermost limits. When they enact these limits on the basis of the recommendations, they receive near universal legitimacy for their very broad continental shelf powers. One could actually turn the question around and ask why would states not follow the rules that legitimized their large entitlements to the continental shelf and to the hydrocarbons?

It was only after this debate was held within the Arctic governance expert community, that we were ready to really penetrate what was problematic in offshore oil and gas exploitation. It was not really the inter-state aspects that were so interesting, since in any case most of the hydrocarbons would sit comfortably in one or another state's jurisdiction. Instead, the important issues seem to be taking place within the limits of national jurisdiction. Therefore, we were finally able to focus on the questions regarding the most problematic aspects of Arctic resource exploitation. These include: whether states are allowing very risky Arctic offshore oil and gas exploitation; if so, how Arctic communities and ecosystems are taken into account in planning such operations; how indigenous rights are protected; how worker safety is ensured, etc.

Already, we have some tentative answers to these questions. It seems that the Arctic states (and also e.g. the Greenlandic Inuit) are ready to open their hydrocarbons for exploitation by companies (state-owned or private), and interest is being shown despite there being significant risks involved, including among other things, drilling in ice-infested waters. The Arctic Ocean coastal states' national regulatory systems and institutions are mostly in place to regulate and ensure that this is done in a safe and environmentally sound manner. Moreover, two agreements have been negotiated under the auspices of the Arctic Council – the search and rescue agreement and the oil spills agreement[22] – and both are important for preparing for worst-case scenarios relating to Arctic offshore oil and gas development. In a similar vein, the Arctic Council has already twice revised its Offshore Oil and Gas Guidelines, which testifies to the effect that these Guidelines are taken seriously, despite no monitoring of how they are used in practice is taking place.[23] Some questions though are left unanswered. How can we, for example, make sure that these rules are monitored and enforced in the Arctic's remote conditions, when both personnel and equipment resources are lacking? This latter issue may point to the importance of the corporate social responsibility standards of companies operating in the Arctic, and this is another issue on which the Arctic Council has started to take action.

14.4 Mining in the Arctic

A similar evaluative process has been seen in many of the policy areas of the Arctic. Currently, as regards extractive industries (oil, gas, minerals), we can fine tune our diagnoses of what is really the problem(s), and therefore what may be the possible solutions. For instance, with respect to offshore oil exploitation, we no longer perceive this as provoking possible inter-state conflicts or even tensions, but start from the view that although most of these activities are inherently risky, they need to be resolved within the boundaries of nation-states. For this reason, they pose challenges to the vulnerable Arctic environment, and the unique cultures and societies in the region. The environment may be polluted, societies divided, or indigenous cultures threatened by permitting extractive industries to operate in various parts of the Arctic, so it is important to manage and control these risks.

Mining is also a current issue. All mining activities contain various kinds of risks, but most of the time these can be controlled and mitigated. There are however two on-going and very controversial mining projects in the Fennoscandia region. In the Talvivaara nickel mine in Finland, large quantities of contaminated water leaked into surrounding rivers and lakes in 2012 and 2013, and this has led to public demonstrations, criminal prosecutions etc.[24] Sami indigenous rights have clashed with mining interests in Kallak (in Sámi *Gállok*), located in Northern Sweden in the county of Jokkmokk, where a proposed mining site is located on reindeer grazing lands.[25]

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[22] Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (2011) and Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (2013); See also Koivurova (2012).

[23] The first Guidelines were published in 1997, the first revision was done in 2002 and the latest revision was in 2009. Arctic Council, Arctic Offshore Oil and Gas Guidelines (2009).

[24] See e.g. Heikkinen et al. (2013).

[25] These lands have been used by the Sámi since time immemorial and play a key role in Sámi reindeer herding. The Swedish government has given test mining permission to a British owned

Mines are very difficult to govern, given the fact that demand for the resources they produce is great from a perspective of general population growth and an increased global demand for such resources. Solutions to problems in mining are also made more complex by the fact that various levels of governance (and different sectors of policy) already regulate many mining aspects.

It is important to establish whether states are allowing mining in general (for example, in some places practices such as uranium mining are banned, whereas other types of mining are permissible[26]). It is also of importance to establish the whole array of legislation applicable to mining, and perhaps place severe restraints on the conduct of mining in certain areas. For instance, it would be very difficult to establish a large-scale mine in an area that has been designated as a protected site under the EU's NATURA 2000 policy.

If mining is in general permitted (as is usually the case in the Arctic), then important questions must consider for example: how Arctic communities and ecosystems are taken into account in the permit conditions; how indigenous and local rights are protected from the adverse impacts of mining; how worker safety is ensured in the operation of the mine; and who will reap the benefits and who will pay the costs resulting from the mining operation. Mining in general is vulnerable to the phenomenon of economic decoupling – a situation where the economic benefits of the process are exported to other regions and do not stay in the remote localities where mining is often conducted.

There are various governance solutions that have been able to promote sustainable mining in different areas of the Arctic. In some countries, there is a strong mining code that protects various rights and interests that may be adversely impacted upon by mining.[27] Environmental impact assessment (EIA) is also essential, since this is one important tool whereby the company can show the locality that it takes their concerns seriously and carefully examines potential threats to the environment. Often, the difficult operating conditions of the Arctic cannot be uniformly addressed by laws and regulations that apply across the nation-states, both in the south and the north. It is also very difficult for a government to monitor and enforce regulations in remote Arctic regions. For this reason, there is a clear need for companies to exceed the national standards by taking on voluntary self-regulation – normally referred to as corporate social responsibility (CSR). Investors in these

company – Beowulf. Mining permission on these lands offers various adverse consequences to the Sámi in terms of both their livelihood practices, as well as other land use and resource practices. The mining location is expected to put the Luleå River at risk of pollution and affect the River's water quality. Thus the Sámi have strongly resisted the developments by means of active demonstration and road blocking. Clashes between government forces and Sámi activists brought mining issues to the fore in discussions regarding Sámi rights within the country, in response to the emerging mining activities which affect indigenous livelihoods and culture.

[26] Greenland's government, amidst much controversy, lifted its ban on uranium mining. McGwin (2013).

[27] For instance, Finland revised its 1965 Mining code in 2011, to better take into account the other interests and rights adversely affected by mining. See Koivurova and Stepien (2008). See also Koivurova and Petrétei (2014).

multinational mining companies often require them to gain a "social licence to operate",[28] both to reduce the financial threats to opening a mine, and also to accommodate the long-term local realities and perspectives which may be influential on operations.

14.5 Conclusions

We have progressed in our understanding of what is, and is not problematic as regards non-renewable exploitation in the Arctic. As shown above, at first, offshore oil and gas were perceived as problematic because they were the cause of states competing with each other over the Arctic Ocean sea-floor. As the expert community started to examine the problem, however, it emerged that what was actually causing this continental shelf activity was in fact the rules of UNCLOS, which required states to provide technical-scientific information to evidence how far into the sea their continental shelves extended. What was thought to be problematic (and media still continues to diagnose this as the problem), was not in fact the central issue. Only this realization led to more nuanced views being formed as to what is really problematic in the arena of Arctic offshore oil and gas exploitation. This important learning process within the expert community has allowed us to examine the central issue: how nation-states and self-governing entities like Greenland have opened their waters to offshore oil and gas, and how they and the companies involved try to ensure how this can be done sustainably. The same can be said of mining, where we need to be very careful in taking a context-specific approach when trying to find sustainable solutions for complicated problems.

The Arctic is not a unified region – it is in fact a compilation of very different regions, which share certain similar climatic and environmental features. As such, we have to be aware of both the local and wider contexts whenever we examine any non-renewable resource exploitation, so as to uncover the real management problem. Sustainable solutions are not easy, given that we are living in a world of very complex governance systems, all of which influence mining and hydrocarbon activities in various ways. Overall, it seems that in the remote regions of the Arctic (where monitoring and enforcement of rules is difficult), we need to tailor specific governance guidance, and encourage companies to exceed the national standards by applying their own standards of CSR to address the varying issues involved.

[28] The concept of social license originates from community opposition to mining projects, but now the concept is being applied in a broader context. It is understood not as something granted by government, but rather as an intangible agreement that is renewable daily and granted by the people only when their needs are being met. Patience and constant attentiveness to the aspirations of the local people are necessary in maintaining such a license. Gunningham et al. (2004).

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Chapter 15
Comparing the Health of Circumpolar Populations: Patterns, Determinants, and Systems

Kue Young and Susan Chatwood

Abstract Arctic communities are undergoing rapid social, cultural and environmental changes which affect their patterns of health and disease. Circumpolar peoples and their governments and organizations have developed health system responses to such changes. Innovations involving both technological advances and revitalization of traditional cultural practices hold promise for improving access to and the quality of health care and ultimately the wellness of circumpolar people and their communities.

Keywords Health status • Health determinants • Health systems • Wellness • Indigenous people

15.1 Introduction

There is a diversity of regions and populations in the Arctic (Young et al. 2012). While they differ substantially in their physical and social environments, they also share many common features that reflect their experiences with the changing climate, close relations with the land, and political and historical evolution with increasing levels of autonomy being repatriated to Indigenous groups. In this chapter, we discuss human health in the context of the changing Arctic and comment on the emerging responses of circumpolar peoples.

The health of Arctic peoples can be described from three perspectives: (1) the patterns of health – how common diseases and health problems are distributed in the

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population; (2) the determinants of health – what are some of the underlying factors which contribute to the health patterns that we observe; and (3) their health systems – what national and regional governments and health authorities have developed in response to the health conditions. These divisions are not rigid. They are inter-related and capture the depth and complexity of health challenges facing circumpolar peoples at this time.

15.2 Health Patterns

The 8 Member States of the Arctic Council, with the exception of Russia, report the best indicators of health, wealth, and well-being in international league tables, such as the United Nations' Human Development Index, a composite index of health, education and standard of living (United Nations Development Programme 2013). Within countries, however, there are often considerable disparities between North and South, and between Indigenous and non-Indigenous peoples. Such disparities, however, are not consistently observed – they are most pronounced between Alaska Natives and other Alaskans, between the northern territories of Canada and the rest of the country, and between Greenlanders and Danes, but least between the Sami and other Scandinavians. Overall, the northern regions of Russia tend to have the worst health indicators. A compendium of selected health indicators on 27 circumpolar regions has been compiled and available from the Circumpolar Health Observatory (http://circhob.circumpolarhealth.org).

As an example, one can take the infant mortality rate (IMR) – the number of deaths among infants under 1 year of age per 1,000 livebirths – a sensitive indicator not only of child health, but also of overall health status of a population. IMR varies from less than 5 per 1,000 livebirths in the Nordic countries to over 10 in Nunavut and Greenland, and over 20 in some Russian regions. There is little difference between the northern regions of the Nordic countries and the rest of the country. There is a 30-year time lag between the IMR of Greenland and Denmark (Bjerregaard 2008). In Alaska, the Alaska Native rate is more than twice the rate among non-Natives in the state (Alaska Native Epidemiology Center 2009). In Canada, the Inuit rate is 3 times higher than Canadians nationally (Inuit Tapiriit Kanatami 2010).

Circumpolar populations, similar to populations elsewhere, have undergone a health transition (Young and Bjerregaard 2008). Until the middle of the twentieth century, infectious diseases were major causes of death. Since then, mortality rates have decreased markedly, although the overall burden of infectious diseases in the Arctic remains high, and higher than in southern populations. There are also infections that are prevalent in the Arctic because of its physical environment and socioeconomic conditions (Parkinson et al. 2008). Tuberculosis is a good indicator condition for highlighting the relationship between the built environment and health. The geographical variation within the Arctic is substantial. The highest incidence rates are reported by Nunavut, Greenland, and some Russian regions (Fig. 15.1).

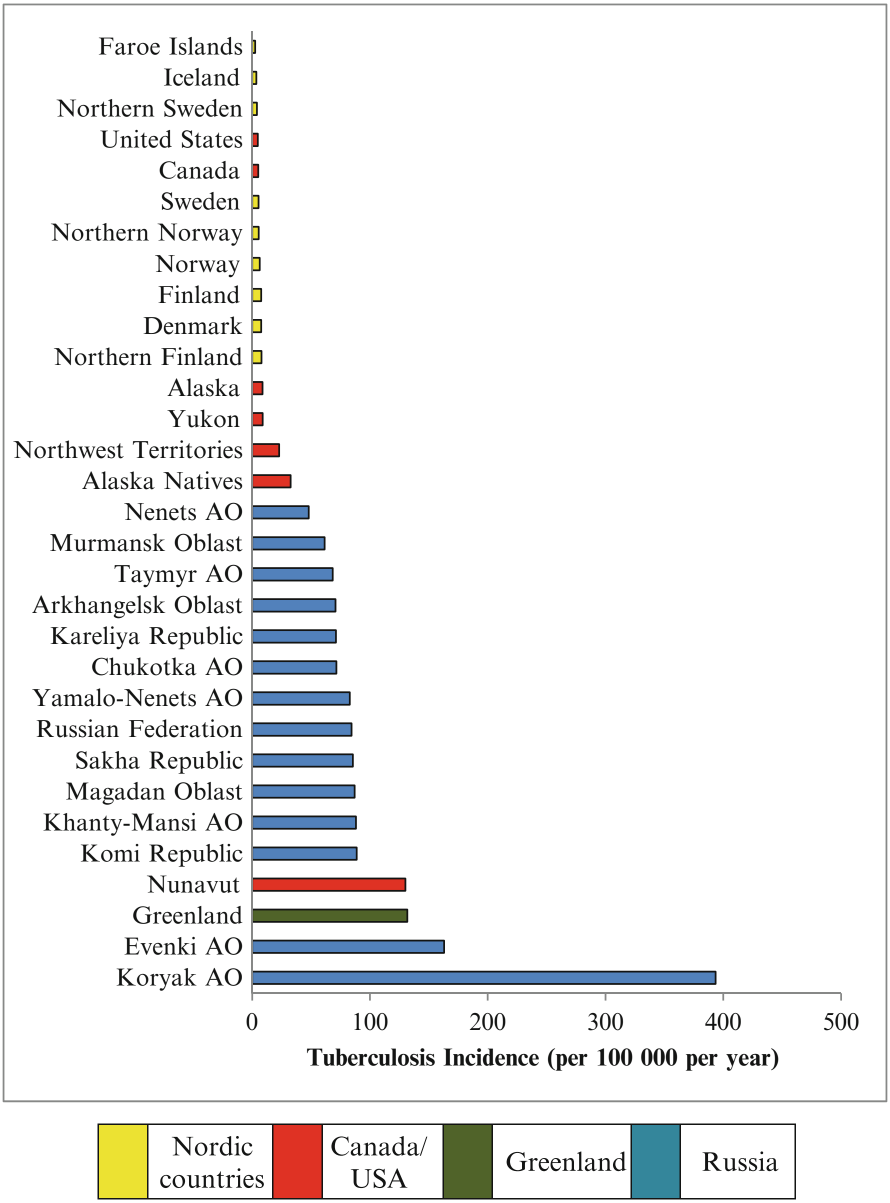

Fig. 15.1 Incidence of tuberculosis in circumpolar countries and regions, 2000–2009, new cases per 100,000 per year (Source: Circumpolar Health Observatory)

The rapid transitions in dietary practices and activities of daily living have contributed to the emergence of chronic diseases such as cancer, cardiovascular diseases, and diabetes (Bjerregaard et al. 2004). These new health threats have eclipsed infectious diseases in recent years. Cancer is not a single disease, but a cluster of diseases affecting different body tissues, with different causes or risk factors, all having in common the uncontrolled growth and spread of abnormal cells. When grouped together, there is also variation in cancer incidence across the Arctic, with Nunavut and Greenland reporting the highest rates. This reflects their predominantly Inuit population, among whom cancer has steadily increased over the past decades, especially in cancer of the lung (Circumpolar Inuit Cancer Review Working Group 2008).

Among the most serious health problems affecting northern peoples in recent decades are injuries sustained as a result of accidents and violence, whether intentional or unintentional, self-inflicted or inflicted by others. Mortality from injuries is highest among Russian regions. In Alaska and Northern Canada, the rate is 2–3 times their respective national rates. Greenland's rate is more than 4 times that of Denmark. In northern Fennoscandia, the rates are little different from the respective national rates. In all jurisdictions, injury mortality is higher among men than women. In both Alaska and northern Canada, the rates among the indigenous population is higher than the non-indigenous population. Suicide is a particularly serious problem among the Inuit in Greenland and Nunavut, and Alaska Natives (Fig. 15.2). For every completed suicide, there are many more suicide attempts, and for every sui-

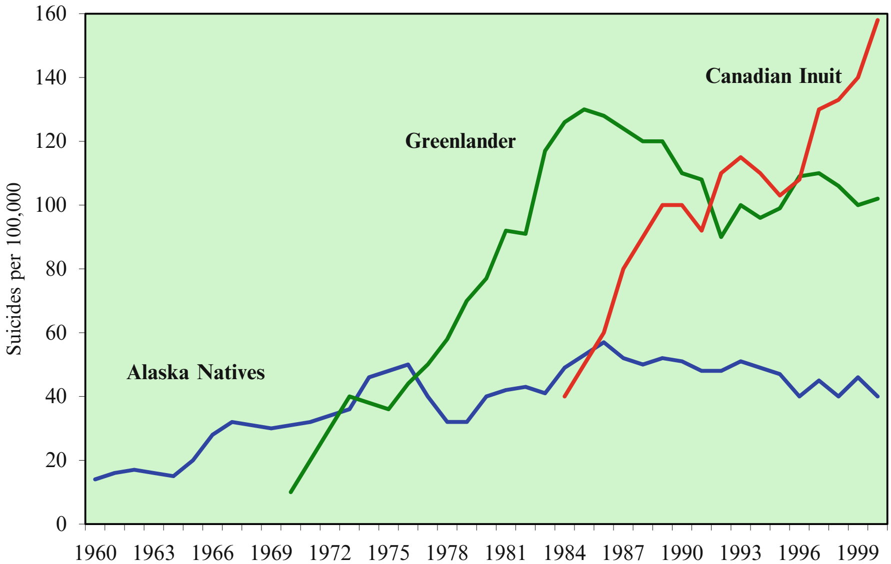

Fig. 15.2 Evolution of the suicide epidemics in three Arctic Indigenous populations (Source: Data from Jack Hicks, reproduced from *Hope and Resilience Report*)

cide attempt there are numerous people harbouring suicidal thoughts. Studies such as the The Survey on Living Conditions in the Arctic (SLiCA) among indigenous people in several regions provides some measure of the extent of suicidal ideation (in the past year and over the lifetime) and also the people's perception of suicide as a community problem (Government of Greenland 2010).

As the communities are recovering from profound social and cultural changes that have been influenced by national assimilation policies, manifestation of mental health issues is very prevalent, yet statistics that capture the true impact are not readily available, due to challenges in measurement and access to services. Higher rates of alcohol use provide an indication of non-optimal adaptive behaviour to underlying mental health challenges.

15.3 Health Determinants

It is well recognized in many populations that different factors, or determinants, contribute to the health status differences that we observe. These could broadly be categorized as human biology (genetics, adaptation to cold), the physical environment (e.g. climate, water supply, sanitation, housing, pollution), lifestyles and behaviours (smoking, diet, physical activity), and social, cultural and economic factors.

There are two major kinds of environmental health threats. The first result from poor quality of housing, water supply, sanitation and solid waste management. The associated health problems (such as gastrointestinal, respiratory and skin infections) are well recognized, and the solutions already exist. The second type of threat arises from the invisible contamination with man-made chemical substances which are produced far from the Arctic but transported to the region by ocean and atmospheric currents, biomagnified in the marine food chain, and bioaccumulated in humans (Arctic Monitoring and Assessment Programme 2009). Rapid resource developments, especially in the extraction of minerals and oil and gas are currently underway in many Arctic localities. Their adverse impact on the immediate environment, and the social conditions and health of the people need to be monitored and mitigated. The Arctic is also recognized as the sentinel of global warming, and its residents face new health threats including increased land based injuries and food and water insecurity.

A major determinant of health in circumpolar regions is diet, and more broadly food security. For the indigenous people of the Arctic, food obtained from hunting and fishing, or "country food", continue to be a major part of the diet (Kuhnlein et al. 2004). Subsistence and living off the land, besides the immediate nutritional benefits, promotes physical activity and enhances spiritual health. There is variation across the Arctic in the pattern of food consumption. Analyses of traditional foods tend to show that nutritional quality is superior to that of imported or market foods. Imported food is generally rich in saturated fatty acids while the fat of marine mammals and fish are high in polyunsaturated fats. Traditional food does not contain refined sugar and is therefore beneficial also for dental health. The notion that country food is healthy and imported food is unhealthy is an over-simplification. Initiatives to address food security and nutritional status need to include improving access to healthy imported foods in stores (for e.g. through improved shipping and cost containment). Communities need to make informed choices that balance the nutritional benefits of country foods with the health risks associated with contaminants in some species. Continued access to country foods is also dependent on the health of wildlife (mammals, fish and birds) populations that could be affected by climate change.

The association between socioeconomic factors and health has been observed for a long time. A gradient across different socioeconomic classes, no matter how such classes are defined, has been consistently demonstrated for various measures of mortality and morbidity, for individual diseases and for all causes combined. This gradient exists in many countries around the world, and has persisted despite major improvements in the overall health and wealth of the population.

Within circumpolar regions, indigenous people tend to fare worse in their socioeconomic status (SES) than non-indigenous people, especially in Alaska, northern Canada, and Russia. While Alaska and Yukon report better SES than the national averages, the disparities relative to the country as a whole widens as the proportion of indigenous people increases. This situation reflects the in-migration of non-indigenous people seeking employment; those who are no longer employed or retired tend to leave the North.

15.4 Health Systems

In circumpolar regions health systems and their responsiveness plays an important role in promoting wellness and recovery from disease. The health care system in any country comprises the preventive, curative, rehabilitative and long-term care sectors. The boundaries of these sectors are not well demarcated – they overlap with social services, with education, with environment, and with food and agriculture, usually administered by distinct government ministries.

Fundamental differences in the political systems of the Arctic States affect the way health care, indeed most government services and programs, is organized. Canada, the United States, and the Russian Federation are federal states, with division of authority between the national and sub-national levels of government, with some duplication of roles and responsibilities. The Nordic countries are unitary states where there is a national ministry of health with delegated service delivery functions to various regional/local governments. The Faroe Islands and Greenland are both parts of the Kingdom of Denmark but quasi-independent states as far as domestic affairs are concerned. The health departments of Greenland and Faroe Islands are completely separate from Denmark's.

Across circumpolar countries there are a broad array of programs and services of varying quantity and quality that address the full spectrum of health care (Young and Marchildon 2012). Health systems in circumpolar regions have had to be adaptive to the unique environment that includes a large geographical expanse, small scattered populations, severe climate and varying degree of health disparities within the population, especially between indigenous people and other citizens. In this context there have been adaptations to health systems so they may be more responsive to the environment.

The health care system for Alaska Natives pioneered the training and deployment of village-based Community Health Aides and Dental Health Aide Therapists who provide primary care, supported by physicians and dentists based in regional clinics. Nurse practitioners and physician assistants are also used.

In northern Canada nurse practitioners are the backbone of the system. They provide both primary care and public health services in the communities. While supported by visiting physicians, they function quite independently in the health centres. Greenland, which resembles Nunavut demographically and geographically, has a different system of small hospitals in all the main towns staffed by 1–5 general medical officers. However, consolidation into larger health regions has been introduced with the Greenland government's health care reform since 2011.

The Russian health care system developed a middle-level cadre of medical practitioners called *feldschers*; in remote areas, mobile medical teams have served remote reindeer herding brigades. In towns and cities, primary care services are delivered in polyclinics. Under the Russian system, primary care was poorly developed relative to the hospital sector, and over-reliance on specialists rather than general practitioners. Strengthening of primary health care is also a priority of health care reform with mixed results.

All circumpolar health care systems are faced with serving a scattered population separated by large distances. The "glue" that keeps this geographically dispersed and tiered service delivery system has been transportation and telecommunication. Information technology has been much touted as the solution to remote health care delivery, particularly in clinical support of peripheral health units. Examples of applications include transmission of digital imaging, videoconferencing for consultations, internet-based electronic health records, remote control robotic surgery, etc. Bandwidth limitations have proved an obstacle to robust applications in the North, which is less of a problem in Fennoscandia than elsewhere. The increased utlization of such technology could result in improvements to the quality care, decreased transportation costs and reduction in hospitalizations.

15.5 What Is New and What Is Different?

With the complex web of determinants of health and continuing health transition among circumpolar populations, new and innovative health system responses have emerged, especially those created by and intended for Indigenous peoples. These are culturally based programs that are respectful of holistic worldviews and recognize the influence of sectors beyond health care on community and individual wellness. Notable examples of culture based care are Inuit specific community birthing programs pioneered in northern Québec, the Nuka System of Care for Alaska Natives conceived by the Southcentral Foundation in Alaska, and mental health services developed in northern Norway serving Sami (known as SANKS). These improvements occurred in the context of increasing levels of autonomy and Indigenous control over health systems responses and designs.

With Indigenous governments and organizations playing an increased role in wellness initiatives, activities that incorporate traditional knowledge and promote practices that revitalize culture have far reaching effects on health determinants, health outcomes and health systems. Emerging research increasingly utilizes participatory methods and engage elders and youth, who each bring unique perspectives on how to approach health issues in the modern context. In recent years, climate change and its impact on health and wellness have been studied by communities and have provided important contributions to understanding a broad range of challenges such as food security, emergency response and water quality (Climate Telling 2014). These activities have been complemented by partnerships involving university researchers and government policy makers. Such partnerships have the potential to apply rapidly research evidence into program design that is relevant and appropriate for Arctic communities (Brubaker et al. 2013).

Circumpolar populations are undergoing rapid social and environmental changes that are reflected in their evolving patterns of health status and health determinants. While there are many struggles inherent in the health systems responses to such changes, therein also lies may innovations through revitalization of cultural practices and adaptations to modern applications of new technologies to improve access and quality of health and wellness. These holistic approaches promote multisector approaches to health that incorporate education, environmental quality, and economic development, to name a few. These adaptations provide a basis for best practices that could have applications in other global context, especially when the Arctic is the sentinel for impacts of global phenomena such as climate change (Chatwood et al. 2012).

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Chapter 16
Food Security or Food Sovereignty: What Is the Main Issue in the Arctic?

Lena Maria Nilsson and Birgitta Evengård

Abstract Food security and food sovereignty have been highlighted as priority issues in the Arctic, since climate change and industrial processes likely will have a severe effect on living conditions in the north in the near future. Food security can be defined as situations where people have both physical and economic access to food that meets their dietary needs as well as their food preferences. Food sovereignty describes situations when local peoples are in control of the processes leading to food security. Of 12 previously suggested measurements of food security indicators for the Arctic, three were related to food sovereignty. In this chapter we discuss the concepts of food security and food sovereignty, and their interrelations and relevance from an Arctic perspective.

Keywords Food security • Food sovereignty • Arctic • Climate change • Sustainability

Abbreviations

AMAP	Arctic Monitoring and Assessment Programme within the Arctic Council
BMI	Body mass index
FAO	Food and Agriculture Organization
HFSSM	Household Food Security Module
SD	Standard deviation
SLiCA	Survey of Living Conditions in the Arctic

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http://faostat3.fao.org/faostat-gateway/go/to/download/FB/BL/E

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16.1 Introduction

Worldwide food security is considered a major social determinant of health, and recently it has also been highlighted as a priority issue in the Arctic (Nilsson et al. 2013a). This is due to an increasing awareness that climate change will substantially affect living conditions in the circumpolar area to a much greater extent than anywhere else on earth. For example in the Yukon Territory, in Northern Canada, one of the most rapidly warming regions on earth; the melting of permafrost there is causing drainage of lakes that have been of substantial importance since time immemorial for food supply and local indigenous culture (Mecredi 2010). Decreased opportunities for fishing and hunting mean increased dependency on imported food, and thus increased vulnerability to fluctuations in food prices and changes in transportation systems. The example of the Yukon also illustrates the special attention needed for indigenous or aboriginal food security (Council of Canadian Academies 2014; Nilsson et al. 2013b), as well as food sovereignty (Council of Canadian Academies 2014). The aim of this chapter is to briefly describe the general state of knowledge about food security in the Arctic, and to discuss the concepts of food security and food sovereignty and their interrelations and relevance from an Arctic perspective.

16.1.1 Food Security

According to the present Food and Agriculture Organization (FAO) definition, food security exists "*when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (FAO 2014). In other words, food security is a matter of food availability, accessibility, safety, adequacy and acceptability, regardless of how these different aspects are handled. Using our previous example in Northern Canada, where the availability of traditional local food is threatened, community food programs–including soup kitchens and food banks–are indispensable for many families (Ford et al. 2012). Similar food supply systems have been described in Alaska (Gerlach and Loring 2013). Food security is thus achieved through external community action. Food security can also be achieved within the global commercial system through trade, which–as with community action–entails a certain vulnerability. Table 16.1 illustrates this by showing national food production for 2011 as a proportion of national domestic supply (that is, national needs) in the Arctic Countries. In regard to meat and fish, the national production of most Arctic countries equals or exceeds their national needs. On the other hand, national production of fruits and vegetables is generally much lower than the national needs. One exception is the United States, with only a tiny fraction of the population living in the Arctic region (0.2 %). It is important to stress that for climate reasons, merging data from northern regions with southern may hide important insights in food insecurity.

Table 16.1 National food production as a proportion of national domestic supply in the Arctic Countries, 2011. Proportions are calculated from FAOSTAT data, http://faostat.fao.org/

	Meat (%)	Fish (%)	Vegetables (%)	Fruit (%)
Canada	>100	98	55	17
Denmark	>100	>100	44	15
Finland	96	62	55	4
Iceland	>100	>100	24	0
Norway	95	>100	37	3
Russia	79	>100	82	26
Sweden	68	59	34	3
USA	>100	69	91	75

16.1.2 Food Sovereignty

Food sovereignty has been defined as the ability and the right of people "*to define their own policies and strategies for the sustainable production, distribution and consumption of food that guarantee the right to food for the entire population, on the basis of small and medium-sized production, respecting their own cultures and the diversity of peasant, fishing and indigenous forms of agricultural production, marketing and management of rural areas, in which women play a fundamental role*" (WFFS 2001). In other words, the concept of food sovereignty can be understood as a way to emphasize the sustainability aspect of food security on a local or regional level. People who are dependent on food on their table should make all decisions regarding the local food system, including production, distribution, preparation and consumption. The challenge is to find ways to support local food systems in a changing natural and political environment–an issue that has been highlighted from many different perspectives and in many different Arctic countries (e.g. Council of Canadian Academies 2014; Lindborg et al. 2009; Ries 2009; Brubaker et al. 2011; Goldhar et al. 2010; Anthony 2013). In this context, community-based research involving local stakeholders is of great importance. For example in Nunavik, Quebec, Canada, the local community is supporting the development of nine greenhouse horticultural micro-projects where families can produce their own vegetables (Avard 2014). Vegetables grown in these greenhouses cannot be considered traditional food in the area, but are locally accepted because of the local community's involvement.

16.2 Data on Food Security and Food Sovereignty in the Arctic

Data on food security and food sovereignty is only available to a limited extent, and neither of these topics has been equally highlighted in the Arctic. In Canada, which has significant economic disparities in the population, and where every eighth household experienced food insecurity in 2011 (Council of Canadian Academies

Table 16.2 Number of publications in a Web search of scientific literature at "Web of Science" on food security (topic) + area (title) and food sovereignty (topic) + area (title) respectively, June 11th 2014

	Food security (N)	Food sovereignty (N)
Canada	52	4
Denmark	2	1
Greenland	1	0
Finland	2	0
Iceland	2	0
Norway	1	0
Russia	20	0
Sweden	3	0
USA	13	0
Alaska	10	0
Arctic	20	0

2014), food security has been on the scientific and political agenda for decades. In Sweden and other Nordic countries, which have fewer economic disparities and no focus on food insecure households in official reporting, the question of internal food security could almost be described as non-existent. Table 16.2 shows the results of a quick Web search of scientific literature at "Web of science" for the topics "food security" and "food sovereignty" respectively and different Arctic countries specified in the title. Most of the references found on the topic "food security" were for Canada, followed by Russia; together, Canada and Russia constituted 87 % of all references. As regards "food sovereignty", few papers were found; one Danish and four Canadian. It is worth noting, however, that this does not mean that food sovereignty has not been covered to a further extent. Upon further inspection, some aspects of food security might actually be labeled as food sovereignty.

16.2.1 International Data Reflecting the World

At FAO's FAOSTAT webpage, where time-series and cross sectional data relating to food and agriculture are available for some 200 countries (http://faostat.fao.org/), 32 food security indicators can be tracked in the period from 1990 to 2013. It is noteworthy that none of these indicators covers the entire time period, and some measures are actually only available for developing countries, as illustrated in Table 16.3. In this table, four indicators previously used to describe food security in Asia and the Pacific (Timmer 2014) were chosen. Selected data from the previous description (Timmer 2014) are shown together with available data for the Arctic countries. As shown, only one of four indicators included Arctic country data. Aggregated data reflecting the Arctic or northernmost regions are missing, which means that comparisons are limited to country specific data only; e.g. an average. To summarize, the main focus of FAO's monitoring program for food security is acute starvation and malnutrition, and it is not adapted for the living situation in the rapidly changing Arctic region.

Table 16.3 Four FAO indicators of food security reflecting the period 2010–2012 in the world, the Arctic countries and Sub-Saharan Africa. Only one of these four indicators, food supply, include data from the Arctic Countries

	Prevalence[a]	Food supply[b]	Food deficit[c]	Food security gap[d]
World	12.5	121	5.1	15.9
Canada	NA	135	NA	NA
Denmark	NA	133	NA	NA
Finland	NA	127	NA	NA
Iceland	NA	133	NA	NA
Norway	NA	136	NA	NA
Russia	NA	128	NA	NA
Sweden	NA	123	NA	NA
USA	NA	145	NA	NA
Sub-Saharan Africa	26.8	109	11.8	−2.8

Source: FAOSTAT
[a]Prevalence of undernourishment
[b]Average dietary energy supply adequacy
[c]Depth of the food deficit in kcal/capita/day as a percent of minimum dietary energy requirement
[d](Supply-100)-Food deficit. When the gap is 0, there is enough food to feed the population, if it is equally delivered in the country/region

16.2.2 International Data Reflecting the Arctic

So far, data related to food security have not been systematically and uniformly collected over the entire circumpolar area, with few exceptions. For example, in the SLiCA (Survey of Living Conditions in the Arctic) joint research project, some questions relating to food security, with a focus on the indigenous population, were indeed included in the research protocol. For various reasons, however, only a few of the partners finally chose to merge their data into the shared micro-data file of the project (SLiCA 2014); consequently, no data from the entire Arctic area has been presented in public so far (Eliassen et al. 2012a, b; Broderstad et al. 2011a, b; Kruse et al. 2009). For example, most data from the Swedish partner is still only available to the Swedish research group. Thus food security data from the SLiCA study has only been presented to a limited extent (Kruse 2007; SLICA 2012).

To overcome this lack of knowledge, a set of 6 indicators (12 measures) of food security were recently proposed to the Arctic Council's Sustainable Development Working Group (SDWG), an intergovernmental forum for Arctic governments and peoples (Nilsson et al. 2013a, b), namely:

1. Average body mass index (BMI, kg/m^2) in the population
2. Proportion of obese persons (BMI >30 in adults, or >+2 SD in children) in the population
3. Self-estimated proportion of traditional food in the diet
4. Proportion of the population eating traditional food the previous day or week
5. Cost of nutritious food basket, as a proportion of disposable household income

6. Proportion of families/households including a hunter/fisher/collector/herder
7. Foodborne diseases: incidence rate in humans
8. Foodborne diseases: Seroprevalence in humans
9. Foodborne diseases: Seroprevalence in subsistence species
10. Food-related contaminants: Chemical contaminants in food
11. Food-related contaminants: Microbiological contaminants in food
12. Food-related contaminants: Chemical contaminants in human tissue

What is noteworthy is that half of the measures are related to food safety (numbers 7–12). Of these, the measures on contaminants in food (numbers 10–12) have previously been elaborated all across the Arctic as part of the Arctic Monitoring and Assessment Programme within the Arctic Council (AMAP), though data from Russia have been reported separately (AMAP 1998, 2003, 2004, 2009) as further described in Chap.19, Environmental health in a changing Arctic. Further, it is worth pointing out that on the proposed list, three of the measures (numbers 3, 4 and 6) are actually relevant to the concept of food sovereignty. As regards other suggested measures, only one of these has been elaborated so far, to the best of our knowledge: the cost of a nutritious food basket as a proportion of disposable household income. Preliminary data suggest that the cost of a nutritious food basket is generally higher in the North compared to the South, with Russia as the only exception (Nilsson et al. 2014). Apart from this, so far no general description of food security in the entire Arctic area is available. Consequently, to determine the state of knowledge about food security and food sovereignty in the Arctic, we must for now settle for local national assemblies.

16.2.3 Regional Data Reflecting the Arctic

As already described, there is a large disparity in national awareness of food security in the Arctic, which also affects the data available. From the Nordic countries no general descriptions exist of all available aspects of food security and food sovereignty in the Arctic region. Some data is available from Greenland (Goldhar et al. 2010), as well as from Alaska (Driscoll et al. 2013), though there is a lack of a general description of the region. Russia and Canada are positive exceptions.

In Russia, the food security situation of the general population of Russian Arctic, Siberia and the Far East has been described according to available Russian official statistics (Dudarev et al. 2013a, b). These reports portray a situation of high relative food costs in combination with insufficient qualitative control of chemical and biological contaminants in food (Dudarev et al. 2013a), as well as a situation of alarmingly high incidence rates of infectious and parasitic food- and waterborne diseases (Dudarev et al. 2013b). The food security measures proposed to the Arctic Council's Sustainable Development Working Group have only been used to a limited extent in the general descriptions from Arctic Russia, and no aspects of food sovereignty are included.

In a thorough description of aboriginal food security in Northern Canada, recently published by the Council of Canadian Academics, food security is measured using a Household Food Security Module (HFSSM) (Council of Canadian Academies 2014), a questionnaire that combines different aspects of food security and focuses on the consumption narrative of the individual/family. The HFSSM was not among the food security measures preliminarily proposed to the Arctic Council's Sustainable Development Working Group, since it was considered a relatively costly indicator in need of further development in order to be applicable to the entire circumpolar region (Nilsson et al. 2013b). HFSSM surveys of Canada show that there are major inequalities between the general Canadian population and the aboriginal population. In total 92 % of all Canadian households – but only 29.7 % of Nunavut Inuit households – are food secure. Furthermore, of the 70.3 % of Nunavut Inuit Households that are food insecure, 35.1 % are considered severely household insecure (Council of Canadian Academies 2014).

In contrast to the description of food security in Russia, food sovereignty is highlighted as an important aspect together with food security in the Canadian report (Council of Canadian Academies 2014). The report concludes that the practice of harvesting native plant and animal wildlife species is of greatest importance for identity and quality of life of the aboriginal population of Canada, and thus "*Support for autonomous community food systems, community-based research, and community-based solutions that respond to locally identified needs emerged as essential steps towards meeting the goal of sustainable and local food self-sufficiency*" (Council of Canadian Academies 2014).

16.3 Discussion

In considering food security as the goal, food sovereignty may be seen as a way of achieving and/or maintaining it. There are no simple answers as to which solutions are the best, especially not in the Arctic area. Unique considerations must be taken into account when studying food security in Arctic populations. This applies in particular when indigenous peoples are in focus. A large spectrum of traditional food systems, contemporary market food systems, and future modern horticulture adapted to a northern climate must be taken into account.

The concept of food sovereignty stresses the importance of autonomous local food systems. In countries with large economic disparities between different regions, ethnicities or social classes, such as Russia and Canada, food security is clearly unevenly distributed among the population. In this situation, food sovereignty could be seen as a way of empowering vulnerable groups. Authorities could claim that they support the development of local food production systems to make peoples in remote areas self-sufficient. But supporting the development of local food systems could also be used as an excuse not to work towards a more equitable economic distribution throughout society. Additionally, from a colonial perspective, natural resources from the North are continuously transferred southward by extraction industries, with major environmental consequences for the availability of traditional food. It could thus be argued that seeing the return of food from southern regions to northern as a natural part of this kind of interdependence would be reasonable. If authorized and managed by local communities, this could also be internalized as a variant of the giving and food sharing practice described in many northern populations.

Similarly, a colonial perspective may also be applied to the food security situation in remote isolated areas such as Greenland and Alaska, compared to the political administrative core areas of Denmark and the eastern United States. It could be argued that if a political entity shares the natural resources of a northern colony, food resources within the political entity should be shared as well, and thus food sovereignty could be applied to the entire political entity rather than smaller local communities.

This is also generally the case in Arctic countries such as Norway, Sweden and Finland that administer a more condensed political area, and which thus could be defined as food secure countries. But, there are also observable differences in the Nordic countries between the south and north as already described (Nilsson et al. 2014). To be precise the relative cost of a nutritious diet is higher in the northernmost parts of the Nordic counties, as well as in all other Arctic countries except Russia.

The main issue regarding food sovereignty is defining the self-sufficient area. In history, a family-based subsistence economy was obviously one possible way of surviving in the circumpolar region. Today, when most items consumed by a household are not available in the immediate surroundings, absolute food sovereignty is not possible. Another complicating factor is contamination of traditional subsistence species. Interviews with elderly Sami, the indigenous peoples of northernmost Fennoscandia and the Kola Peninsula of Russia, demonstrated the importance of fish from rivers and lakes in the traditional Sami diet. Among the Sami of southern Lapland in Sweden, fish dishes used to be served at least once a day, all year round (Nilsson et al. 2011). Today, much of the Arctic fish stock in Sweden exceeds European maximum limits for dioxin and PCB. Because of a permanent exemption from European standards, Swedish fish can still be consumed locally, but eating at most three local fish meals per week is recommended (Livsmedelsverket). As shown in Table 16.1, Sweden and Finland, with a similar environmental situation, are not self-sufficient on fish, while Arctic countries with coastlines towards the less polluted Arctic Ocean are. It has also been hypothesized that indigenous peoples in the North American Arctic may have a larger adaptive capacity for small-scale food production than Russia and the Nordic countries (Nilsson et al. 2013c), where the northerners are more industrialized.

In light of climate and environmental factors, it is doubtful whether the Arctic countries could be completely self-sufficient for food in the future, if defining self-sufficient areas is based on the Arctic as politically defined. It could thus be questioned whether food security could ever be re-established by a process of food sovereignty in the North. Including national frameworks into the concept of food sovereignty, however, would consequently make the process of food sovereignty easier to achieve as a way of reaching long-term stable food security in the Arctic.

16.4 Conclusion

Food sovereignty should always be discussed in relation to food security, from an Arctic perspective as well. A situation of 100 % food sovereignty is an unlikely future scenario in the Arctic, because of decreased availability and the safety of harvesting traditional food. But there are many examples of activities with a potential for increasing food sovereignty of the north, for example community greenhouses. Further, it is worth emphasizing that, in order to be able to follow the process of food sovereignty and discuss its balance in relation to food security, there is an urgent need to start following indicators of food security in the Arctic, including the suggested indicators related to food sovereignty: self-estimated proportion of traditional food in the diet, proportion of the population eating traditional food the previous day or week, and proportion of families/households including a hunter/fisher/collector/herder, as already proposed (Nilsson et al. 2013a).

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Chapter 17
Water Information and Water Security in the Arctic

Arvid Bring, Jerker Jarsjö, and Georgia Destouni

Abstract Water is common to many environmental changes that are currently observed in the Arctic. To manage environmental change, and related water security challenges that are rising in the Arctic, adequate water information and monitoring is critical. Although water information systems have been deteriorating in the Arctic, there are still opportunities to combine existing data to inform policy decisions on how to manage water security. Furthermore, implementing a set of water security indicators can help identify areas of concern within the region. However, accessible climate change information is not always relevant for the scales of policymaking. In addition, improved representation of water on land in climate models is needed to better inform adaptation.

Keywords Hydrological monitoring • Environmental information • Arctic climate change • Water security • Water pollution

17.1 Introduction

The Arctic region is currently undergoing a series of rapid changes. Climate change is perhaps the most recognized of these, but socio-ecological, political and economic factors are also transforming at a rapid pace. These changes present the people residing in the Arctic, and their activities in the region, with a number of challenges.

Water is a central component in many of the environmental changes in the Arctic (Vörösmarty et al. 2001; Bring and Destouni 2014). For instance, the effects of climate change often manifest themselves through changes in the water system. Examples include increasing runoff in Arctic rivers (Peterson et al. 2002, 2006); increasing precipitation (Rawlins et al. 2010), although precipitation increases have generally been smaller than discharge increases (Bring and Destouni 2011), indicating a potential contribution of stored water or permafrost thaw; increasing mass loss of Arctic glaciers, with concurrent increases in both glacier and river runoff

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(Dyurgerov et al. 2010); and changing Arctic lakes (Smith et al. 2005; Karlsson et al. 2012, 2014).

One of the fundamental needs for managing these large-scale environmental changes is adequate and relevant water information. The importance of monitoring and observations, as a fundamental source of information about the state and change of the environment, has also been identified by the International Council of Scientific Unions as one of five "Grand Challenges" for science in the present decade (ICSU 2010; Reid et al. 2010).

Another major challenge for people and livelihoods in the Arctic will be to ensure an adequate and sustainable management and use of water and water resources (White et al. 2007; Evengard et al. 2011). In this chapter, we will highlight the critical role of water information, with a specific focus on water and water security in the Arctic, for managing change. We begin the chapter with defining the scope of the Arctic region in the context of water information and security.

17.2 Definitions

17.2.1 The Arctic

Definitions of the spatial extent of "the Arctic" may vary, depending on the context. In many cases, the 10° July isotherm provides a clear delineation of the relatively severe conditions that characterize the high Arctic. Alternatively, from a strictly geographical perspective, the 60°N latitude, or the Arctic Circle at 67.5°N, are sometimes used to constrain the northern polar region.

From a surface water perspective, however, the natural unit of investigation, and therefore of delineation, is the physical drainage basin. A drainage basin may be defined as the area upstream of a point, or shoreline of a water body (lake or sea), that contributes with surface runoff to that point or shoreline. A natural definition of the Arctic from this hydrological perspective is illustrated in Fig. 17.1, with all land draining to the Arctic Ocean and its adjacent seas, including major rivers.

From the figure, it is clear that a definition starting from the perspective of water resources extends far outside the area considered in the definitions based on climatic or strictly geographical boundaries outlined above. As a corollary, the Arctic, from a surface water perspective, is a very diverse region that comprises physical and socio-ecological environments not commonly seen as typically Arctic.

To collect and use information on water, be it just for a small catchment or a major drainage basin the size of the largest Arctic rivers, governments operate observation systems that monitor various parameters of the water system. These networks of monitoring stations provide information that is critical to water management, including management of water security.

Fig. 17.1 The land area draining to the Arctic Ocean and its adjacent seas. Major rivers are shown in *blue*

17.2.2 Water Security

Although the Arctic is not commonly perceived as a region where access to reliable freshwater would pose any problem to people and users in the region, several studies have highlighted that the particular circumstances in the Arctic in fact give rise to serious water security problems. We will return to these later, but first we briefly discuss the concept of water security.

The term "water security" has increased rapidly in prevalence in the academic literature over the last decade (Cook and Bakker 2012). Initially, it appeared more often in the context of military security, and security of human society, but today it is discussed in a wide range of academic disciplines and policy contexts. The broader use of water security as an integrated aspect of adequate water provisioning for all aspects of society, relating to its various uses across sectors and scales, is in line with our use of the term in this text.

The increasing focus on water security from a linked systems perspective is also in line with a more integrated approach to investigating the impacts of climate change on human society. For instance, initial work on impacts and adaptation by the Intergovernmental Panel on Climate Change (IPCC) had a more restricted approach to water security, and focused largely on direct impacts of increasing temperatures or changed precipitation on yields of various crops (Parry et al. 1990). Such direct biophysical links on the plant level have been relatively well studied in agricultural sciences, not the least in efforts to understand how to improve yields, and it was therefore possible to get a first-order picture of impacts by synthesizing such studies.

In recent years, climate research has changed emphasis to instead focus more on systems effects, in several ways. In terms of biogeophysical systems, research now puts greater emphasis on the landscape *effects* of precipitation changes, as the latter do not translate directly to changes in runoff, soil moisture or other critical components of the land-water system. Examples include studies on linked precipitation-runoff changes, also for the Arctic (Rawlins et al. 2010; Bring and Destouni 2011), and soil moisture changes (Destouni and Verrot 2014). Furthermore, evidence indicates that effects of land-use change and other human modifications of the land-water cycle have a strong influence on the regional partitioning between runoff and evapotranspiration (Destouni et al. 2013), and thus also on water availability in the landscape. These studies have illustrated the importance of explicitly considering the land-water system, and its propagating and transforming effects, when studying how climate change will affect human societies.

Further to these coupled physical changes, policy-oriented climate research has also shifted emphasis from investigating the local impacts of biogeophysical changes on crop yields, whether such studies adequately consider the coupled land-water system or not, to instead focus on the end effects on human societies (Porter et al. 2014). This means that greater importance is placed on identifying the actual food and water security of humans, which implies that the coupled context of food production and consumption must be considered. Food security also naturally incorporates water itself, as a foodstuff in its own right.

17.3 Water Security in an Arctic Context

As noted above, a water security approach has only relatively recently become established as a research framework, and investigations of the particular situation in the Arctic have been relatively limited in number.

White et al. (2007) investigated a number of water security challenges in the Arctic, with an emphasis on indigenous Arctic communities at high latitudes. As in other parts of the world, people tend to settle close to water also in the Arctic, and the hydrological setting of the settlements then determines the resilience of the community. Among other things, White et al. (2007) pointed out that a changing climate will most likely have effects on the permafrost underlying many northern communities. Other research has indicated that permafrost thaw may change flow pathways (Bosson et al. 2013), for example by instigating drainage or creation of thermokarst lakes, depending on stage in the thaw development (Smith et al. 2005; Karlsson et al. 2012, 2014). Such decreased availability of surface water may influence the reliability of water supply for Arctic communities. White et al. (2007) noted that efforts to draw on groundwater resources in the Arctic, in cases of attempting to replace surface water resources, have been met with disappointment, with problems including frozen soil and saline water.

In the White et al. (2007) study, water security was analyzed in conjunction with food security. This coupling between food and water security takes a variety of forms depending on the context. In general, the coupling is closely related to the share of market-based foods consumed – with a larger share of market-based foods, the supply of food itself is mostly disconnected from the local issue of water security. In contrast, water security is impossible to disconnect from the local water supply situation, as transportation of freshwater over large distances is prohibitively difficult and costly. At the same time, the *ability* to purchase foods on the market is likely strongly connected to both local food and water security, as the ability to produce local goods and services in demand in the market is often an important source of income for indigenous communities. These local goods and services then, in turn, likely depend strongly on local water and food security.

The water security context in the Arctic differs markedly with the various types of societies and ecosystems in the basin. In the circumpolar far north, indigenous communities face challenges as those described above. In modern settlements and larger cities, some challenges may be similar, such as ability to secure a sufficient supply of surface water, due to similar physical constraints, whereas others, such as the ability to buy food on the market, and access to infrastructure and transportation, are likely different.

Further south in the basin, the climate is mostly milder, and water availability is, in general, greater, although competition between various sectors is also greater, with a greater intensity of hydropower, agriculture, forestry, mining and industry. Following from this, the absolute levels of pollution from wastewater, transportation and production are greater in southern basins, even though the relative increase in pollution levels for the very pristine areas in the far north may be larger.

Risks related to metal pollution are currently increasing in the Arctic due to intensified mining activities. In addition to Alaskan, Canadian and Russian mining, there are considerable mining booms in the southern regions of the Arctic, for instance with mining of gold, silver, copper and coal in northern Mongolia (Chalov et al. 2012; Thorslund et al. 2012). Over 750 companies are presently involved in Mongolia alone, and a common practice is placer mining, which implies that alluvial deposits are mined in, or near rivers. Metal-rich sediments can then be released back to the rivers, where they can travel considerable distances in suspension. Due to changing ambient conditions in downstream Arctic environments, metals that have been transported with the sediments may dissolve into water and thereby become more bioavailable (Chalov et al. 2014; Thorslund et al. 2012). The large Arctic river Yenisei and the well-known Lake Baikal are both located downstream of northern Mongolia's mining region, and are additionally affected by Russian mining activities. Notably, metals have been shown to accumulate in biota of Lake Baikal, reflecting water quality issues despite the very large volume of the lake.

More generally, communities in regions subject to decreasing surface water availability – due to decreased runoff or water quality – will have to increasingly rely on groundwater resources. This is already a main issue in Central Asia, where an increasing number of people are subject to considerable health risks as they have to use contaminated groundwater as drinking water source when their main river systems dry up (Törnqvist et al. 2011). In the Arctic, groundwater resources are relatively inaccessible due to permafrost, as mentioned earlier, which lowers the water security. Furthermore, permafrost thaw may actually have adverse effects on groundwater quality in Arctic communities, since sewage infiltration may increase into water systems that supply drinking water (Smith et al. 2014).

Atmospheric deposition of hydrocarbons, including persistent organic pollutants (POPs), is considerable in the Arctic due to condensation of POPs that have volatilized from contaminated areas in warmer regions of the world. A main problem with the presence of POPs in the Arctic environment is that they are known to bioaccumulate in local food chains. In particular, in Alaska and northern Scandinavia, POPs have accumulated over time in glaciers and can be released to downstream water recipients as a result of increased glacier melt from global warming (Schindler and Smol 2006). In addition, intensified human activities in the Arctic means that its water resources are under increasing risk of contamination from accidental fuel spills related to snowmobiles, helicopters, military installations, pipelines, and damaged storage tanks.

Climate change poses an additional challenge to Arctic communities and cities. For the small communities, a ready supply of liquid freshwater is today often limited to a few months of the year. Although increased temperatures would allow water to remain liquid for a larger share of the year, other changes imply that water availability may in fact decrease. For instance, temperature increases in other northern regions have been linked to increasing evapotranspiration, in turn contributing to declining water content in the soil. As evident from the map in Fig. 17.2, large portions of the near-coastal Arctic can be considered polar deserts, with annual runoff below 50 mm, and for these regions, a declining water content in the soil would potentially contribute to small rivers and streams completely drying up during dry months.

17.4 The Water Information Challenge

The Arctic is a remote region, and for all Arctic states, a relatively small proportion of their populations live in the region. Despite the remoteness and sparse population, interest in the Arctic has recently increased markedly, with several states and

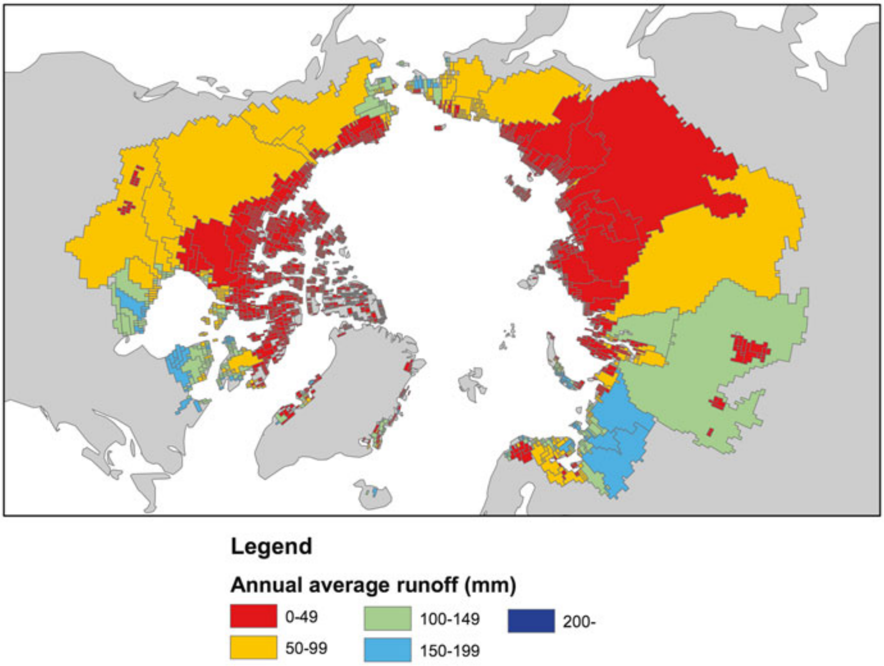

Fig. 17.2 Average annual surface water runoff in Arctic drainage basins (Data compiled from the climate data archive of Willmott and Matsuura (http://climate.geog.udel.edu/~climate/) for the period 1961–1990)

multilateral organizations formulating Arctic policies where none existed before (e.g., Sweden, Finland, and the European Union). Several factors contribute to this development: increasing accessibility due to declining extent of sea ice, increasing importance from a resource perspective, and as a corollary, from a military and political perspective. All these factors fundamentally arise from the effects of climate change in the region, which in turn has also contributed to put the region more in a global research spotlight. This increasing interest also implies a greater need for information, to guide both scientists, communities, industry and policymakers.

Water information is a fundamental requirement for adequate understanding and management of the water security situation, for any given region, country or community. First, information systems should allow continuous observation of the surface water system, so that its functioning and dynamics can be studied and understood. Secondly, continuous monitoring allows detection of any changes to the land water system (i.e., the coupled surface and groundwater system), so that this detection does not become erratic and unsystematic. Thirdly, in order to manage the adaptation to changes, a continuous monitoring allows for following up on any actions taken, evaluating the outcome, and adjusting any applied measures accordingly.

Although the need for information to understand the water system can be perceived as a pure basic science, it is in fact difficult to establish a strict hierarchy between the three uses of water information systems outlined above. To begin with, the understanding of the land water system is important on several levels. As a fundamental component in the surrounding environment, water propagates changes across the landscape, and between different systems in the biosphere, such as the troposphere, the shallow soil zone, rivers, lakes, and oceans. Observations of the land water system help develop the physical, biogeochemical and socioeconomic understanding and modeling that is used to both describe and project processes in the environment.

This knowledge, however, is also required for applied science and to resolve societal challenges, such as allocation of water for various uses, formulation of strategies for adaptation to climate change, and enforcement of environmental legislation. Misjudged perceptions about the functioning of the land water system may lead to policy decisions that are inefficient or even encourage counterproductive measures. For example, the design of engineering works to withstand given return floods may need to be changed with a changing land water system, but without observations, neither the understanding, nor the change detection or evaluation of measures is possible.

Despite the importance of information, the need for observations and observation capacity is often not considered explicitly. A sign of this is that the state of continuously operated monitoring systems that convey information on the status of the water system in the Arctic has deteriorated in recent decades. Several studies have highlighted this unfortunate development (e.g., Lammers et al. 2001; Vörösmarty et al. 2002; Hannerz 2008). Initially, most studies placed an emphasis on water quantity monitoring, but subsequently, other studies have revealed even greater shortcomings in water quality monitoring (e.g. Holmes et al. 2000, 2002; Zhulidov et al. 2003). The first integrated assessment of both water quantity and quality monitoring was presented by Bring and Destouni (2009), who also pointed out some critical areas where improved monitoring is needed.

17.4.1 Synthesizing Water Information and Assessing Water Security

Despite the limitations and fragmentation of monitoring systems, opportunities still exist for extracting useful information to guide policy on water security and climate adaptation. One example is the possibility to jointly analyze information on hydrological and ecological changes in the Arctic. The combination of these two types of information is essential for understanding hydrological controls and drivers on ecological changes, which in turn affect Arctic communities, e.g., through reindeer and caribou grazing areas, subsistence fisheries and availability of surface freshwater.

Karlsson et al. (2011) showed that reports of hydro-ecological regime shifts in the Arctic are extremely fragmented, and centered around major ecological research stations. Few reports of changes in other areas are available. However, that analysis also showed the opportunity for some of the areas, in particular where observed regime shifts coincide with good hydrological monitoring capacity, to contribute to a greater understanding of coupled hydro-ecological changes.

Other approaches deal even more directly with assessing the issue of water security in the Arctic. To handle the information challenge for remote Arctic communities, Alessa et al. (2008) proposed a measure termed the Arctic Water Resources Vulnerability Index (AWRVI). The AWRVI was developed through an iterative expert judgment process termed Delphi, in which representatives of various areas of expertise evaluated information needs and data requirements to arrive at a combined index. The AWRVI was constructed out of a perceived need to adapt other available global or regional indexes into a compound measure of both biogeophysical and socio-ecological vulnerability particularly adapted to remote communities in the Arctic.

The need for better information and monitoring in the Arctic was also noted by Evengard et al. (2011), who particularly indicated potential health risks to people in the Arctic due to lacking capacity of water infrastructure and management. A call for a set of indicators that would allow this information to be synthesized and easily accessible was put forth in Nilsson et al. (2013). That study also noted that while a systems perspective is needed for integrated understanding of threats to water security in the Arctic, establishing and using quantitative indicators of specific system components that are already feasible is a more rapid way of reaching an acceptable basic information situation.

The shortcomings in monitoring systems require that these information gaps and uncertainties be considered in policymaking. To this end, Azcárate et al. (2013) suggested an approach specific to the implementation of strategic environmental assessments in the Arctic.

There is some sign that the importance of information for informing policy in the Arctic is beginning to be appreciated more. The Sustaining Arctic Observation Networks (SAON) process, under the umbrella of the Arctic Council, aims to facilitate partnerships and synergies to make Arctic data more accessible. Although SAON is now operational, and recurring Arctic Observing Summits have been held to foster discussions and information sharing, the influence of SAON on the development of water information infrastructure in the Arctic is still uncertain.

17.4.2 Water Information and Climate Change Adaptation

In addition to the fundamental uses of water information outlined previously, water information must today also adequately consider climate change. Although the Arctic region is much in focus in climate research in general, less emphasis is put on the role of water on land, and how this will change. In fact, large-scale climate modeling has generally considered water on land of secondary importance, with greater emphasis given to accurate reproduction of major water flows between the atmosphere and the oceans. Although this emphasis is motivated for achieving principal stability and accuracy in the models representing the large-scale climate system, the question of water on land, and not just over land, is of key concern in adaptation of human society to climate change.

Until recently, developers of the large-scale models that aim to reproduce the global climate system have stressed that their output should not be considered predictions of the future. Instead, scenarios provide potential future states of the atmosphere, conditioned on certain circumstances being realized. More recently, however, interest has grown in also attempting to predict climate on time scales of high relevance to policymakers, such as decadal time frames (Trenberth 2010).

Irrespective of the intended uses of climate models, their output is bound to be used in policy-prescriptive settings, and is already being used in that way (Kundzewicz and Stakhiv 2010). The reason is simply that there is no better alternative for many parts of the world, and for many end users, as output from global climate models is provided freely online, whereas dedicated downscaling to a particular region may only be available to organizations and in regions with greater resources.

Furthermore, the downscaled modeling that provides finer-resolved and potentially more accurate climate change information for a specific region still depends on the accuracy of the reproduction of the land water system in the global-scale models. Previous studies have indicated limits to this accuracy for several model generations and regions of the world (Asokan and Destouni 2014; Bring and Destouni 2014; Jarsjö et al. 2012).

For example, Bring and Destouni (2013) showed that an environmental planner in the Arctic may have limited use of the scenarios and models that underlie the IPCC's Fourth Assessment Report in planning for where to prioritize efforts to adapt to or prepare for climate change. That study presented the degree to which recent observations of climate change, in the form of deviations from the long-term mean, aligned with climate model projections of future change. The focus of the study was to establish the degree of regional coherence, that is, the degree to which observations and models agreed on which basins that, in relative terms, were the sites of greatest impact from climate change.

The results showed that there was no agreement at all between observations and projections of where temperature change was occurring or would occur across the studied basins. For precipitation, the relation between observations and projections was even negative, so that basins with the greatest recorded positive deviation (increase) in precipitation were projected to be the basins with the smallest increases in precipitation in the future. In addition, for precipitation, the signs of the changes were also not in agreement, so that in some cases large observed decreases in precipitation were projected to turn to increases at some time in the future.

This disagreement between observations and future projections poses a challenge to planning for where resources are best spent, and several choices may be considered rational. One strategy could be to prioritize resources to the regions where observed changes are the greatest, as these are irrefutable, measured changes that have concrete impacts. Another would be to instead prepare plans based on best knowledge of future changes. A reconciliation of these two strategies is presently not possible, and in the absence of such a strategy, other information goals may need to be formulated to guide adaptation to changing water availability in the Arctic.

Another recent analysis has investigated whether models that tend to reproduce temperature observations in the Arctic are also good at reproducing precipitation observations, and vice versa (Bring and Destouni 2014). Again, for the models underlying the IPCC Fourth Assessment Report, this is not the case. This leads to difficulty in selecting a single or a few best models, something that is often done due to computational limitations, where more detailed regional climate modeling is performed using a downscaled model. A priority to best reproduce the thermodynamic system may for instance lead to selection of the best-performing model in terms of temperature simulations, which then tends to be a worse model in simulating precipitation patterns.

Furthermore, the analysis shows that models may still provide reasonable results on drainage basin scales, but for the wrong reasons. In the study, models with large absolute deviations from observed values for individual cells in some cases showed relatively small bias errors; a measure of the magnitude of averaged errors. Even though the results may appear accurate for the basin, the underlying process representation is in these cases not accurate, and should reflect a lower confidence in those models.

17.5 Conclusions

The environmental changes already taking place in the Arctic are likely to lead to dramatic changes in living conditions for its inhabitants. Along the coastlines, settlements will experience changes from multiple directions. Shore erosion, storms and rising sea levels will pressure communities from the sea, while rising temperatures, degrading permafrost and changes in surface water availability will constitute pressures on land. Further inland and south, permafrost decay and increasing economic interest in the Arctic will affect human societies.

Changes to Arctic communities in terms of water security are both positive and negative, but in all cases they present people in the Arctic with a challenge to properly manage the change. With environmental conditions moving outside the previous envelope, governance must be adaptive to change and monitor environmental parameters in order to detect and understand changes.

Water information challenges are not essentially unique to the Arctic, but the sparse population, remoteness, and increasing rate of change, as well as economic interest in the Arctic make the situation special. Although water information accessibility may improve with a successful continuation of the SAON process, there will be a continued need to use the windows of opportunity that are presented by higher information density for certain parts of the Arctic to inform understanding about wider Arctic change. A more solid prioritization basis for water monitoring networks is also needed under the dual challenges of cost efficiency and a changing background climate, as indicated by Bring and Destouni (2013).

Water security changes in the Arctic are also partly driven by other processes than those giving rise to water security issues elsewhere. Improved climate model information on the land water system will be essential to plan for adaptation to changing permafrost conditions, which in turn lead to hydrological changes, e.g., in runoff patterns and soil moisture. In this regard, further investigation and development of the land water system representation in global and regional climate models is a priority, and should complement the focus on large-scale atmosphere-ocean interactions.

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Chapter 18
Infectious Disease in the Arctic: A Panorama in Transition

Alan Parkinson, Anders Koch, and Birgitta Evengård

Abstract Many interconnected factors are responsible for the continuing and growing importance of infectious diseases in the Arctic. Many of these factors not only contribute to the risk of infectious diseases but also are broad determinants of the populations overall health. In the last part of the nineteenth and first part of the twentieth centuries, infectious diseases were major causes of mortality in Arctic communities. However the health of indigenous peoples of the circumpolar region has improved over the last 50 years. Despite these improvements, rates of viral hepatitis, tuberculosis, respiratory tract infections, invasive bacterial infections, sexually transmitted diseases, infections caused by *Helicobacter pylori*, and certain zoonotic and parasitic infections are higher in the Arctic indigenous peoples when compared to their respective national population rates. More recently the climate and ecosystem driven emergence of climate sensitive infectious diseases and disease patterns in the Arctic region presents an emerging challenge to those living in the Arctic. As in other parts of the world, a key component of prevention and control of infectious diseases is surveillance. The use of circumpolar health networks, together with effective coordinated surveillance can facilitate timely control of infectious disease outbreaks, inform public health officials' decisions on resource allocation, provide data to adjust prevention and control strategies to maximize their effects, and inform future research needs.

Keywords Arctic • Circumpolar health • Infectious diseases • Indigenous peoples • Climate change

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18.1 The Arctic Environment and Populations

The Arctic is home to four million people of whom almost half reside in northern part of the Russian Federation. People in the Arctic live in social and physical environments that differ from their more southern dwelling counterparts. Approximately 400,000 (10 %) of persons are of indigenous ancestry, half of whom live in the northern part of the Russian Federation (Arctic Human Development Report 2004; Parkinson et al. 2008).

The indigenous populations of northern Canada, Alaska, Greenland and the northern Russian Federation generally reside in remote isolated communities consisting of 150 to several thousand inhabitants. In some regions the only access to communities is by small aircraft or boat in summer and by small aircraft and snow machine in winter. Indigenous peoples of Scandinavia live in the northern parts of Norway, Sweden, and Finland, but their life styles are more similar to those of the populations of the southern parts of Scandinavia. Arctic communities on a whole, once isolated, are now very much a part of the global village we all live in and are as vulnerable to health threats as any other community on the globe. Through their unique relationship with nature, many of these peoples are more vulnerable for health threats generated by climate change.

These communities often have little economic opportunities and are still largely dependent on subsistence harvesting of wildlife resources from terrestrial, fresh water and marine ecosystems for a significant proportion of their diet. Food security is often dependent on subsistence wildlife migration patterns, predictable weather, and some method of food storage. In these remote regions access to public health and acute care systems is often marginal and poorly supported.

The disease pattern described in this chapter mainly describes that of the indigenous populations of northern Canada, Alaska, and Greenland, both as this pattern is quite different from those of their more southern neighbours, and as of the northern populations most is known about these groups.

18.2 The Panorama of Infectious Diseases

Many interconnected factors are responsible for the continuing and growing importance of infectious diseases in the Arctic: changes in the size and composition of the population (overcrowding, migration, from rural communities to urban centers); changes in personal behaviors (increased travel, substance abuse, and risky sexual behavior) health care practices (increasing use of antibiotics) and changes in the physical environment (contamination of subsistence foods, climate change and greater human contact with altered wildlife habitats). Many of these factors not only contribute to the risk of infectious diseases but also are broad determinants of the populations overall health.

In the last part of the nineteenth and first part of the twentieth centuries, infectious diseases were major causes of mortality in Arctic communities. The small geographically isolated communities provided some protection, but when a new pathogen was introduced epidemics frequently followed. In Alaska outbreaks of influenza and influenza like-illness were frequent in the nineteenth century often occurring with European or American whalers and merchant ships during the summer months (Fortuine 1989). The "great sickness" epidemic of the 1900, a combined measles and influenza outbreak, resulted in the death of one quarter of Alaska's Eskimo population but barely affected the non-native population. In October of 1918 the Spanish flu was introduced to Nome Alaska by ship from Seattle, Washington. Some smaller surrounding villages (Brevig Mission) lost 85 % of their population within 5 days (Reid et al. 1999). In 1925 more than half of all deaths in Greenland were caused by acute infectious disease and tuberculosis. Similarly in 1934 in Alaska the annual death rate for tuberculosis among Alaska Natives was 655 cases per 100,000 persons, compared to 56 per 100,000 for non native persons (Fortuine 2005).

In Canada a major measles epidemic reached Baffin Island in 1952 and the Ungava peninsular in northern Quebec following Inuit visitors to the armed forces base at Goose Bay Labrador, infecting 99 % and killing between 2 and 7 % of these remote populations (Peart and Nagler 1952). The first cases of measles did not appear in Greenland until 1945 but occurred as a result of increasing plane travel to Greenland whereby infected persons could reach the country while still infectious. Complications included pneumonia, otitis media, and meningitis. In 1955 the incidence of tuberculosis in Greenland reached 2,300 cases per 100,000 persons, and similar figures were seen in native populations of Alaska and Canada. It was during this era that large scale population based intervention programs were mobilized to combat tuberculosis and these programs began laying the foundation of the modern public health system in these regions (Fortuine 2005; Wherret 1945; Stein 1994).

The health of indigenous peoples of the circumpolar region has improved over the last 50 years or so. Much of this improvement can be attributed not only to the implementation of prevention and treatment activities that have resulted in reductions in morbidity and mortality from infectious diseases, such as tuberculosis, and the vaccine preventable diseases of childhood, but also to the provision of safe water supplies, better housing conditions and sewage disposal in many communities.

However despite these improvements, rates of viral hepatitis, tuberculosis, respiratory tract infections, invasive bacterial infections, sexually transmitted diseases, infections caused by *Helicobacter pylori*, and certain zoonotic and parasitic infections are higher in the Arctic indigenous populations of the circumpolar north when compared to their respective national population rates (Koch et al. 2008).

The high rates of tuberculosis in Aboriginal populations in Alaska, Canada, and Greenland in the early to mid-1900s are well-documented (Fortuine 2005; Wherret 1945; Stein 1994). However since that time improved screening and continued maintenance of robust surveillance systems, have resulted in decreasing rates of tuberculosis in Alaska, Canada and Greenland (Funk 2003; Njoo 2000; Søborg et al. 2001; Skifte 2003; Thomsen et al. 2003; Birch, et al. 2014).

However outbreaks continue to occur with one likely explanation being reactivation of latent tuberculosis infection often masked as other respiratory ailments common in the population (Funk 2003) and fueled by persistently poor living conditions (Clark et al. 2002; Nguyen et al. 2003). Recent rates of disease reported in Alaska increased from 8.9/100,000 population in 2005 to 10.4/100,000 in 2006 (Centers for Disease Control and Prevention 2007). In Canada, the overall rate of tuberculosis in 2002 was 5.2/100,000 population, however regional variations vary, rates ranged from less than 1/100,000 population in Nova Scotia to 93.4/100,000 population in Nunavut (Public Health Agency of Canada 2005). Multi Drug Resistant-tuberculosis occurs rarely in these regions and is found most frequently in immigrant populations in Canada and the U.S., however, there is concern that it will spread to the general population including the Aboriginal populations which are most affected by tuberculosis (Centers for Disease Control 2007; Moniruzzaman et al. 2006; Public Health Agency of Canada 2004).

In 1954 Greenland increased biannual screening, introduced mass BCG vaccination of Neonates, established tuberculosis sanatoriums and sent patients to Denmark for treatment. Efforts resulted in a dramatic decline in rate of tuberculosis comparable to other western countries and was lowest in 1985 (25/100,000 population). Following this success tuberculosis interventions were phased out. And by 1997, the incidence of tuberculosis had doubled. Following two fatal cases of TB meningitis in children BCG vaccination was resumed and a national intervention program was launched in 2000 (Søborg et al. 2001; Skifte 2003; Thomsen et al. 2003). The incidence has steadily increased since then to reach a maximum of 205 cases per 100,000 in 2010 with 14 % of 10th grade school children TB infected, figures similar to those of Nigeria, Myanmar and DR Congo. (Yearly Report 2012 Office of the Chief Medical Officer of Greenland).

Persistently high tuberculosis rates continue in northern populations and are partly due to risk factors such as persistent poverty and crowded living conditions as well as reactivation of latent tuberculosis, often miss-diagnosed as other respiratory ailments in these populations. Improved screening and the development and continued maintenance of robust surveillance systems are essential to control tuberculosis. A new blood test (the gamma interferon assay) for the detection of latent infections may improve diagnosis in these regions.

All five types of viral hepatitis (A, B, C, D, and E) have been found in Arctic regions. In most Arctic regions, HAV has become rare due to successful vaccination programs coupled with improved water and sanitation. Routine HBV vaccination has dramatically reduced HBV rates in several regions, such as Alaska, Canada, and the Russian Federation. Greenland is considered a high endemic region where horizontal HBV transmission remains. A particular HBV subgenotype B6 has recently been identified in the Eastern Arctic (Sakamoto et al. 2007). However, after implementing routine HBV vaccination in 2010, the possibly changing HBV epidemiology in Greenland deserves further evaluation. High prevalence's of HCV continue to be seen in some urban parts of the Arctic region and are linked to recent increases in drug use, mainly among the young population. The outcome of HCV disease is worsened by alcohol abuse. HDV and HEV are not reportable in the Arctic region.

HDV has been reported as a major contributing factor in liver cirrhosis in the Russian Federation. In Greenland, HBV/HDV co-infection, resulting in severe disease, is a concern; it is hoped that the recent introduction of universal HBV vaccination will improve this situation. Possibly due to infrequent testing, only a few cases of HEV (mainly imported) have been recorded across the Arctic Region (Langer et al. 1997; McMahon and Blystad 2013; Fitzsimmons et al. 2013).

Upper and lower respiratory tract infections cover a wide spectrum of infections from common colds to severe life threatening influenza and pneumonia and are common cause for hospitalization. Alaska Native and American Indian people living in Alaska have an average of three- to fourfold higher mortality rates due to pneumonia and influenza than non-Alaska Native persons (Groom et al. 2009). Alaska Native people remain at high risk for early and substantial morbidity from pandemic influenza episodes (Wenger et al. 2011). During the 2009 pandemic influenza A (H1N1) epidemic, in rural regions of Alaska, disease occurred earlier, than other regions, and Alaska Native people were two to four times more likely to be hospitalized than non-Natives. Although reasons are not fully understood, increased household crowding, especially during dry cold fall and winter, lack of running water for handwashing, may facilitate transmission of respiratory pathogens, and greater remoteness, distance between population centers and health care facilities may delay care and result in increased mortality. Other Arctic indigenous populations including the Canadian First Nations people appear to have increased rates of 2009 H1N1 (Kumar et al. 2009; Charania and Tsuji 2011).

Alaska Native and Canada Inuit infants experience one of the highest reported hospitalization rates for lower respiratory tract infections globally (Singleton et al. 2010; Banerji et al. 2013). The incidence and prevalence of childhood respiratory tract infection in Greenland exceeds rates found in many developing countries (Koch et al. 2002). Few studies have been undertaken to determine the microbiologic causes of respiratory tract infections. Although a number of viral agents have been found in hospitalized Alaska Native and Canadian Inuit children with lower respiratory tract infections, Respiratory Syncytial Virus (RSV) appears to be the leading cause of hospitalization and long term sequelae in young children. However in a recent study in western Alaska, human metapneumovirus and parainfluenzavirus type 1 were also common and were associated with more severe illness (Singleton et al. 2010). Again these infections are commonly associated with environmental factors such as household crowding and lack of running water and result in a significant morbidity, chronic sequelae including bronchiectasis and high cost of hospitalization (Banerji et al. 2013).

Indigenous populations of the Arctic are at particular risk for several invasive bacterial diseases. *Streptococcus pneumoniae* is a leading cause of pneumonia, bacteremia, sepsis, and meningitis in these populations. In the US Arctic and northern Canada the rate of invasive pneumococcal disease among indigenous persons is four times that of non-indigenous persons (Bruce et al. 2008; Degani et al. 2008). While there are more than 90 different serotypes of *Streptococcus pneumoniae* it has been estimated that more than 80 % of pneumococcal disease occurring in the US Arctic, northern Canada, and Greenland are potentially preventable through the use of the

23-valent polysaccharide vaccine in adults and the 13-valent conjugate vaccine in children less than 5 years of age providing the rationale for implementation of vaccine programs in most Arctic countries. *Haemophilus influenzae* can cause meningitis, bacteremia, respiratory tract infections otitis media, sinusitis, epiglottis, pneumonia and septic arthritis. Among the six serotypes (a–f), *Haemophilus influenzae* type b (Hib) was the most common cause of childhood meningitis prior to the introduction of the *Haemophilus influenza*e type b vaccine in the early 1990s. Prior to 1991, rates of invasive Hib disease in Alaska Natives were the highest in the world with rates >300 cases per 100,000 in those under 5 years of age, four times the non-Native rate in Alaska. Since the introduction of the Hib conjugate vaccine programs in 1991 the rates of invasive Hib disease has declined by 98 %. Universal vaccine programs in Canada began in 1992 and in Greenland in 1997 and have had a similar impact (Bruce et al. 2008; Degani et al. 2008; Meyer et al. 2008). As a result most invasive *Haemophilus influenzae* disease in the north is now caused by non Hib strains and in Alaska and Canada in particular Hia has emerged as an important cause of this disease. Continued surveillance of invasive disease caused by all serotypes of *Haemophilus influenzae* is needed to monitor the continued success of Hib vaccination and the continuing emergence of Hia and other serotypes in these populations (Bruce et al. 2013).

Another cause of meningitis in Arctic Regions is *Neisseria meningitidis*. While sharp epidemics occur sporadically, the incidence of meningococcal disease in Alaska, northern Canada and Greenland has remained stable at 1–2 cases per 100,000 per year with children under 5, and young adults having the highest risk. The majority of disease is caused by serogroups B and C. Multi-valent vaccines containing groups A, C, Y and W-135 are available, and a new conjugate group B vaccine licensed for use in Europe is under evaluation for use in other countries (Zulz et al. 2014).

Illnesses caused by group A Streptococcus range from upper respiratory infections, skin infections, or occasionally more severe and life threatening diseases such as necrotizing fasciitis and toxic shock syndrome. Between 2000 and 2010, 488 cases were reported from northern Canada and the US Arctic, with an 11 % case fatality rate. Highest rates occurred in children <2 and those over 65 years of age. Two cases were reported from Greenland, and 54 cases from northern Sweden (Zulz et al. 2014). There is no vaccine to prevent group A infections. Control depends on case detection and antibiotic therapy and prophylaxis in close contacts to prevent further spread.

Group B Streptococcus can also cause a range of diseases, such as bacteremia, sepsis, pneumonia, meningitis, and various conditions associated with pregnancy. Between 2000 and 2010 346 cases were reported from the US Arctic and northern Canada, with an overall fatality rate of 10 %. Bacteremia was the most common clinical presentation. The highest rate occurred in children <2 (Zulz et al. 2014).

Of the sexually transmitted diseases gonorrhea and chlamydial infections are the most common in Arctic populations, highly transmissible, and if untreated can lead to significant morbidity, especially in women (pelvic inflammatory disease, ectopic pregnancy and infertility). In Greenland, following systematic intervention consisting of contact tracing and treatment, rates of gonorrhea have declined from a high of 20,700 per 100,000 persons in the late 1970s to about 1,100 per 100,000 in 2004. Rates are still 100 times rates in Denmark, and remain the highest in Arctic regions (Gesink-Law et al. 2008). In 1973 Alaska rates of gonorrhea were 913 cases per 100,000 persons. In 2008 the overall rate had declined to 85 cases per 100,000, however rates in Alaska Native persons remain higher at 300 cases per 100,000 (State of Alaska 2009). In 2010 overall rates were 179 cases/100,000. Infection rates were highest among AI/AN females and males (915 and 588 cases per 100,000 persons, respectively) (State of Alaska 2011). In northern Canada in 2006 rates of gonorrhea were 281 cases per 100,000, and in northern Quebec the incidence rate of Gonorrhea was 1,000 cases per 100,000, almost ten times the National rate (Gesink-Law et al. 2008).

Similarly chlamydial infections continue to be a challenge for public health in Arctic regions. In Greenland chlamydia infections became notifiable in 1995. Since then the incidence has doubled to 3,400 per 100,000 between 2000 and 2004, ten times the rate in Denmark (Gesink-Law et al. 2008). In Alaska rates have steadily increased since the mid-1990s from 307 in 1998 and exceed 660 per 100,000 in 2005. Rates in Alaska Natives are considerably higher. In 2012 rates were 749 cases per 100,000, with rates of 3267 and 1132 cases per 100,000 in Alaska Native females and males respectively. Continuing interventions include increased community and provider awareness through educational outreach efforts, disease intervention services, and expedited partner therapy (State of Alaska 2013). In northern Canada rates of chlamydial infection were 1,922 cases per 100,000 ten times the National rate (Gesink-Law et al. 2008). A critical component of controlling STD epidemics involves promptly locating, notifying and treating all sex partners with antimicrobials. This has been a challenge for public health providers, especially in geographic areas where partner services are not available or when patients are unwilling or unable to participate.

While much of the improvement in the health of indigenous peoples of the circumpolar region can be attributed to the advent and liberal use of antimicrobial agents that have resulted in reductions in morbidity and mortality from infectious diseases, overuse of antimicrobials has resulted in the emergence of bacterial strains that are now resistant to these agents. In Alaska the percentage of invasive isolates of *Streptococcus pneumoniae* demonstrating full resistance to penicillin increase from <1 % in 1993 to almost 15 % by 2000. However this trend has been reversed by the introduction in 2001 of pneumococcal conjugate vaccines that eliminated those serotypes most common in infants that were most resistant to penicillin. For the time period 2000–2006, 5 % of isolates were resistant to penicillin in the US Arctic, <3 % in northern Canada, but <1 % from Greenland, Iceland and northern Sweden (Zulz et al. 2014).

Once considered to be an infection only acquired in health care settings methicillin–resistant *Staphylococcus aureus* (MRSA) infection acquired in the community is an emerging public health challenge in the Arctic especially in small remote communities where household overcrowding, frequent skin to skin contact, challenges to personal hygiene, sharing of personal contaminated items, limited access to adequate in-home running water, sanitation services and health care are common. In Alaska a large outbreak of *Staphylococcus aureus* skin infections were reported in 1999 from several communities in south western Alaska. The majority (86 %) of infections were MRSA. Those infected were more likely to have had received antibiotics in the previous year, and used an MRSA contaminated sauna (Baggett et al. 2004). It is believed that antibiotic pressure from a drug resistant strain carrying a particular cytotoxin producing gene Panton-Valentine Leukocidin (PVL) led to the emergence and spread of MRSA in these remote communities of south western Alaska. In northern Canada community acquired MRSA was first reported among an Aboriginal community in Alberta in 1986 (Taylor et al. 1990). Since 1983 the incidence of MRSA has increased in small indigenous communities in northern Manitoba (Larcombe et al. 2007), northern Saskatchewan (Golding et al. 2011) and in the remote Inuit community of Nunavut (Dalloo et al. 2008). The cases in these areas reveal a similar epidemiology with predominance in younger age groups, skin and soft tissue infection, and similar MRSA strains exhibiting the virulence cytotoxin PVL. In Greenland only sporadic cases have occurred (Statens Serum Institut, Copenhagen, Denmark).

Chronic *Helicobacter pylori* infection increases the risk of peptic ulcer disease and gastric cancer and is of increasing concern among northern communities and health care providers. The prevalence of *Helicobacter pylori* infection in Arctic Countries is very high with high rates in many indigenous populations. Studies in the US Arctic have found the seroprevalence of *Helicobacter pylori* infection is significantly increased among Alaska Native peoples (75 %) overall compare with non-Native Alaskans (24 %) (Parkinson et al. 2000; Lynn et al. 2007). Similarly estimates of *Helicobacter pylori* seroprevalence in Aboriginal communities in northern Canada range from 50 to 95 % (Goodman and Jacobson 2008), and in Greenland the seroprevalence is 58 % in persons 15–87 years of age (Koch et al. 2005). Studies in non-Arctic populations have shown that *Helicobacter pylori* can be treated successfully using a combination of 2 or more antimicrobials resulting in cure rates of between 60 and 95 % (McMahon et al. 2014). However in Alaska, prior use of commonly used antimicrobials has been associated with increasing rates of resistance and treatment failure (McMahon et al. 2003; Bruce et al. 2006). Reinfection following apparently successful treatment is also common in regions with a high prevalence of infection. In a 2 year study of Alaska Natives seeking treatment for *Helicobacter pylori* infection, there was a 14.6 % reinfection rate after 2 years of successful treatment (McMahon et al. 2003, 2006). Since rates of antimicrobial resistance to agents used to treat *Helicobacter pylori* are high and increasing, use of these agents in high prevalence populations could lead to increasing antimicrobial resistance not only to *Helicobacter pylori* but also to other common bacterial agents such as *Streptococcus pneumoniae*, *Staphylococcus aureus* and *Haemophilus influenzae*. More information on the risk factors associated with *Helicobacter pylori* infection, treatment and preventive strategies are needed from Arctic communities in other circumpolar countries.

A number of parasitic infections with potential to infect humans are endemic in wildlife in Arctic regions (Jenkins et al. 2013). Trichinellosis is caused by the freeze resistant nematode *Trichinella nativa* transmitted by intake of infected raw or undercooked game meat, in particular polar bear and walrus. Human outbreaks occur, and Canada implemented a prevention program in the 1990s (Proulx et al. 2002). Echinococcosis disease caused by *Echinococcus granulosus* and *Echinococcus multilocularis* occurs in wildlife in Alaska, Canada, Northern Norway, Sweden, and Finland, but not in Greenland. Wolves, foxes and dogs are definitive hosts (Jenkins et al. 2013). Other parasites causing disease in Arctic populations include Giardia, Cryptosporidium, Toxoplasma, Ascaris, Anisachis, and Diphyllobotrium (Jenkins et al. 2013). Rabies in Arctic areas has been known for over 150 years and is endemic in Arctic wildlife, mainly foxes, but human cases are very rare (Mørk and Prestrud 2004).

18.3 Climate and Environmental Change and Infectious Diseases

The Arctic, even more so than other parts of the world, warmed substantially over the twentieth century, principally in recent decades. According to the most recent assessment by the Intergovernmental Panel on Climate Change (IPCC 2013), climate models predict continued warming in the coming decades, with even greater warming in the Arctic resulting in a mean increase between 1.5 and 5.8 °C by 2,100. With these projected mean global temperature increases, it is likely that the Arctic sea ice cover will continue to shrink and thin, the winters will warm more so than summers, the mean annual precipitation will increase, global glacier volume will decrease, and the Northern Hemisphere spring snow cover will decrease during the twenty-first century (IPCC 2013). Continued melting of permafrost and sea ice is expected to augment river discharge and contribute to a rise in sea level by 1 m by 2,100. Moreover, some predictions suggest that these changes will be accompanied by greater overall climate variability and an increase in extreme weather events (Arctic Council ACIA 2005).

The current level of warming in the Arctic has already brought about substantial ecological and socioeconomic impacts, caused by the thawing of permafrost, flooding, shoreline erosion, storm surges, and loss of protective sea ice (Brubaker et al. 2011). In many Arctic communities, the physical infrastructure was built on permafrost. Weakening of this permafrost foundation will likely damage water intake systems and pipes, and result in contamination of community water supplies. Moreover, the failure of the foundation of access roads, boardwalks, water storage tanks, and wastewater treatment facilities can turn water distribution and wastewater treatment systems inoperable. In the US Arctic (Alaska) reduced access to treated water for hygiene has already been shown to result in increased hospitalizations for skin respiratory tract infections and pneumonia (Hennessy et al. 2008; Wenger et al. 2010) A number of Alaskan villages are already threatened by relocation due to the failing of foundational support for houses, water systems, and civil infrastructure (Warren et al. 2005; Brubaker et al. 2011).

A shift in the boundaries of climatically and geographically linked ecosystems (biomes) will result in new habitats for plants, insects, and animals with profound implications for human activity. It is likely that the ecology and epidemiology of infectious disease will change as well. Climate and weather affect the distribution and risk of many vector-borne diseases, globally, such as malaria, Rift Valley Fever, plague, and dengue fever in more southern latitudes (Semenza and Menne 2009; PAHO and WHO 2012). Weather also impacts the distribution of food- and water-borne diseases and emerging infectious diseases, such as West Nile virus, hantavirus, and Ebola hemorrhagic fever, etc. (Brookes et al. 2004; Pinzon et al. 2004; Haines et al. 2006; Dearing and Dizney 2010; Money et al. 2010). However, less is known about the influence of climate change and the risk and distribution of infectious diseases in Arctic regions (Hueffer et al. 2011; Revich et al. 2012; Revich and Podolnya 2011). Nevertheless, it is likely that the climate change impacts could result in changes of rates of respiratory infections, skin infections, diarrheal diseases, and many other conditions caused by bacterial, viral, and parasitic agents (Evengard et al. 2011; Brubaker et al. 2011; Hennessy et al. 2008; Wenger et al. 2010; Dudarev et al. 2013a; Tokarevich et al. 2012). Specifically, rising temperatures are expected to favor a northward expansion of boreal forest into the tundra, and of tundra into the polar desert (Arctic Council ACIA 2005). Increasing temperatures may thus shift the density and distribution of animal hosts and arthropod vectors which could result in an increase in human illness or a shift in the geographical range of disease caused by these agents (*Echinococcus* spp., *Francisella tularensis*, West Nile virus, Hantaviruses, and tick-borne encephalitis viruses, *Borrelia burgdorferi*, arboviruses including Sindbis virus, California serogroup viruses) (Hueffer et al. 2013; Revich et al. 2012, Parkinson 2008; Ahlm et al. 2013; Campagna et al. 2011; Ryden et al. 2011). A 2014 report from northern Alaska documented an increased risk to residents of contracting infectious diseases transmitted by wildlife (Goyette et al. 2014). Invasive bacterial infections are of special concern in the Arctic (Bruce et al. 2013; Helferty et al. 2013). Rising temperatures may allow reservoir host animal species to survive winters in larger numbers, increase in population size and expand their habitat range. Such shifts can favor the transmission of *Brucella* spp*., Toxoplasma gondii, Trichinella* spp. *Coxiella burnetti* and Puumala hantavirus to humans in more northern locations (Parkinson 2008; Parkinson and Evengard 2009; Evander and Ahlm 2009; Tokarevich et al. 2012; Kersh et al. 2012). In 2004 an outbreak of gastroenteritis caused by *Vibrio parahaemolyticus* from oysters grown in Alaskan waters occurred. This outbreak extended by 1,000 km the northernmost documented source of oysters that caused illness due to *V. parahaemolyticus with* rising temperatures of ocean water seeming to have contributed to the outbreak (McLaughlin et al. 2005).

Many Arctic residents depend on subsistence hunting, fishing and gathering for food and a stable climate for food storage. Food storage methods often include above ground air-drying and smoking of fish and meat at ambient temperature, below ground cold storage on or near the permafrost, as well as fermentation. Changes in climate may prevent the proper drying of fish or meat, resulting in spoilage (botulism) and contributing to food borne disease outbreaks (McLaughlin et al.

2004). Similarly loss of permafrost may result in spoilage of food stored below ground (Brubaker et al. 2011). Loss of these traditional food storage methods will also contribute to reduced food security for many Arctic communities (Nilsson et al. 2013; Dudarev et al. 2013b).

Changes in global and Arctic climate may result in increased transport of persistent organic pollutants and other toxic metals to the Arctic (Kirk et al. 2012). Bioaccumulating contaminants in animals can impact their survival, affect their immune responses, their possible role as reservoirs of zoonotic agents, and pose a food-safety risk if they are animal species hunted for food (Fisk et al. 2005; McDonald et al. 2005; Proulx et al. 2002).

18.4 Prevention and Control-Use of Existing Networks

The climate and ecosystem driven emergence of new infectious diseases and disease patterns in the Arctic region presents a continuing challenge to those living in the Arctic and to the public health and health care provider communities. However the Arctic is unique in that Arctic countries have a long history of international collaboration and cooperation when dealing with issues that affect their communities including human health. The International Union for Circumpolar Health (www.iuch.net) is a non governmental organization comprised of associations of five circumpolar health organizations which can trace its origins back to the 1960s. The IUCH promotes cooperation on human health through activities of 13 working groups, including infectious diseases and promotes communication through the International Journal of Circumpolar Health (www.circumpolarhealthjournal.net) and a triennial Congress on Circumpolar Health. The Circumpolar Health Research Network (www.circhnet.org) is a network of researchers, research trainees, supporters of research based in academic institutions, indigenous peoples organizations, and regional health authorities who share the goal of improving health of the residents of the Arctic region through international cooperation in health research. The Arctic council (www.arctic-council.org), established in 1996, is a ministerial intergovernmental forum which promotes cooperation among the eight Arctic states (including indigenous communities and other Arctic residents) on issues relating to sustainable development and environmental protection. Human health is embedded in two working groups: The Arctic Monitoring and Assessment Programs (AMAP) Human Health Assessment group which tracks the impact of environmental pollution on human health, and the Sustainable Development Working Groups (SDWG) Human Health Experts Group which has the role of fostering sustainable development by ensuring good health and wellbeing of indigenous communities and other residents of the Arctic (Parkinson 2010).

As in other parts of the world, a key component of prevention and control of infectious diseases is surveillance. Effective surveillance can facilitate timely control of infectious disease outbreaks, inform public health officials' decisions on resource allocation, provide data to adjust prevention and control strategies to maximize their effects, and inform future research needs.

Using these established international collaborations the International Circumpolar Surveillance of Emerging Infectious Diseases (ICS) system was initiated in 1998. This was initially an Arctic Council, SDWG IUCH project that aimed to link public health laboratories, institutes and academic centers for the purpose of monitoring and sharing standardized information on infectious diseases of concern, collaborating on research and prevention and control activities across the circumpolar north (Parkinson et al. 2008; Zulz et al. 2009). Initially a working group was established for surveillance of invasive bacterial diseases in northern populations (Bruce 2008) and has been instrumental in demonstrating the effectiveness of pneumococcal vaccines in circumpolar populations, and detecting the emergence of non type b serotypes *Haemophilus influenzae* invasive disease in children in both Alaska and northern Canada (Tsang et al. 2014). ICS research working groups have since been formed for collaborative work on diseases caused by *Helicobacter pylori* (McMahon et al. 2014), and viral hepatitis (McMahon and Blystad 2013). A tuberculosis surveillance working group was formed in 2007 to improve surveillance, identify trends of tuberculosis in the north, assess incidence, improve awareness and collaborate on research (Bourgeois et al. 2013). In 2010 an ICS Climate Change and Infectious Disease Working Group was formed to share information on climate sensitive infectious diseases in the circumpolar North (Parkinson et al. 2014 White paper). The Arctic provides a unique opportunity to use a "one health" approach as an organizing concept to understand the disease ecology and the potential impact of climate on disease occurrence in both human and animal populations in Arctic regions and to expand local, regional, and international networks to increase interdisciplinary collaboration and understanding about climate change and infectious disease emergence, prevention and control (Aenishaenslin et al. 2014; American Medical Veterinary Association 2008; Dehove 2010) The working group provides the opportunity to bring together public, wildlife, and environmental health professionals from other Arctic Council Working Groups such as CAFF, PAME, and other networks and organizations such as the WHO, CDC and ECDC, to share information on activities related to the impact of environmental change on human and wildlife health, and to provide a forum for identifying ideas and areas of common interest and collaboration at the local regional and circumpolar levels.

18.5 Conclusions

Arctic societies are societies in change. During the twentieth century traditional life styles have been rapidly changing towards those of western life styles including improved economic, housing, and sanitation conditions, facilitation of travels, and improvement of health systems and preventive measures. These changes have affected the traditional pattern of infectious diseases exemplified by e.g., reduction of the previously very high rates of tuberculosis.

Yet, climate changes are expected to influence the infectious disease pattern of the Arctic. It is likely that increasing temperatures may result in increasing rates of respiratory, skin infections, diarrheal diseases, zoonoses, and a range of other bacterial, viral, and parasitic agents.

Such influence may be carried out through a number of possible mechanisms. Northwards expansions of boreal forest and tundra following increasing temperatures may shift the density and distribution of animal hosts and arthropod vectors leading to higher rates of diseases in humans associated with these factors. Reservoir host animals may survive winters and increase in population size. Changes in global and Arctic climate may lead to increased transport of persistent organic pollutants and other toxic metals to the Arctic. Bioaccumulation of these substances in animals may affect their survival, their possible role as reservoirs of zoonotic agents, and pose a food-safety risk if they are animal species hunted for food. Traditional Arctic food storage methods may be inadequate for food safety in case of warming temperatures. Destruction of physical infrastructure that in many places is built on permafrost may have detrimental effects on sanitation and water supply. Facilitated travel conditions through e.g., melting of sea ice may favor introduction of microbiological agents from the outside world and facilitate their spread.

While a warming climate may have beneficial societal effects through e.g., improved travel conditions and new occupational possibilities such as agriculture, the health effects of a warming climate in the Arctic are not expected to be generally positive.

At present there is little firm knowledge of health effects in Arctic populations following global warming. Such warming is, however, expected to pose a major challenge to human health, and to the collaborations that study these effects and devise and implement possible prevention and control measures.

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Chapter 19
Environmental Health in the Changing Arctic

Arja Rautio

Abstract Human health and well-being are the result of complex interactions among genetic, social, cultural and environmental factors. Especially in the Arctic regions, where the climate and living conditions are demanding, the environment and nature are important elements for good and safe every-day life. Changes in the environment and climate have huge impacts on life in the Arctic areas. The Arctic has been contaminated by chemicals resulting from human activities and natural processes, mostly from distant sources via the atmosphere, rivers and ocean currents. Arctic environment is now in great change with the melting of permafrost and ice, which may release some of the accumulated contaminants into water and air. The results of the multidisciplinary ArcRisk research project show that the contaminants may re-circulate in the food-webs and concentrate in food items. The processes and pathways between environmental compartments are very complex, and influenced by many factors, like weather conditions, temperature and ice cover. The future Arctic will be more urbanized, with a more elderly population and closer connections to the other parts of the globe. All of this will be a big challenge for the health and well-being of the different populations, indigenous and non-indigenous, living in rural and urban areas. It is important to focus on living conditions, including clean air, water and food, which all will support good life in the Arctic. The results of the ArcRisk project provide important information for the decision-makers on how to meet the future needs of the changing Arctic.

Keywords Environmental health • Contaminants • Climate change • Monitoring programs • Quality of life

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19.1 Introduction

The living conditions and health of indigenous peoples have been a specific research focus during the last years. Indigenous peoples comprise 10 % of the whole population living in the Arctic, ranging from 0 % in Iceland up to 90 % in Greenland. The disparities in health still exist when compared to other countries, especially among the indigenous populations in Canada and Russia. During the last decades, there has been migration to towns and cities. For instance, at the moment half of the Arctic Russian population is concentrated in nine big cities. This phenomenon is seen in all of the Arctic countries. The migration of the new Northerners, the people working either temporary or more permanently in the Arctic, has already started; and the warming climate may attract more people to move to the North. The overall trends of human development are presented in the Arctic Human Development Report –II (Larsen and Fondahl 2014).

At the moment, the economic interest is increasingly focused on the warming Arctic due to its huge resources and possibilities for the shipping and mining industries. However, the warming climate poses some threats to human health, such as worsening food and water security, new infectious diseases and the increased risk of contaminants. Changing climate conditions, together with permafrost melting, also disrupt the transportation routes and destroy other infrastructure in communities. The changes in the livelihoods and ways of living cause stress and mental problems to the local populations. There have been conflicts between the mining and tourism industries and the traditional livelihoods, like reindeer herding, fishing and hunting. One alarming sign is the increase of suicides and depressions in young reindeer. herders, who do not perceive a future for their work. The preservation of cultural heritage plays a central role in the health and well-being of the indigenous communities.

Several international organizations and monitoring programs are promoting the health and well-being of different populations living in the Arctic countries. During the last 20 years there have been successful circumpolar monitoring programs and projects of human health established by the Arctic Council (http://www.arctic-council.org/index.php/en/). These projects are based on the development of international collaboration in data collection, management and dissemination. Excellent examples include the human health assessment reports of the Arctic Monitoring and Assessment Programme (AMAP), the International Circumpolar Surveillance of Infectious Diseases (ICS), the Circumpolar Health Observatory (CircHOB, http://circhob.circumpolarhealth.org/) and the Survey of Living Conditions in the Arctic (SLiCA). In all of these, the traditional way of life of the indigenous peoples is included as an important part of the surveys. The major focus of this chapter is on the effects of climate change on persistent contaminants in the environment and on human health.

19.2 Monitoring Contaminants in the Circumpolar North

The Arctic Monitoring and Assessment Programme (AMAP, http://www.amap.no/) is one of the six Working Groups of the Arctic Council. It is focused on monitoring and assessing the status of the Arctic region with respect to pollution and climate change issues since 1991. It has published several science-based and policy-relevant assessments and reports about the levels, trends, and processes of persistent organic pollutants and heavy metals, and on their impact on ecosystems and humans. The actions of AMAP, together with other international frameworks, like those of United Nations and EU, support the work to reduce the global threat imposed by pollution and climate change. The monitoring regions of AMAP are shown in Fig. 19.1.

AMAP also regularly publishes reports on human health and on the trends of environmental contaminants and heavy metals in the environment, traditional/local foods and humans (AMAP 2009; see http://www.amap.no).

Due to globalization and climate change, there are many new challenges for individuals and communities in the Arctic. The Arctic is already and will continue to be less isolated than in the past. However, in case of contaminant transfer, the Arctic has been tightly connected to the other parts of the globe. Without borders, the persistent organic pollutants (POPs), like pesticides, dioxins and mercury, are transferred by air and water streams to the North from where they have been produced and used. Humans are exposed to POPs and mercury through food, drinking water and, to a minor extent, via inhalation.

Figure 19.2 shows one of the most important and followed-up POPs, DDT. DDT (and its metabolite DDE) still exists all around the Arctic regions, where it is transported from other parts of the globe. DDT was synthesized in 1874, and it has been used against malaria and as an agricultural insecticide. DDT was found to be toxic to humans and animals, and was consequently banned in agricultural use. Although the ban was implemented 40 years ago, DDT is still used in limited quantities, e.g. in South Africa. DDE is the main metabolite, which is formed from DDT in human body and in the environment. It is excreted into human breast milk, which may expose fetuses to the substance during the pregnancy. The levels of DDE in pregnant women and women in child-bearing age are still rather high, and there are only some regions where the trend is lowering (Fig. 19.2).

Human health and climate change have been the topic of several joint research and educational projects, such as the multidisciplinary EU-funded ArcRisk project led by AMAP (*EU7PW;* Arctic Health Risks: Impacts on health in the Arctic and Europe owing to climate-induced changes in contaminant cycling, www.arcrisk.eu), which aims to determine how climate-mediated changes in the environmental fate of contaminants affect the exposure of human populations via the food-web, both now and in the future.

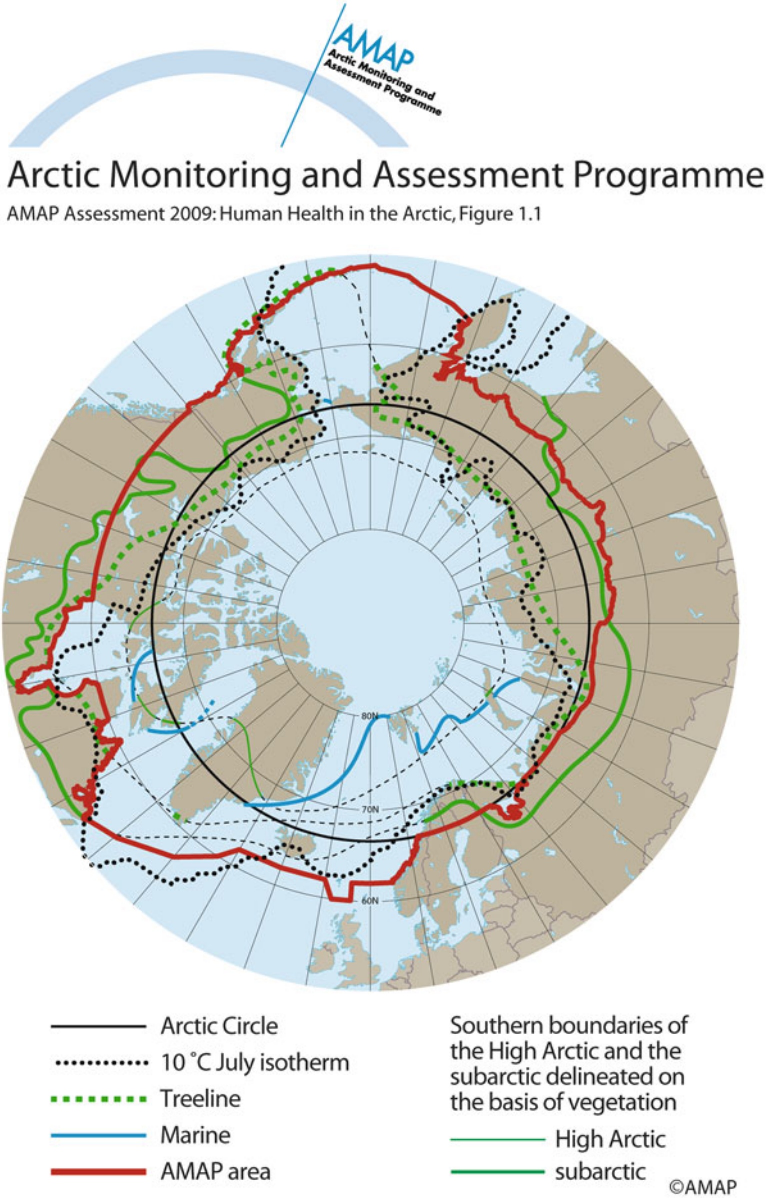

Fig. 19.1 Geographical boundaries of the Arctic by AMAP (Copyright: AMAP 2014)

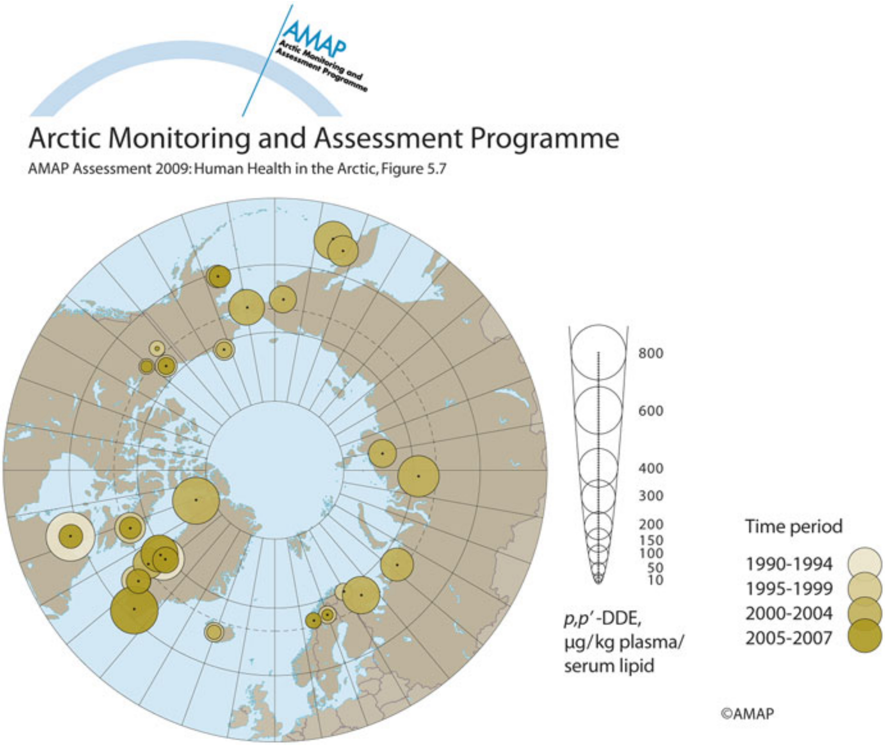

Fig. 19.2 DDE concentrations in blood of mothers, pregnant women and women of child-bearing age in the circumpolar countries (www.amap.no)

19.3 Effects of Climate Change on Contaminant Transfer and Human Health

The main focus of the ArcRisk project was to develop climate change adaptation and prevention strategies for the different regions in the Arctic, but also for the EU and global contexts. The research was divided into three parts: (1) the sources and origin of long-range transported contaminants, which reach the Arctic ecosystems; (2) the levels of contaminants in Arctic biota and ecosystems; and (3) levels of contaminants in humans exposed. The main results of the project were the development of new models to study the impacts of climate change on pollutant transport and fate in the Arctic, and their accumulation in the food chains. The estimation of the future levels of contaminants is very much dependent on the transfer between the atmosphere, marine and terrestrial ecosystems and the uptake into food chains. Primary emissions of many banned POPs (like dioxins, DDT) will decrease in the future, but the effects of the warming climate may increase the volatility of POPs. Models showed that climate change can affect future levels of concentrations of POPs, either increasing or decreasing depending on the chemical properties of the POP. There are also differences between geographical regions.

Mercury and one of the dioxins, PCB153, were selected as case studies in the ArcRisk project. During the project, all the possible information concerning these two contaminants was collected and future scenarios (until 2100) were made. Mercury emissions result from both man-made and natural sources (like volcanic eruptions). Very high mercury levels have been found in marine mammals and fish species (top of the food chain) in the Arctic Canada and Greenland. Especially indigenous populations, who consume those animals as a part of their diet, have been heavily exposed. At the moment, the levels of mercury in populations in the Arctic are slightly decreasing, but there are notable differences between the regions, populations and individuals. There is regional variation in the atmospheric deposition of mercury in the Arctic within the climate change scenario. According to the results of the ArcRisk project, the atmospheric deposition decreases over the Arctic Ocean, but increases over the continents due to changes in ice cover and ozone concentrations. The processes and pathways between environmental compartments are very complex and difficult to estimate, as they are influenced by many factors, such as weather conditions, temperature and ice cover.

One of the main tasks of the ArcRisk project was to study the effects of climate change on dietary exposure and human health in the Arctic, and to compare these results to those observed in the Mediterranean region. Seafood is the major source for mercury in human diets. However, fish is also a very important source of nutrients, and eating fish has been shown to promote good health. Thus, the risks and benefits must be taken into consideration when giving dietary recommendations, especially for the most vulnerable groups, pregnant women and children. The results of the ArcRisk project showed that the concentrations of mercury in human blood and hair were at the same level in the Mediterranean and the Arctic populations. There are several mother-child cohorts in the Arctic, especially in Faroe Islands, where children, who have been heavily exposed during the pregnancy, have been followed up. Several harmful effects on their health were discovered. Due to the dietary recommendation not to use the most contaminated food items during pregnancy, the levels of mercury exposure are now lower. However, in the Mediterranean countries higher fish consumption during pregnancy was associated with higher cognitive and language developmental performance.

Mercury levels in fish vary according to species. There are also differences between wild caught and farmed fish, with wild catches typically having higher levels of mercury. Due to harvesting and climate change, the number of fish species will decrease, and recommendations to increase fish consumption may not be possible in the future. The discussion about mercury levels in food items and human body will continue. Especially those indigenous populations who use traditional food, e.g. marine mammals, continue to be at risk. The benefits of fish consumption are clear, but the question as to what is the acceptable amount of contaminants and toxic metals in food items, remains difficult to answer. Follow-up studies and further research into the causes for the high inter-individual variations of contaminant levels in the Arctic populations and biological mechanisms behind methyl mercury are needed. There may also be other important sources of mercury exposure, like elemental mercury through inhalation and inorganic mercury in food, which should be taken into account.

What are the main health effects of POPs and toxic metals on human health? It is very difficult to find a straightforward answer. It depends on the chemical and the time of exposure (fetuses and children are the most sensitive), as well as on individuals and their behavioural habits (like smoking, diet and alcohol consumption). Mercury is undoubtedly toxic, but the question is, what is the lowest level at which it will start to have harmful effects on the human body? There are only a few contaminants concerning which we can give straightforward answers. The association between concentrations of lead in human body and the adverse effects found in central nervous system and malformations are among the most known examples. In the cases of other environmental contaminants, it is difficult to find evidence-based toxicological data about the correlation between health outcomes and exposure to one or more contaminants, since the individual study designs and methods used vary from one study to another. It is important to harmonize study protocols so that the results are comparative. In this way, it would be possible to draw more powerful conclusions and estimate the cut-off levels for one contaminant and even for mixtures of contaminants. It is also important to follow up on those population groups that have had the most exposure to contaminants. Climate may change the present trend, where pollutants in the Arctic are on the decline. Human exposure levels to POPs and mercury should be followed also in the future. The levels of the old environmental pollutants are mainly decreasing in the environment and in humans in the circumpolar regions, but there are differences among regions and among contaminants. In the Russian North, it has been found that there are new “hot spot” areas, where increased quantities of environmental contaminants and heavy metals, especially mercury, are being released from the frozen soil and contaminate drinking water.

Multidisciplinary research projects, like ArcRisk, will provide important information for future monitoring activities and offer insight into the effects of climate change. This information is relevant not only for the vulnerable population groups, but also for the decision-makers in the circumpolar North and across the globe (Table 19.1).

Table 19.1 Key findings of the ArcRisk project

Levels of legacy POPs in human tissues are declining in many regions of the circumpolar Arctic. New sources and patterns are being seen in Arctic Russia
Levels of mercury in human tissues are declining in several Arctic regions. Inuits continue to have the highest exposure levels of mercury in the Arctic and most often exceed blood guidelines
Traditional foods are an important source of nutrients for many Arctic residents. These foods are also the main source of exposure to contaminants
New evidence indicates that contaminants and toxic metals may affect human health; especially fetuses and children are at risk
Climate change may increase the mobilization of POPs and mercury, and lead to higher releases of contaminants within the Arctic

19.4 Food and Water

The changing climate causes permafrost melting, reduced ice cover, as well as floods and storms. All of these phenomena affect food and water security in the Arctic, an issue that was taken as one of the priority themes during the Swedish chairmanship of the Arctic Council (2011–2013). The joint circumpolar project was started to identify indicators relevant to monitoring food and water security in the Arctic areas. Following an extensive literature research and critical review, 12 candidate indicators for future monitoring were selected jointly by the Sustainable Development Working Group's (SDWG) Arctic Human Health Expert Group and the Arctic Monitoring and Assessment Programme's (AMAP) Human Health Assessment Group (Nilsson et al. 2013). These 12 indicators (including contaminants in food and water) are based on existing WHO and FAO indicators, and they will be the starting point for monitoring both indigenous and non-indigenous populations in rural and urban areas of the Arctic (Table 19.2).

A more detailed description of the promoted measures regarding food security are provided in Chap. 16.

During the last twenty years there has been a dietary transition from traditional and local foods to a Western type of diet. This shift has already led to increased rates of obesity, diabetes and cardiovascular diseases. There is less physical activity, as modern technology, such as snowmobiles and motorbikes, are used in activities like reindeer herding. The store-bought food is often cheaper than the traditional and local food, and climate change may decrease the possibilities for hunting and fishing. Dietary recommendations have been made to ensure a balanced and nutritious diet. However, the transportation costs are high, and the hunting equipment, fuel, and vehicles are more expensive in the North than in the southern parts of the same country. All of these factors contribute to the emergence of more unhealthy dietary patterns.

Table 19.2 Indicators of food and water security (Nilsson et al. 2013)

Healthy weight (BMI, ratio >30, also for children)
Self-estimated proportion of traditional food in diet
Non-monetary food accessibility
Monetary food accessibility
Food-related contaminants
Food borne diseases
Per capita renewable water
Accessibility of running water
Waterborne diseases
Drinking water contaminants
Authorized water quality assurance
Water safety plans

19.5 Good Life in the Changing Arctic

The increasing economic interest in the Arctic will produce new jobs and new Northerners. Demographic changes, including aging, will put strain on the infrastructure in many parts of the Arctic. Support is needed to secure the health and wellbeing of older people. Both globalization and climate change will affect environment and every-day life. What are the dimensions or parameters of good life in the Arctic? Are those the same in the circumpolar North as elsewhere? Are they the same for the indigenous and the non-indigenous peoples? According to the United Nations' Human Development Index, the parameters for good life are health (Infant mortality and Life expectancy), education (Educational attainment) and income (Gross Domestic Product). From the health point of view, the Arctic regions are divided into four groups: Nordic countries; Alaska, Yukon and North West Territories; Greenland and Nunavut; and the Russian Arctic. Almost all health, education and income parameters have improved during the last 5–10 years, but there are notable differences between the populations, sub-groups, regions and genders.

Life in the Arctic has its specificities, and there has been an attempt to develop indicators that can be used for Arctic, but also for more global, comparison (see more, Larsen and Fondahl 2014; and Arctic Social Indicators by Larsen et al. 2010, 2015). At the moment, several studies are being conducted on measuring subjective or community well-being or quality of life in different parts of the Arctic, and their results will be used to build a common set of indicators for the circumpolar area.

Close environmental relationship will also be important for the future Northerners. To ensure a clean and safe environment, global, national and Arctic strategies and decisions are needed. We must work towards restricting the use and release of chemicals, which will transfer and accumulate in the sensitive Arctic environment, and take care of the health and well-being of the populations in the North.

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Chapter 20
Scientific Cooperation Throughout the Arctic: The INTERACT Experience

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Abstract Climate change, globalisation and sociological changes are occurring rapidly in the Arctic with impacts on environment and consequences for local and global communities. The changes are complex and observing power in the vast lands of the Arctic is low. The scale and complexity of the Arctic system requires international cooperation in identifying, understanding, predicting and managing environmental change. Many international networks and organisations have formed since the first International Polar Year was held in the late nineteenth century, some multidisciplinary, others focusing on individual disciplines. Some major examples are the working groups of the Arctic Council, the International Arctic Science Committee, the University of the Arctic and INTERACT. However, barriers to international cooperation still exist. Sustainability of networks is a particular problem. Incomplete understanding of the Arctic system results from underdeveloped interactions between the observing and process-based communities and among various disciplines and domains. The internet has brought a new dimension to sampling in the Arctic but the power of observation and interpretation resides in people

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and the resulting understanding of changes in our Arctic environment and ecosystem services is aimed at improving the well-being of Arctic inhabitants and the global community.

Keywords Networking • International cooperation • Mobility of researchers • Standardized monitoring

20.1 Introduction

Climate change is accelerating in the Arctic and at twice the global rate. Early concerns led to a rigorous assessment of climate change and its consequences in the Arctic (ACIA 2005), initiated by the Arctic Council and the International Arctic Science Committee. Within a decade, a new assessment was implemented (AMAP 2011) and each year there have been up-dates (Jeffries et al. 2014). Furthermore, climate change is not the only accelerating change in the Arctic: globalisation and sociological changes are also occurring rapidly with impacts on global communities as well as on the environment (Larsen et al. 2014).

Despite dramatic changes in the Arctic and important consequences for humanity, political actions on mitigation and adaptation have not so far achieved a commensurate response. In contrast, many nations and multi-national corporations have identified potential commercial opportunities: nations such as China, Singapore, South Korea and India are increasingly active in the Arctic, for example by building scientific research stations, while planning by multi-national industry for oil and mineral extraction as well as new shipping routes is progressing. This generates a mismatch between possible mitigation measures that will benefit some, and lack of action that will lead to devastation of others (Callaghan et al. 2014). It also leads to an inequality of resource availability – wealth of natural resources including agriculture, forestry and water resources in some future northern areas, but diminishing natural resources in high population centres to the south. These inequalities of action and resources could possibly lead to conflict, and some international disagreements are already evident. Overall, there is an emerging disconnect between the ability to predict possible futures and the ability to achieve a preferred future (Callaghan et al. 2014).

Before preferred futures can be discussed, however, it is imperative to document current environmental and sociological changes and to understand the processes driving the changes. Only then can knowledge-based management be implemented. This task is far from simple as the Arctic is vast – up to 14 million km^2 (according to definition), is sparsely populated (about 4 million, again depending on definition: ACIA 2005), and its harsh conditions and remote areas provide physical challenges for environmental monitoring and research. Consequently, our observing capacity is low. Furthermore, the Arctic's environment is far from homogeneous at all scales. In other words, the Arctic tundra, which is the world's largest "biome" (biomes are major vegetation types such as boreal forest, tropical rainforest, grassland etc.), stretching about 30° of latitude and with the greatest rate of environmental change from south to north (Matveyeva and Chernov 2000), contains a huge complexity of cryospheric, biospheric, hydrological and atmospheric conditions. On top of this complexity, responses of the Arctic system, and particularly its ecology, have also proven to be surprisingly complex with some counterintuitive changes observed.

This scale and complexity of the Arctic system requires international cooperation in identifying, understanding, predicting and managing environmental change.

20.2 Historical Developments

20.2.1 International Polar Years

Probably the first programmes of international cooperation in the Arctic were the Polar Years. The First Polar Year occurred in 1882–1883. The idea came from the Austrian Officer Karl Weiprecht and 12 countries (having 12 stations in the Northern Hemisphere and 2 in the Southern) were involved. There were 13 expeditions to the Arctic and 2 to the Antarctic. The First IPY included geophysical, meteorological and a few biological observations. The establishment of a network of stations around the North Pole, where regular observations using similar equipment and common techniques would take place, was initially suggested and implemented during preparation of the First Polar Year.

The Second International Polar year was held on the 50th anniversary of the first one (1932–1933). The wide expansion of radio and electric power convinced scientists that further study of the Earth's geophysics was required. The results of the First IPY showed that international cooperation in the field of such research could have been more efficient than individual expeditions. The Second Polar Year initiated systematic observations in the Arctic and the number of stations increased to 44. During these 2 years a vast amount of data was collected, and the Second IPY gave birth to the organisation that eventually was called the "International Meteorological Organization".

World War II and the subsequent "Cold War" interrupted international cooperation in the Arctic but in 1957–1958, the Third IPY occurred as a part of the International Geophysical Year. Sixty-seven countries participated in the IGY.

These programmes had a rather weak biological component but were extremely important in exploring and recording physical processes. On land, some observatories were established such as the first Russian station Malye Karmakuly on Novaya Zemlya which opened after the First IPY and is still operating. At sea, expeditions took place such as the voyage of the icebreaker "Sibiryakov" in 1932 that sailed from Murmansk to Vladivostok with a single navigation and initiated regular voyages along the Northern sea route (Kotlyakov and Sarukhanian 2007).

20.2.2 International Biological Programme

The largely missing biological component on land was rectified during the International Biological Programme (IBP: Worthington 1968) of the late 1960s and 1970s. During this global programme, the world was divided into "biomes", including a Tundra Biome. This network reached across national boundaries and there was good cooperation between Soviet and Western researchers. The project was very productive and much fundamental knowledge about Arctic ecosystems was gathered and published and is still of relevance today (Bliss et al. 1981). Importantly, the project pioneered ecosystem/vegetation dynamics (e.g., Callaghan et al. 1978) and early ecosystem modelling (e.g., Bunnell and Scoullar 1981). In addition, the first measurements of feedbacks to the climate system – now of great importance – were made. These were measurements of methane fluxes by Svensson (1974) which are still ongoing and have been developed by Christensen et al. (2004) (Fig. 20.1). They also included measurements of CO_2 fluxes by Coyne and Kelly (Coyne and Kelly 1975). During the project, many new research sites were established: some remain today and the network consisted of 21 northern sites, many of which still network within "INTERACT" (see below). Also, as the recording of vegetation some 50 years ago was rigorous, following standard protocols, site re-visits have been possible to record change (Fig. 20.2). An international synthesis of change, using the legacy of IBP sites and researchers, was published in 2011 (Callaghan and Tweedie 2011). Furthermore, the legacy of collaboration from the IBP Tundra Biome Programme led to the formation of the International Tundra Experiment (ITEX), the International Permafrost Association (IPA) and SCANNET/INTERACT (see below) (and to some extent, the University of the Arctic).

20.2.3 UNESCO Man and the Biosphere Northern Sciences Network

The MaB NSN was established in 1982 and all Arctic countries participated (Archer and Scrivener 2000). Its mission was to exchange information and facilitate cooperation between countries in planning, conducting and reviewing MaB activities in northern areas. The network was terrestrial and focused on Fennoscandian subarctic birch forest ecosystems and their management (Wielgolaski 2005). In 1988, research into sustainable development became a priority (Archer and Scrivener 2000). Sadly, lack of funding became an issue and, together with the loss of interest in some northern MaB reserves such as the Lake Torne Biosphere Reserve in Sweden, the MaB NSN ceases to exist.

Fig. 20.1 *Top*: Professor T.R. Christensen demonstrates the can with which B. Svensson pioneered field measurements of methane (photo: T.V. Callaghan). *Below*, modern automatic chamber techniques used to monitor methane at Stordalen, northern Sweden alongside the historical site (Photo: Mikhail Mastepanov 2009)

20.3 Current International Programmes and Organisations

20.3.1 Multi-disciplinary Networks and Organisation

20.3.1.1 Arctic Council and Its Working Groups

The Ottawa Declaration of 1996 formally established the Arctic Council as a high level intergovernmental forum to provide a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic Indigenous communities and other Arctic inhabitants on common Arctic issues, in particular issues of sustainable development and environmental protection in the

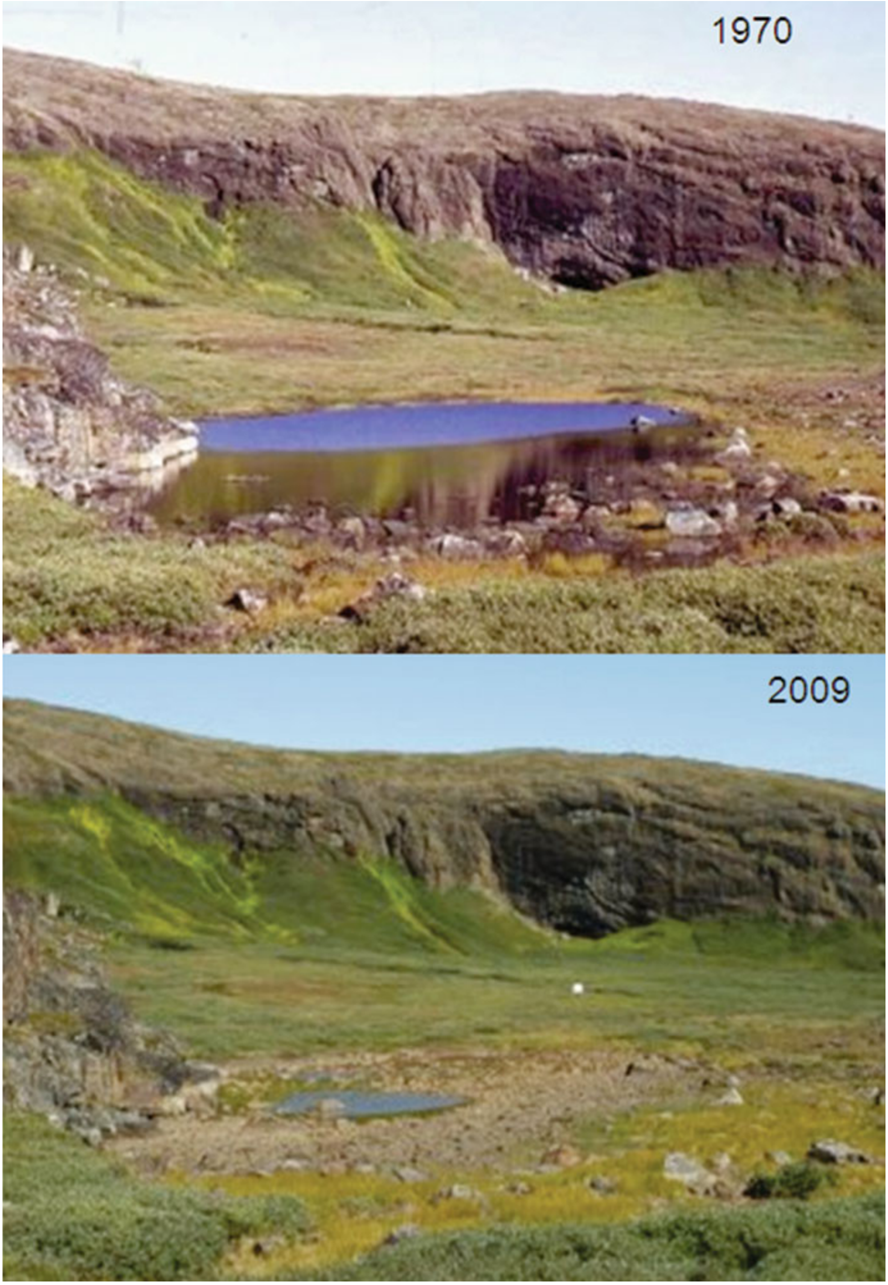

Fig. 20.2 Research site near the Arctic Station on Disko Island, West Greenland, established during IBP and revisited to record change (pond) – and no change (vegetation) as part of the project "Back to the Future" (Callaghan et al. 2011)

Arctic. Arctic Council Member States are Canada, Denmark (including Greenland and the Faroe Islands), Finland, Iceland, Norway, Russian Federation, Sweden, and the United States of America.

The Council's activities are conducted in six working groups. The working groups are composed of representatives at expert level from sectoral ministries, government agencies and researchers. Their work covers a broad field of subjects, from climate change to emergency response. The Working Groups are:

- Arctic Contaminants Action Program (ACAP)
- Arctic Monitoring and Assessment Programme (AMAP)
- Conservation of Arctic Flora and Fauna (CAFF) that includes the Circumpolar biodiversity Monitoring Programme (CBMP)
- Emergency Prevention, Preparedness and Response Working Group (EPPR)
- Protection of the Arctic Marine Environment Working Group (PAME)
- Sustainable Development Working Group (SDWG)

The working groups were largely established as a response to the "Rovaniemi Process" of 1989 that led to the "Rovaniemi Declaration on the Protection of the Arctic Environment" in 1991 (Archer and Scrivener 2000) and the Arctic Environmental Protection Strategy (AEPS) which is a forerunner of the Arctic Council [www.arctic-council.org].

20.3.1.2 International Arctic Science Committee

The International Arctic Science Committee (IASC) is a non-governmental, international scientific organisation founded in 1990. Twenty-two countries, including non-Arctic (China, Republic of Korea, Japan, France, Italy, etc.) are members of IASC. The IASC mission is to encourage and facilitate cooperation in all aspects of Arctic research, in all countries engaged in Arctic research and in all areas of the Arctic region. Overall, IASC promotes and supports leading-edge multi-disciplinary research in order to foster a greater scientific understanding of the Arctic region and its role in the Earth system.

IASC has five Working Groups (WGs): Terrestrial WG; Cryosphere WG; Marine/AOSB WG; Atmosphere WG; Social and Human WG that aim to initiate and support science-led international programs by offering opportunities for planning and coordination, and by facilitating communication and access to facilities.

Some examples of networks that IASC has sponsored are the Network on Arctic Glaciology (NAG); the Polar Archaeology Network (PAN); the Arctic Coastal Dynamics (ACD) network; the Circum-Arctic Lithosphere Evolution (CALE) network; the Arctic Climate System Network (ACSNet); the Palaeo-Arctic Spatial and Temporal Gateways (PAST Gateways) network; the Arctic in Rapid Transition (ART) network; the Arctic Freshwater Synthesis (AFS) network; and the International Study for Arctic Change (ISAC) network [http://www.iasc.info/].

20.3.1.3 Co-operation Between IASC and the Arctic Council

IASC has produced several assessments on climate change in the Arctic and its impacts together with the working groups of the Arctic Council. Some examples are the Arctic Climate Impact Assessment (www.acia.uaf.edu) that was published in 2005 and the subsequent Snow, Water, Ice and Permafrost in the Arctic (SWIPA) assessment in 2011. SWIPA was an up-date that focused on the rapidly changing cryosphere and its impacts (www.amap.no/swipa).

Another form of collaboration between IASC and the working groups of the Arctic Council is the planning of future Arctic research agendas. In 1995, the first International Conference on Arctic Research Planning (ICARP) was held in Hanover in New Hampshire, USA. At this conference, the state of Arctic science was reviewed and gaps and priorities were established that resulted in a series of IASC supported research projects. ICARP II was held in 2005 in Copenhagen, and the outcome was 12 science plans that contributed to research agendas during the International Polar Year. ICARP was held in Toyama, Japan in 2015.

The Arctic Council of Ministers working groups and IASC are also collaborating through a coordinated Arctic Observing Network that meets identified societal needs (the Sustained Arctic Observing Networks – SAON). SAON was formed to develop a set of recommendations on how to achieve long-term, Arctic-wide observing activities that provide free, open, and timely access to high-quality data that will realise pan-Arctic and global value-added services and provide societal benefits.

20.3.1.4 University of the Arctic

The UArctic is based in the circumpolar region and consists of universities, colleges and other organisations with an interest in promoting education and research in the circumpolar North. It was launched in 2001, and endorsed by the Arctic Council. With over 130 member institutions and organisations spanning 24 time zones in the Arctic and non-arctic countries, UArctic is the North's only truly circumpolar higher education institution and one of the world's largest education and research networks. UArctic offers graduate and undergraduate programs, a selection of short, thematically focused courses, mobility and issue-based cooperation. UArctic's Thematic Networks (independent and thematically focused networks of experts in specific areas of northern relevance) foster issues-based cooperation within networks which are focused but flexible enough to respond quickly to topical Arctic issues. They form a natural framework for development of UArctic education and research providing an optimal structure for increasing the knowledge generation and sharing across the North [http://www.uarctic.org/].

20.3.1.5 International Arctic Social Sciences Association

The International Arctic Social Sciences Association (IASSA) is an association of social scientists, humanities scholars and others interested in the Arctic and Subarctic. IASSA was organized to promote and stimulate international cooperation and to increase the participation of social scientists in national and international Arctic research. IASSA has Observer Status at the Arctic Council, and is a member of the International Social Sciences Council. The association is governed by an elected eight-member Council and a General Assembly consisting of all members. IASSA has over 600 members from 30 countries [www.iassa.org].

20.3.1.6 ArcticNet

A Network of Centers of Excellence of Canada was founded as a not-for-profit corporation "ArcticNet Inc." in 2003. ArcticNet is a cooperation of scientists and managers in the natural, human health and social sciences with their partners from Inuit organisations, northern communities, federal and provincial agencies and the private sector. The objective of ArcticNet is to study the impacts of climate change and modernisation in the coastal Canadian Arctic. Over 145 ArcticNet researchers from 30 Canadian Universities, 8 federal and 11 provincial agencies and departments collaborate with research teams in the EU, Japan, Russia and the USA. Network members gather once a year at the ArcticNet Annual Scientific Meetings. ArcticNet has been implementing a comprehensive training strategy to recruit and train new generations of researchers and technicians [http://www.arcticnet.ulaval.ca/].

20.3.1.7 The International Polar Year 2007/2008

The International Polar Year 2007/2008 was a large scientific programme focused on the Arctic and the Antarctic from March 2007 to March 2009.

IPY, organized through the International Council for Science (ICSU) and the World Meteorological Organization (WMO), is actually the fourth polar year, following those in 1882–1883, 1932–1933, and 1957–1958 (see above). In order to have full and equal coverage of both the Arctic and the Antarctic, IPY 2007–2008 covered two full annual cycles from March 2007 to March 2009 and involved over 200 projects, with thousands of scientists from over 60 nations examining a wide range of physical, biological and social research topics (Krupnik et al. 2011).

During IPY, several networks were established – some persistent, some temporary. One example was "Back to the Future" that involved older and younger generations of researchers re-visiting old sites to record change and hand-over site stewardship between generations (Callaghan and Tweedie 2011). Another example was the Thermal State of Permafrost (TSP) project during which several hundred boreholes were drilled in the Arctic to record ground temperature and initiate long term monitoring aimed at monitoring the thermal state of permafrost.

20.3.2 Single Discipline Networks

Some examples of single discipline networks are listed below.

20.3.2.1 International Permafrost Association

The International Permafrost Association, founded in 1983, disseminates knowledge on permafrost and promotes cooperation among persons and national or international organizations engaged in scientific investigation and engineering work on permafrost. IPA covers aspects of theoretical, basic and applied frozen ground research, including permafrost, seasonal frost, artificial freezing and periglacial phenomena. Committees, Working Groups, and Task Forces organise and coordinate research activities and special projects. However, the Association's primary responsibilities are convening International Permafrost Conferences, undertaking special projects such as preparing databases, maps, bibliographies, and glossaries, and coordinating international field programs and networks. Field excursions are an integral part of each Conference, and are organized by the host country.

To provide a future for permafrost and related research activities, the IPA established PYRN – the Permafrost Young Researchers Network - that maintains communication among young researchers. Also, the Global Terrestrial Network for Permafrost (GTN-P) was initiated and established in 1999 by IPA to organize and manage a global network of permafrost observatories for detecting, monitoring, and predicting climate change. The network brings together 850 sites in the Northern and Southern Hemispheres (in continuous, discontinuous and sporadic permafrost) [http://www.gtnp.org/].

20.3.2.2 International Tundra Experiment

The International Tundra Experiment involves scientists from more than 11 countries, including all the Arctic nations. The program started in 1990 at a meeting of tundra ecologists (including the first author of this paper) who established a resolution with general principles of research (Webber and Walker 1991). ITEX seeks to examine the response of circumpolar cold-adapted plant species and tundra ecosystems to an increase in summer temperature. The ITEX research model combines long-term and short-term experimentation with monitoring and has the elegance and simplicity called for to understand ecosystem response and vulnerability to change. The experiment is designed to examine the effects of temperature change; maximize geographic representation, by minimizing technical and equipment requirements; be long-term; focus primarily on species; and, if resources permit, allow for genetic and system level studies. Each ITEX site operates some form of warming experiment, mainly using open-top chambers to warm the tundra, and established protocols are used to standardise response variables. The network has published meta-analyses on plant phenology, plant growth and reproduction, composition and abundance, and carbon flux [http://www.geog.ubc.ca/itex/].

20.3.2.3 The Shrub Hub

Another botanical network researching changes in woody vegetation in Arctic and alpine tundra ecosystems is the Shrub Hub. The Shrub Hub is a network of researchers investigating changes in woody vegetation in Arctic and alpine tundra ecosystems. This network was established to foster communication between researchers working in tundra ecosystems around the Arctic and to promote data synthesis. It is basically a response to the initial observations that showed rapid and widespread expansion of shrub vegetation throughout the Arctic. The network has members from 18 different countries. The scientists (including early career researchers) work in each of the eight Arctic Nations and also in alpine tundra sites. The program is supported by the International Arctic Science Committee (IASC) [http://shrubhub.biology.ualberta.ca/].

20.3.3 The Russian Experience: A Special Case

As high latitudes of the northern hemisphere are particularly sensitive to global changes, scientists expect drastic changes in ecosystem dynamics, biogeochemical cycles, and atmospheric conditions in these latitudes. Siberia, the largest terrestrial area of the Arctic Region, plays a key role in these changes and global climate change impacts are already particularly evident there. Due to historical and political factors, Russian scientists have not been able to take part in the work of international networks and programs for a long period. Although international cooperation is currently developing, international research programs initiated with the participation of Russian scientific and academic organisations remain the best programs available for Russian scientists. Below are examples of some international networking.

20.3.3.1 The Fram Arctic Laboratory

The Fram Arctic Laboratory (FAL) involves joint Norwegian-Russian research on Arctic climate change. Thematically, the cooperation focuses on long-term changes in the physical system including the marine system (ocean and sea ice), the atmosphere and the terrestrial system (glaciers and fresh water). Geographically, the focus is on the Euro-Arctic region, with special emphasis on Svalbard and the Greenland and Barents Seas. The collaboration includes joint research programmes in Barentsburg, Ny-Alesund and Longyearbyen. The Norwegian partners are the Norwegian Polar Institute and The University Centre in Svalbard [http://www.fram.nw.ru/].

20.3.3.2 The Otto Schmidt Laboratory for Polar and Marine Research

The Otto Schmidt Laboratory for Polar and Marine Research (OSL) involves Russian-German cooperation. OSL's main objective is to support young scientists in Polar and Marine Research through the OSL Fellowship Program. The German partners are the Leibniz Institute of Marine Sciences IFM-GEOMAR and the Alfred Wegener Institute for Polar and Marine Research. The OSL network includes institutes of the Russian Academy of Science, universities and research stations in Russia and Germany [http://www.otto-schmidt-laboratory.de/].

20.3.3.3 The French-Russian Research Network CARWETSIB

The French-Russian research network CARWETSIB (Carbon, Water and Metal Transport in Wetlands of Western Siberia and in forested watersheds of Central Siberia: Key for understanding the future climate and environmental health of the boreal zone) started in 2007. CARWETSIB explores challenges of global climate change in Siberia which, due to the presence of permafrost and important stocks of organic carbon in forest soils, tundra and swamp zones, is particularly vulnerable to climate change. The study focuses on three regions of Siberia: the forested watersheds of Central Siberia, the thermokarst lakes of North-Western Siberia, and the large surface of pristine peatlands (‘mires’) of Western Siberia. The key activities comprise a combination of field studies (ground observations), chemical and isotopic analyses and various remote sensing and modeling techniques. Eight French research institutions and six Russian partners are participating. In addition, CARWETSIB now also cooperates with a German partner.

20.3.3.4 The Siberian-French Centre for Education and Research

The Siberian-French Centre for Education and Research (SFC ER) developed in 2012 based on the experience of French-Russian cooperation in CARWETSIB. SFC ER is a network of 38 French and Russian national institutions that bring together scientists working in natural, social and human, Earth and life sciences and also chemistry in Siberia (Fig. 20.3). Its objectives are to facilitate and encourage participants to share information, to organise joint events, to prepare joint research proposals and also to exchange students and develop trainings via national, European and international funding calls. The SFC ER is currently based on five topics, and one of these is “Environment, Biosphere, Climatic Change”. To allow the French-Russian scientific community involved in the “Environment, Biosphere, Climatic

Fig. 20.3 O. Pokrovsky and colleague taking sediment samples to measure sediment chemistry as part of the CARWETSIB network in an expedition to the Western Siberian wetlands, in 2008 (Photo: Sergey Kirpotin)

Change" topic to form lasting collaborations, a first workshop on "Siberia's role in current global change" took place at the Observatoire Midi-Pyrénées in Toulouse in December 2013. This interactive workshop intended to pave the way for efficient sustainable cooperation on research, data, training and education between France and Russia.

20.4 INTERACT as an Example of a Successful and Comprehensive Network

In 2001, a network (SCANNET: Callaghan et al. 2004) of nine research stations in countries surrounding the North Atlantic Region were awarded an EU grant to build capacity for environmental monitoring and research (Fig. 20.4a). The great advantages of working together to improve environmental monitoring, opportunities for researchers, and accessibility to data, attracted more station managers: by 2010, 33 research stations located in all 8 Arctic and neighbouring countries joined together to create INTERACT, funded by the EU. Just 3 years later, the number of stations has doubled to more than 70 (Fig. 20.4b). The stations are multi-disciplinary

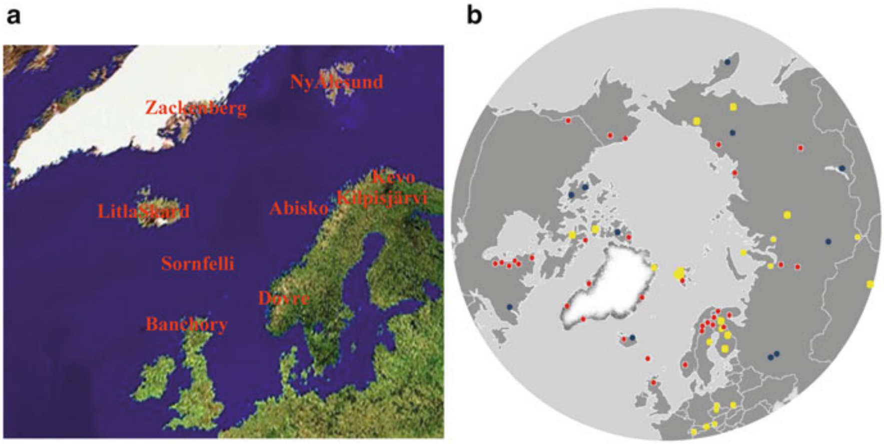

Fig. 20.4 (**a**) SCANET sites in 2001 (*left*) and (**b**) INTERACT Sites by May 2014 (*right*) where *Red dots* = partners from 2010; *yellow dots* = observer stations joining since 2010; *blue dots* = current applications being processed

covering the cryosphere, biosphere, lower atmosphere and human dimensions. Together, the stations host thousands of researchers annually as well as single discipline networks while the geographical distribution of the stations in the network ensures that the whole environmental envelope of the Arctic is observed (Fig. 20.5a). Furthermore, it has recently been understood that the network also samples northern areas that show different types of responses to climate change (Xu et al. 2013: Fig. 20.5b).

INTERACT is building significant capacity for research, monitoring and education. It brings together managers of the research stations in a Station Managers Forum. Here, issues such as improved and standardised monitoring, data accessibility and best practices for operating stations are discussed and decisions implemented. Major output includes reports on facilities and environment at each station (http://www.eu-interact.org/station-managers-forum/station-catalogue/), best practices of operating a remote research station (http://www.eu-interact.org/station-managers-forum/report-deliverables/station-management/), a meta-database of monitoring and research projects since 2000 (in progress) and a book of "science stories" based mainly on scientific findings from researchers granted transnational access awards by INTERACT (see below) (in progress).

INTERACT also provides transnational access which is centralised funding for researchers to visit stations outside the countries where they work. This EU funding has been leveraged to gain funding in Canada and the US and for the first time, researchers can apply to INTERACT for travel and subsistence to visit stations in all northern countries including Russia. The funds have been used strategically to focus research on high priority gaps identified by major international organisations and to build international collaborations. By the end of 2014, about 520 INTERACT-sponsored researchers will have spent around 10,000 research days at cold region

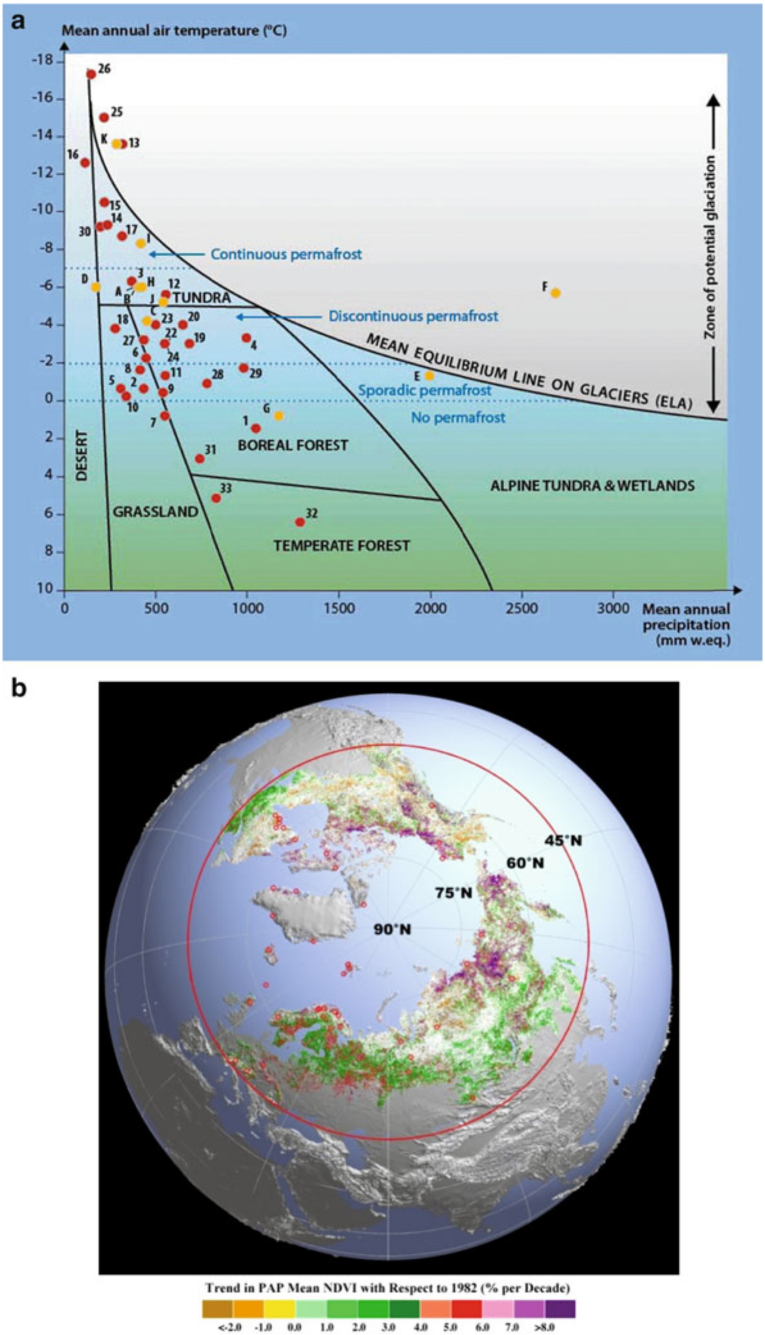

Fig. 20.5 INTERACT's strategic sampling framework. (**a**) Distribution of stations related to the Arctic's environmental envelope, including thresholds: Callaghan et al. 2004 up-dated. (**b**) Distribution related to patterns of greening of the Arctic and boreal regions (Xu et al. 2013)

Fig. 20.6 Downloading and checking equipment at an INTERACT site (Nuuk, west Greenland) to record exchanges of energy and water between the ground surface and lower atmosphere (Photo: T. R. Christensen)

research stations. Many recipients are early career scientists that can leverage the transnational access funds to get national awards.

Although EU-funded infrastructures are not eligible for funding for research projects, they are supported for the R & D that underpins more efficient monitoring and data access. Within INTERACT, new energy-balance equipment has been designed, tested and established at multiple sites (Fig. 20.6) in collaboration with ICOS (Integrated Carbon Observing System) while improved methods for recording phenology and networking sensors have been developed. In addition, a GIS system has been developed to combine station management with archiving research and monitoring data. INTERACT also has a strong outreach component and is actively involved with school education and citizen science.

The stations and the network provide an invaluable role in integrating projects and building collaborations. Of particular importance is the "MMM and M" concept whereby Monitoring (that identifies environmental change) is integrated with environmental Manipulation (that gives a process-based understanding of change) and Modelling (that up-scales changes and predicts future changes) (Johansson et al. 2012). These integrated activities can then be used to develop knowledge based environmental Management. INTERACT also works with local stakeholders to integrate local and traditional knowledge with science knowledge and with education in general. It works with the University of the Arctic at the wide, circum-Arctic

Fig. 20.7 International Summer School in 2013, arranged by Tomsk State University at its Aktru Research Station, in the Altai Mountains. The Aktru Research Station is a member of INTERACT (Photo: Yana Pchelintseva)

scale, and with individual stations such as Aktru in the Altai Mountains to deliver information to students at summer schools (Fig. 20.7) (Pchelintseva et al. 2014).

INTERACT is increasingly being sought-after as a partner by national and international projects and programmes and is happy to collaborate [www.eu-interact.org].

20.5 Barriers to Networking and Cooperation

20.5.1 Sustainability

Networks tend to be ephemeral as science questions, priorities and measurement/experimental technologies change over time. However, the infrastructure building blocks that they are based on represent major investments and should be persistent. They can then, as they have in the past, support the work of new networks and international collaborations as science questions develop and change over time. What is important, is that the research station building blocks continue to collaborate so that they can more efficiently support a diversity of scientific networks and help to answer a flow of continuing new science questions. Although new research stations are currently being established in Canada, Russia and Svalbard, others have insecure funding. Any loss of individual stations will weaken the current geographically comprehensive holistic network and understanding of the diverse Arctic system.

20.5.2 Observing Power and Scales

Traditionally, research stations have performed and facilitated intensive observations that require constant/repeated effort, advanced technology and/or integration with experiments. However, a simple calculation can estimate the degree to which the Arctic is under-sampled: assuming there are 100 research stations within the 11,000,000 km^2 of the Arctic and that each research station intensively observes within a radius of 5 km^2, then the intensively observed area is less than 0.01 %. Of course remote sensing (from satellite, planes, helicopters and drones) and modelling fill the gaps to some extent but the process-based understanding, for example derived from environmental manipulation experiments, is usually missing and the communication among the various methodologies is generally poor. There is a consequent need to improve interaction and networking among the ground observation, remote observation, experimental and modelling communities.

Another aspect of scaling is that it is becoming increasingly important to include the Arctic in wider cold region networks such as those dealing with Antarctica (www.scar.org), the Third Pole of the Himalayan Region (www.thethirdpole.net) and the global Mountain Research Initiative (http://mri.scnatweb.ch/en/). Already, the global initiative GEO/GEOSS (https://www.earthobservations.org/geoss.shtml) has a cold region activity and INTERACT is co-leading this and therefore linking the Arctic with the Global Earth system of systems.

20.5.3 Understanding Observations by Integrating Disciplines and Domains

Although discipline- and domain-based observations can readily identify environmental and other changes, the causes of the changes can often only be understood by gaining a process-based understanding. This can be achieved at the small scales by combing approaches such as monitoring, manipulation and modelling as mentioned above. However, at the larger scale, it is becoming more obvious that interactions between cryosphere, biosphere and people – including historical land use, are important. For example, industry in the south produces black carbon that is deposited on snow that melts faster and can result in a change of permafrost condition that may reduce plant productivity and the animal populations that depend on plants for food (apparently no study details all the interactions). Furthermore, interactions between land, coastal areas, ocean and atmosphere determine teleconnections around the world (e.g., Callaghan et al. 2011). For example, loss of sea ice affects temperature and precipitation on land that affects vegetation productivity and herbivore populations (Post et al. 2013). This huge complexity of the Arctic System and the Global system of Systems requires a far greater development of cooperation between researchers in the various domains than at present.

20.5.4 Bottom-Up and Top-Down Observation and Research

The number of research infrastructures in terms of bricks and mortar and the number of observers and researchers is finite. However, the combinations of research themes and constellations of coordination activities appear to be endless. Coordination activities are low-cost and rapidly established in contrast to operating research stations. There is apparently, therefore, a plethora of coordinating activities that have recently developed – and are continuing to be developed – but they all require the data from the fundamental building blocks. A more sustainable balance needs to be established between the infrastructures and the coordinating activities.

20.6 Future Developments

The internet has totally transformed the effectiveness of cooperation in the Arctic and is perhaps more essential in this remote region than elsewhere. Information flows out from the data providers in the Arctic to the research community, managers, policy makers, local inhabitants, students at all stages, the general public and the media. Society is currently data-hungry and multiple data bases request the same information. However, there is no data base of data bases and handling extensive data sets from the Arctic in a coordinated and holistic way has not yet been achieved.

The internet has also brought a new dimension to sampling in the Arctic. Traditionally, researchers visited sites in the Arctic to work in the field. Funding by the EU for Arctic infrastructure programmes in the Arctic established the process of transnational access as described above. This ensures collaboration across international borders and has been very successful on Svalbard, in northern Sweden (ATANS) and in northern Finland (LAPBIAT). Now, the comprehensive geographical coverage of INTERACT and the internet tool provide *virtual access*, i.e., access to data through a station's web site, *remote access*, i.e., the ability for distant researchers to request observations or samples from a geographically dispersed set of stations, and a rapid response capability in which a one-stop-shop can be contacted to make circum-Arctic observations of extreme events and potential hazards. The events and hazards could be extreme weather, tundra and forest fires, advance of invasive species, spread of pathogens and their vectors etc. However, despite the technological advances and burgeoning opportunities offered by the internet, the power of observation and interpretation resides in people and the resulting understanding of changes in our Arctic environment and ecosystem services is aimed at improving the well-being of Arctic inhabitants and the global community. SCANNET started as a "Network of Friends" in 2001 and its continuation as INTERACT continues to expand the number of friends in the network: perhaps this is the basis of its success.

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Chapter 21
The Assessed Arctic: How Monitoring Can Be Silently Normative

Nina Wormbs

Abstract The Arctic is an assessed region. Scientific assessments are becoming larger in number. Evaluations of the state of the art in the Arctic are made based on monitoring and data gathering. As reports are followed up by new ones, comparison is possible and change can be analyzed. Finally recommendations for action are made and put to the members of the Arctic Council. Hence, the task is really to give directions for the future. This chapter argues that this growing business of assessments, which have their correspondence in other areas, are in many ways good since they enlarge our knowledge. At the same time attention should be paid to how the produced knowledge might function in different areas of policy. If they are to function as recommendations on how to change societies and people's behavior for the future, the basis cannot be only natural science but need to be broader. However, moving value-laden recommendations on human societies and economic development into the realm of science might work as a way of de-politicizing policy for the Arctic.

Keywords Arctic Assessments • Monitoring • Policy recommendations • Arctic futures • Arctic social science and humanities

21.1 Introduction

In a recent scientific assessment on the Arctic cryosphere four areas of unknowns are discussed at the end of the popular report; "what will happen to the Arctic Ocean and its ecosystems as freshwater is added by melting ice and increased river flow?", "how quickly could the Greenland Ice Sheet melt?", "how will changes in the Arctic cryosphere affect the global climate?" and finally "how will the changes affect Arctic societies and economies?" (AMAP 2012, x). The first two deal with large-scale changes related to melting ice and the third relates the climate change of this region to that of the global climate. All three of them are within the realm of natural science; oceanography, glaciology and climatology are disciplines that will have to

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be involved in research to investigate the issues. The fourth area, however, is of a totally different kind; it deals with humans. How did an encompassing question on the changing Arctic economies and societies end up in a summary on the cryosphere and what kind of function could it have in such a context?

This chapter analyses a number of scientific assessments in relation to scientific value systems and the political context of the Arctic and inquires into the terminology of monitoring and assessing. The purpose is to reflect closer on the tension between these three different realms: monitoring, assessing and the policy and their overlapping ambitions.

It should be stressed that focus here is primarily the resulting *text*, not the process of producing this text per se, nor the resulting policy, even though the context of this production can be of interest as well as its consequences. However, when the text is printed and distributed, this context is of less importance and the text has to stand for itself. It becomes what sociologist Bruno Latour has called an immutable mobile (Latour 1987). In this case it carries with it the resulting agreed upon statements on the Arctic and what should be done as signed off by those authorized to do so.

21.2 Arctic Assessments: What Are They?

During the last few decades scientific and other assessments have increased in numbers (Mitchell et al. 2006). A simple Google search through ngram also validates this impression. Having been at a steady percentage of the word in books published from 1900 to about 1945, a continuous increase occurs from the late 1940s. In 2000 the word is six times as common as after the war. This does not mean that we have six times as many assessments, but the term occurs six times as often, which is an indicator of its popularity and perhaps also importance. Assessments have taken position in post-war vocabulary and as a phenomenon worthy of analyses it is subsequently attracting the interest of scholars (cf for example ongoing work by Naomi Oreskes or Silke Beck).

Arctic assessments have also increased, even though they are later than the general trend. This has historic explanations as the monitoring and measuring of the circumpolar north was easier to achieve after the end of the Cold War. The organizational and political background was the Rovaniemi Declaration in 1991 when the eight Arctic states adopted the Arctic Environmental Protection Strategy (AEPS), a document aimed at primarily protecting Arctic ecosystems, including humans. To implement the strategy a number of working groups were created, among which the Arctic Monitoring and Assessment Programme (AMAP) became very influential (Russell 1996; Mathiassen 2001). This programme is referred to many times in this book.

The original remit for AMAP was to "measure the levels, and assess the effects of anthropogenic pollutants in all compartments of the Arctic environment, including humans; to document trends of pollution; to document sources and pathways of pollutants; to examine the impact of pollution on Arctic flora and fauna, especially those used by indigenous people; to report on the state of the Arctic environment; and to give advice to Ministers on priority actions needed to improve the Arctic condition" (AMAP 1998, p 4). Hence, giving advice has been part of the task of AMAP all along; the suggestions for action was put into the AMAP-process and thereby made part of the scientific monitoring and assessment as such.

The assessments discussed here are those under the AMAP heading. They are chosen not only because they were influential and has been regarded one of the prime outcomes of the work of the Arctic Council (Kankaanpää and Young 2012), but because they are scientific and my interest is how natural science contributes to policy and subsequently to the formation of Arctic futures. There have been assessments outside of the AMAP system, which have tried to be more comprehensive and incorporating other disciplines than natural science, such as the Arctic Human Development Report in 2004 with a follow-up 2014, or the Arctic Resilience Report (interim report 2013 and full report under preparation); both are projects under the Arctic Council but not part of AMAP. They are not dealt with in this chapter.

21.3 From Pollutants to Ice

The first AMAP report was the result of a 6-year project that resulted in a scientific report 1998 (AMAP 1998) and a summary version 1997 (AMAP 1997). These two reports were both based on the scientific monitoring and assessment, and both contained an executive summary with suggestions. The executive summary was written by a working group and had a legitimate scientific basis (Mathiassen 2001, 75, 109). Since I take interest in the policy function of the assessments and their possible role in formulating futures that politicians and officials and others can relate to, the summary versions are of greater interest and I therefore focus on those.

The report can be said to have two parts. The first was to give a background and description of the Arctic, of transportation of contaminants, of the ecology and of the peoples living there. Then specific areas were described and the consequences of the state of matter were discussed, what we might call the actual assessment. This included four areas of contamination – namely persistent organic pollutants (POPs), heavy metals, radioactivity and acidification and haze; oil exploitation and its observed as well as possible consequences; global issues like climate change and its effects and finally how human health was impacted by pollution. The executive summary with recommendations was placed in the beginning.

Even though the separate chapters could be said to fall into two categories, the difference between the describing chapters and the assessing ones was very small. The entirety of the text was descriptive. In accordance with standard scientific language usage, values were omitted and matters simply stated. Surprisingly enough, this was also true for the executive summary in which recommendations for political action were to be found. A few recommendations involved informing indigenous peoples, but the lion's part was aimed at securing scientific and other knowledge as basis for action. It was stated that international strategies needed more information, further developed models, long-term monitoring and all this in a larger area to ensure a greater coverage and meet local needs. When it came to policy suggestions, the overarching message was to develop and adhere to international protocols and law (AMAP 1997). This was a foundation eventually resulting in the Stockholm Convention on persistent organic pollutants rested, adopted in 2001 (Nilsson 2012; Downie and Fenge 2003).

The second report came some 5 years later and was also focused on pollution issues. In this second phase, AMAP was under the auspices of the Arctic Council, which specifically requested AMAP to "recommend actions required to reduce risks to Arctic ecosystems" (AMAP 2002, iv). In the executive summary this time the language had changed somewhat. The basic setup of the summary were headings stating "It has clearly been established that:" and "There is evidence that:" followed by the heading "It is therefore recommended that:" under which different kinds of suggestions were made. The tone of these suggestions varied but still focused mostly on the need for new knowledge.

In 2004 the influential ACIA report was published. ACIA stood for Arctic Climate Impact Assessment and the word *climate* was of essence. Even though AMAP had had climate as an area to monitor, not much had been done, which was due to the remit of IPCC and the focus on climate change as a global issue (Nilsson 2007, 100–1). The climate modeling at the time was also predominantly global and regional climate models were only starting to appear (Sörlin et al. forthcoming). The ACIA was a cooperative effort between AMAP and one other working group of the Arctic Council, namely the Conservation of Arctic Flora and Fauna (CAFF), and the International Arctic Science Committee (IASC).

In the AICA report, the clarity of the message was even further enhanced through the use of "key findings". Interestingly enough, six out of ten key findings dealt with the impacts on human built societies or infrastructure. It covered coastal erosion, which could hit communities, marine transport that would increase due to loss of sea ice, thawing that would affect infrastructure, the subsequent impacts on indigenous communities, effects on people by radiation and finally the fact that a plethora of changes interacted with each other resulting in even more impacts on people and ecosystems (ACIA 2004, 10–11). This focus on peoples was also present in the opening of the report where Global Climate Change, the Arctic Region and the People of the Arctic were presented as the overall context. However, in the section when the supporting evidence for the key findings were spelled out it was clear that the actual basis for the statements on people and societies was substantially weaker than for the statements regarding climate change, plants and animals (Nilsson 2007). This tension is more visible in the popular report than the scientific report since societal issues were given more room in the former one, but with the same scientific basis.

Despite the traction that ACIA drew there were in this report no clear recommendations. Instead there were "concluding thoughts" that underscored the report as a scientific basis for decision makers. The only point where recommendations could be found was in the section on how assessments could be improved. The focus was on how to monitor natural processes better, where indigenous knowledge was stressed, and how to refine and validate models. This was connected to the separate process of formulating a policy document that was part of ACIA. As Nilsson has showed in detail, this process was all but smooth and also connected to national political considerations (upcoming US elections). In the end, the policy document approved was actually weaker than many preceding documents (Nilsson 2007, ch 5.4).

The same year as the ACIA was published there was also a report on Persistent toxic substances, food security and indigenous peoples of the Russian North as a follow up on the findings in the first report on the health of indigenous peoples. And during the following years a number of reports were issued as follow up to the two first AMAP reports and the ACIA. In 2007 there was an Assessment of Oil and Gas Activities in the Arctic, in 2006, 2009 and 2011 there were reports on Arctic Pollution (2011 with a special focus on mercury), and in 2009 an Update on Selected Climate Issues of Concern. The overarching impression of these reports is that they follow the established mode of recommending adherence to international and legally binding laws and that more monitoring is needed.

The last example is the SWIPA report from 2011, Changes in Arctic Snow, Water, Ice and Permafrost, and a follow-up to ACIA. This assessment focused on the cryosphere and was a cooperation between AMAP, IASC, the World Climate Research Programme / Climate and Cryosphere (WCRP/CliC) Project and the International Arctic Social Sciences Association (IASSA). Scientists worked with experts and "knowledgeable members of the Arctic indigenous communities" between 2008 and 2011. Given this ambition to strengthen indigenous knowledge in the assessment process, the way in which the human condition is treated in the report is interesting.

In the Executive Summary of the overview report 15 key findings were presented, ranging from data on melting ice over statements about changing conditions for transport to the need for more monitoring. Interestingly enough, this need was framed as a finding and by that recommendations were brought into the realm of the monitoring itself. Also *projected* and *expected changes* in the cryosphere were framed as findings, illustrating the ongoing drift in terminology. As modeling becomes part and parcel of climate change the understanding of what is past, present and future is also undergoing change.

The most interesting finding in the SWIPA overview report is key finding 14, which was presented under the heading "What should be done" and thus clearly a recommendation framed as a conclusion. It read: "Everyone who lives, works or does business in the Arctic will need to adapt to changes in the cryosphere. Adaptation also requires leadership from governments and international bodies, and increased investment in infrastructure" (AMAP 2012, ix). Here, the peoples of the Arctic are the ones that *need* to act, whereas what is required by governments and other bodies has been put in a more passive voice. In the text itself the word "urgent" is used several times which balances the briefer key finding. Yet, the final finding, which also sorted under "What should be done", again stressed uncertainty and claimed that more research and monitoring is needed. It is also in this section of the Executive summary that the listing of unknowns brought up in the beginning of this article is to be found. Next to the question of how long it will take before the

Greenland Ice Sheet melts is the magnificent unknown: “How will the changes affect Arctic societies and economies?” (AMAP 2012, x).

It is clear that these undertakings are of a very different kind; to calculate ice melt might most certainly offers a grand challenge to science, however, compared to answering how four million people in the circumpolar North will be affected by climate change, it seems rather straight forward. In order to even start responding to the big question, it has to be subdivided into much smaller investigation, fine-tuned to the fact that Arctic societies are extremely different. The fact that there is not one Arctic is perhaps true in its most profound way when it comes to the human endeavor in the region.

Based on the above, I would now like to discuss three different issues. First I will talk about how the scope of assessments has changed over time and present a reason for why that is. Second I want to focus on the terminology of change and how it might relate to scientific practice. And third I will analyze what function scope and terminology of scientific assessments might have for politics and policy in a new Arctic.

21.4 What Is Legitimate or Necessary to Investigate? A Question of Scope

When the work on AMAP began pollution issues were high on the agenda not just in the Arctic. The 1980s had seen a broad debate on acidification of lakes and death of forests and issues of radioactive fall-out were fresh in mind after the 1986 Tjernobyl accident. Also heavy metals and POPs were being discussed elsewhere and it is therefore not surprising that the task of AMAP was focused on pollution issues. It is also clear that the focus on ecosystems, which keeps recurring as an area of investigation, was in line with a general trend on how to view the workings of the environment.

It is more surprising that climate change is not considered more thoroughly until 2004. It has been argued that this can be explained by the fact that climate change was considered on a global rather than regional level (Nilsson 2007). It can also be argued that climate change was unavoidable in 1999 or 2000 when the work on ACIA began, and had to be investigated for the Arctic. When AMAP started the IPCC First Assessment Report had been around for a couple of years and for a large part of the climate science community there was consensus on anthropogenic climate change (Oreskes 2004). This would indicate that AMAP, a working group then under the auspices of the eight Arctic states in the Arctic Council, was not paving the way for new investigations, but rather behaving cautiously in its choice of scope. Being cautious is often a recommended way to avoid conflict, which can be expected to have been in the interest of the Arctic Council.

That indigenous peoples had to be part of the assessments was clear in the ACIA, even though their voices were rather low and not a fully integrated part of the scientific choir. Again it can be said to have been impossible to leave them out in 2004, and they had also themselves acquired a role as experts not only as carriers of specific knowledge but in fact as participants in this type of processes. Perhaps that is also the answer to why the crude question on the impact of climate change on Arctic societies and economies had to be posed in SWIPA in 2011; it is impossible to leave it out of an assessment on the cryosphere, even if ice, snow and permafrost is at the center of the monitoring. And as the knowledge base for statements about the social is poor, the only way AMAP can address human issues is on a very general level.

However, there could also an inherent problem for scientific assessments to handle and incorporate social science and humanities knowledge in a unified language. It would indeed be difficult to summarize changes in human societies and economy as key findings. Reducing extremely complex questions of the development and change of human societies often result in strong critique (cf The Club of Rome and the pursuing debate). It is possible that the same logic lies behind the reduction of the Arctic peoples themselves. Already in the first report from 1997 there was a formulation stating: "Arctic cultures remain vital and resilient, despite tremendous social, demographic, and technological changes during the twentieth century." (AMAP 1997, vii). In the SWIPA report this was expressed as: "Arctic communities are resilient and will actively respond to cryospheric change" (AMAP 2012, 89). Would it be possible to talk about human societies elsewhere in the same vein, defining them as vital and resilient, or on the contrary lame and doomed? Probably not. Imagine a statement on New Yorkers, or inhabitants of the French city Lyon talked about in the same language. It could very well be a consequence of the mismatch that arises when using the natural science framework for talking about people and societies.

It could, however, also be a consequence of the exceptionalization of the region itself. Historically this has been a place of science, where scientific knowledge has been privileged over other forms of knowledge, even though the scientific project as such has changed over time. The turn of the century heroic science featuring self-sacrifice, exploration and adventure gave way for a more systematic approach albeit slightly different for the Arctic states undertaking most of the research starting in the 1930s with the international polar year 1932–1933 (Doel et al. 2014). The scientific framing of the Arctic arguably still remains and carries explanatory value when analyzing Arctic assessments.

21.5 Terminology of Change and the Values of Science

There is an interesting tension between the two words monitoring and assessing in AMAP. Monitoring is connected to counting, quantifying, measuring, and recording. It seems straight forward enough and only to carry out, once the procedure has been agreed on. (I here overlook the fact that the actual practice might likely involve difficult questions on how to treat the monitored object if it disobeys the procedure or if the apparatus – in any form – steps out of line. Likewise I overlook the process and plethora of decisions leading up to the practice or monitoring. This is not because it is un-important, on the contrary, but it is too complex for this argument.)

When conducted, a set of often numerical values, which might change over time and place, is the result of the monitoring, and hence what Latour would have regarded an immutable mobile; its value does not change with context (Latour 1987). Assessment on the other hand is not. It is truly context dependent since it also entails evaluation. Etymologically the term is Latin and comes from the person who sat beside the judge in court and decided the size of a fine or a tax of a property. To say whether or not a particular level of radiation is harmful or not is a matter of judgment. To decide how much pollutants can be accepted boils down to an evaluation. To put monitoring and assessing together creates a space of uncertainty of what is really going on, whether this is disinterested science or actually policy in the shape of objective data.

The border between science and policy is constantly constructed. This practice of drawing the line or building the brick wall has been called boundary work and has contributed substantially to our understanding of how science and scientists work (Gieryn 1983). Maintaining their credibility, scientists need to choose their position in relation to politics and policy with care (Pielke 2007). Politicians are rarely accused of doing science, but scientists can be questioned if they step out of their expertise and make value judgments, which are inherent in politics (or at least should be if not all politics is to be evidence based). Partly this is because among the varying general demands on science such as transparency and repeatability, the values of neutrality and disinterestedness are also regarded highly. Underlying this is the presumption that it is most difficult, if not impossible, to maintain objectivity in a scientific endeavor if steered by value judgments and ethical convictions beyond that of the scientific method itself.

However, it has recently been argued that disinterestedness (if you for example apply for projects you think can get funding due to research policy consideration) is perhaps not the most hailed values in science any more (MacFarlane and Cheng 2008), and that dispassion is a problem for science communication (Oreskes 2013). More importantly, however, is the claim that the values of science, such as rationality, dispassion and self-restraint, can result in scientists demanding greater support for findings that appear dramatic. Brysse et al. have termed this "erring on the side of least drama" and use climate change as a case in point (2013). Two examples used are ozone depletion and the West Antarctic ice sheet, but they might just as well have looked at the underestimation of the shrinking of the Arctic sea ice, which was not predicted by the majority of the regional climate models (cf Christensen et al. 2013).

Against this backdrop the cautionary language of the AMAP reports is more understandable, but also more problematic. As Brysse et al. point out, strong adherence to perceived core values of scientific endeavor might instead work contrary to the hailed good judgment, as there is a bias towards demanding more evidence when great change is being observed. As the Arctic has been called a bellweather for climate change, where amplitudes are higher and impacts greater, it could be said to be remarkable that the language on the reporting on climate change is so dispassionate and moderate.

21.6 Monitoring as Containment?

The repeated call for more monitoring in the recommendations could hence be interpreted as a way of bridging the science-policy interface, of overcoming the tension between objective monitoring and value-laden politics. It could also answer to the call for more data that has been put forward by those who are not convinced of climate change, and by that the issue is further postponed. It is, however, not difficult to argue that we by now know enough for action.

However, if the monitoring itself can also encompass assessments and even recommendations, then continued measurements can function as a way of de-politicizing climate science and thereby bringing the spheres together. And in that way, assessments also become futures that are relevant for changing societies. In the midst of encompassing data on the natural world, notes on humans can also be incorporated.

However, that would also mean that Arctic pollution issues, climate change and the human condition is contained in monitoring efforts that seem to have no end. It keeps the issues off of the table of the Arctic Council, which can continue to focus on issues where consensus can be reached and argue that this is a region where conflict is history and agreement and peace prevails. During and before the Cold War, the Arctic states produced their own scientific and national data on the Arctic (Doel et al. 2014). In the new Arctic, AMAP has that role and hence there is reason to keep an arms' length distance to politics, at the same time as the Arctic is becoming more politicized. If AMAP would be more demanding, clearer in its statements and leading rather than following in what to investigate, the result might easily challenge the consensus process in the Arctic Council. The consequences might be more voices raised for opening this governance model to more members, arguing that the Arctic Council is not functioning properly. Already now many are knocking on the door of the council, wanting to be part of the inner circle (compare ongoing research by Eric Paglia).

A dispassionate and objective, ongoing monitoring could very well serve political ambitions in the region by keeping scientists busy. The questions that still begs and answer, however, is whether this is a useful way of approaching the challenges facing human societies.

21.7 Conclusion

This chapter argues that there has been a shift in focus of the scientific assessments on the Arctic environment in the last 15 years following the general trend of environmental monitoring in including broader issues on human conditions. The incorporation and focus on human societies and economies, however, is not treated with the same diligence and lacks the depth and thoroughness of its natural correspondence. It also illustrates a mismatch between the tools of natural science and the study object. The knowledge base for the claims made on human societies is weaker than those for nature. By exploiting the space between the practice of monitoring and the practice of assessing – which should be two different things – what is objective and what is value-based can be negotiated. However, the dispassion of the reports reflects a scientific value system that does not necessarily serve the Arctic as a region, but might suit the Arctic states.

Box 21.1. Summary Reports from AMAP (www.amap.no)

Arctic pollution issues: a state of the Arctic environment report, Arctic Monitoring and Assessment Programme, Oslo, 1997

Arctic pollution 2002: persistent organic pollutants, heavy metals, radioactivity, human health, changing pathways, AMAP, Arctic Monitoring and Assessment Programme, Oslo, 2002

ACIA, Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, 2004

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AMAP 2009 Update on Selected Climate Issues of Concern, Arctic Monitoring and Assessment Programme, Oslo, 2009.

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Chapter 22
The Challenge of Governance in the Arctic: Now and in the Future

Douglas C. Nord

Abstract Over the past several years, the Arctic has emerged as a region of growing concern to the international community as a result of the impacts of climate change and globalization in this once remote area. Increasing numbers of scholars and residents of the region believe that some framework for governance in the Arctic is now required to address these and other pressing challenges. This is not, however, an easy undertaking. The process of governance is a multifaceted effort. The Arctic Council, established in 1996, has functioned until now as the primary body for addressing regional concerns and formulating efforts at collective action. This article examines the multiple questions posed by any undertaking of governance in the Arctic. It reviews the ways in which the Arctic Council has sought to respond to each of these over the past 18 years and provides an assessment of its undertakings. The article also considers what should be the guiding principles around which all future governance efforts should be crafted and discusses how such an initiative is central to the future evolution of the region.

Keywords Arctic • Governance • Arctic Council • Diplomacy • Law

The question of governance in the Arctic has become of growing interest to both scholars and residents of the region over the past decade. Whereas during much of the twentieth century this matter seemed of marginal concern, given the relative remoteness of the area and the dominance of a Cold War system which precluded most collaborative efforts, today the establishment of some sort of joint-management system for the Arctic has emerged as a priority for policymakers throughout the circumpolar area and the broader global community. The new "race for resources" in the Arctic and the growing awareness of how the region is undergoing tremendous environmental and social change is encouraging leaders from the area and beyond to discuss a variety of ways in which these developments can be addressed on a collective and cooperative basis.[1] Their efforts to construct a mutually agreed

[1] Emmerson (2010).

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upon governance structure for the Arctic region has become a fascinating study of how policymakers seek to respond to both current concerns as well as future needs of the circumpolar community.

This essay attempts to outline the main features of such efforts. It first seeks to examine the multifaceted nature of governance and its applicability to such a distinctive and evolving region as the Arctic. It explores the differing opinions among contemporary scholars and policymakers regarding the challenges and opportunities for collective management. It then moves on to consider the response of the Arctic Council—perhaps the most significant management structure for the region today—with regard to these contending perspectives on governance. It reviews the body's efforts in each area of concern and evaluates its overall performance in providing a solid foundation and direction for collective action in the Arctic. Finally, the essay turns its attention to what should be the major principles that should direct present and future undertakings at governance in the Arctic. These guiding values are seen to be widely share among the members of the circumpolar community and provide important reference points for the ongoing enterprise of Arctic governance.

22.1 The Multifaceted Nature of Governance in the Arctic

The past decade has witnessed a dramatic upsurge of interest in the multifaceted question of governance in the Arctic. As the region has moved from the margins of international affairs to become a focus of concern for the current global community, there has emerged an expanded interest in outlining the needs and principles around which a system of governance for the Arctic should be constructed. A large number of scholars and policymakers have each outlined what they conceive as being required in such an undertaking. Not unexpectedly, there has been less than complete agreement among these individuals both in their diagnoses of the present situation as well as their in prescriptions for future action.[2]

With regard to matters of Arctic governance, the division of opinion radiates from six central questions: (1) *Who* is to govern? (2) *What* is to be governed? (3) *Where* is governance to take place? (4) *When* is governance to operate? (5) *How* is governance to function? and, finally, *Why* is governance necessary? These are hardly new questions for either Arctic policymakers or residents, but they have received new attention during the past decade. Many pages could be devoted to the specifics of each aspect of the current debate but the main points can be distilled as follows.

Regarding *who* should govern, there remains substantial disagreement between those who favor a state-centric view of the Arctic and those who contend that the region represents a new opportunity for subnational and non-state actors to play significant roles in fashioning its future. As such, the traditionalist vision of state sovereignty comes face to face with demands for inclusion by new participants in

[2] Koivurova (2010).

global decision-making including the several indigenous peoples of the North. Division also exists between those who see the governance of the Arctic to be the sole concern of those governments and non-state actors who occupy the northern areas of the globe and those from "outside the region" who, nonetheless, claim interest in the area. Here preference for a system of governance that reflects "northern interests" confronts claims that the future of the Arctic, is, in fact, a global concern and that any system of Arctic governance should be broadly inclusive.[3]

As to *what* should be governed in the Arctic there is a similar division of opinion. Some contend that only matters that go well beyond the sovereign control and capabilities of individual states should be the focus of any system of governance. Thus, from this perspective, matters such as transboundary Arctic pollution or the provision of safety and security measures for commerce or travel that transcend the region should be the centerpiece of such collective efforts. Others, however, argue that this is a far too narrow framework for collaboration. They contend that the broad and common concerns of the North such as global warming, economic development and the protection and promotion of indigenous languages and cultures should be facilitated by any system of Arctic governance.[4] Equally divisive is the question of whether concerns related to the natural environment or the human presence in the Arctic should be given precedent in directing the discussion of governance.

Regarding *where* Arctic governance should take place, there is again a division of opinion as to whether the locus for action should be primarily maritime or terrestrially-based. As much of the Arctic region encompasses the Arctic Ocean and other adjacent northern waters, some scholars and policymakers argue that Arctic governance should be conceived primarily as a maritime matter. They contend that concerns related to sovereignty and the exercise of jurisdiction and control over such waters—and their resources—should be uppermost in the minds of those who fashion such governance structures. This group has been a proponent of the "Arctic Five" formulation which sees the governance task as being primarily the exclusive undertaking of those countries whose coastlines border on the Arctic Ocean. Their major accomplishment has been the Ilulissat Declaration made in 2008 which makes such an assertion.[5] However, this perspective has been challenged by representatives of the broader "Arctic Eight" as well as spokespersons from the various indigenous peoples of the region who contend that land-based issues as well as maritime matters should be the focus of Arctic governance and that their voices should also be heard in both domains.

As to *when* a new system of Arctic governance should operate there are equally strong currents of opinion. One view suggests that the operation of such a system of governance should take place only as a supplement to individual state efforts. This "limited" perspective argues that the individual Arctic states are best equipped to address most of the specific concerns of the region through their own undertakings. Collective efforts at action are needed only to address a limited number of problems

[3] Graczyk (2012).

[4] Keskitalo (2004).

[5] Ilulissat Declaration, Ministry of Foreign Affairs of Denmark (2008).

that might transcend their sovereign control or that cannot be dealt with effectively on a unilateral basis. An alternative perspective, however, suggests that most Arctic issues are generally broad and common concerns that do, in fact, regularly transcend national borders and the abilities of individual states to address them. Under such circumstances, a robust and "comprehensive" system of Arctic governance is required.[6]

An equal division of opinion also exists with regard to *how* a system of governance in the Arctic should be established. Some authors and practitioners contend that such a governance system should arise from already operating international agreements and practices. They argue, for instance, that the existing Law of the Sea provides adequate guidance and direction for most maritime undertakings in the region. They suggest that constructing an individualized Arctic maritime regime is unnecessary and would risk diluting the impact of presently functioning international law and practice. On the other hand, there is an equally strongly expressed opinion that such comprehensive global agreements do not adequately address the specific needs and requirements of the Arctic. It is argued that the unique ecological and social settings of the area require regional regulation and administration. Broad and inflexible rule making and administration from "outside" the Arctic might pose a threat to both the sensitive environmental conditions of the area and the traditional practices of the peoples of the North. This viewpoint calls for the establishment of a distinctive system of regional governance for the Arctic rather than the importation of global standards and frameworks.[7]

Finally, there are multiple responses to the question of *why* a system of governance in the Arctic is necessary? Some answer by suggesting that it is required to avoid an unregulated and potentially destructive "race for resources" in the region between individual states and international businesses.[8] Others contend that having a recognized structure of governance will assist the peoples and countries of the area to maximize their potential benefit derived from such resource exploitation. Still others argue that by establishing an effective Arctic governance regime those concerned will be able to help protect both sensitive ecological domains and the threatened cultural traditions of the residents of the region. Clearly a variety of motivations and agendas are propelling such assessments.

22.2 The Arctic Council's Response to Such Governance Questions

Over the course of the past quarter century, the Arctic Council and its predecessor, the Arctic Environmental Protection Strategy (AEPS) have provided the focus for designing a framework for governance in the Arctic region. Though both began

[6] Young (1998).

[7] Exner-Pirot (2012).

[8] Ǿstreng (2012).

their efforts in a limited and measured fashion, the last decade has witnessed a growing interest on the part of the Arctic community to make use of such bodies to both study and manage a variety of regional concerns.

Established in 1996, the Arctic Council has now moved from being simply a high level consultative forum to become an emerging regional organization with the ability to assist its members in organizing, managing and directing their collective efforts in the region. In so progressing, the body has had to come to grips with the several dimensions of Arctic governance outlined above.[9]

The Arctic Council has responded to the question of *who* should govern in Arctic in a segmented fashion. On the one hand, it has made clear from the outset of its operation that the eight nation states of the circumpolar north are its chief constituents. The governments of the "Arctic Eight" are deemed to be the central players in its affairs and are accorded primacy in its operation. Nonetheless, the Arctic Council is unique among international governance entities in according somewhat equal status to the representatives of the several indigenous peoples of the North.[10] These Permanent Participants are given seats at the negotiating table, consulted in most decision-making processes and involved in the ongoing research efforts of the working groups of the body. In addition to these indigenous representatives, the Arctic Council accords Observer status to several non-Arctic states, international organizations and other non-state actors.

In recent years, the Arctic Council has evolved in the direction of allowing for the inclusion of additional Permanent Participants and Observers. In so doing, it has had to regularly wrestle with the question of what is an acceptable balance between implementing the desires of the governments of the Arctic Eight and incorporating the views and opinions of its non-state actors. It has not always been an easy task and the body has suffered some criticism for being too "elitist and hierarchical" in its operation and decision-making processes.

The Arctic Council has also had to confront the question of whether participation in its affairs should be restricted to only northern actors or should it be embracing as well of non-Arctic members of the global community. Over the course of its past three Chairmanships, the Arctic Council has endeavored to resolve this matter. It has sought to reconcile the need to protect its distinctive "northern voice" and orientation with the reality that a number of global actors far from the Arctic Circle have expressed an interest and desire to be part of its deliberations and research efforts. At the most recent Ministerial Meeting in 2013 at Kiruna, Sweden it addressed the matter by admitting six new non-Arctic states as Observers including China, Korea, Japan, India, Singapore and Italy.[11]

The question of *what* should be governed in the Arctic has also been a matter of regular discussion within the Arctic Council. While during its first decade, the body clung rather tightly to a narrow range of transboundary pollution and environmental concerns; its agenda has slowly expanded in recent years to embrace questions of

[9] Dobbs (2012).

[10] Tennberg (1998).

[11] Arctic diplomacy: A warmer welcome (2013).

climate change, business development, support of indigenous languages and cultures as well as facilitating emergency response in the region. With the notable exception of a continued ban on the consideration of traditional security and defense matters in the region, the Arctic Council has seen both its agenda items and its research inquiries steadily increase in number and broaden in scope over the last decade.

Nonetheless there remains the challenge of fostering collective action as an alternative to a unilateralist response of sovereign states. Some of the Arctic Council's larger members including Russia, the United States and Canada have often been reluctant to relinquish their prerogatives of addressing issues from their own nationalistic perspective and taking action to resolve perceived problems unilaterally—especially as they relate to their claims to resources and control over security and economic development in Arctic lands and waters. Building trust between long-standing rivals and encouraging a vision of mutual benefit through common enterprise continues as ongoing and often elusive exercise.[12] So is the challenge of securing financial contributions and backing from individual states for agreed upon Arctic Council initiatives.

A growing debate is also emerging between those who favor a continued focus on environmental protection within the Arctic Council and those who would prefer to see a new emphasis placed on the human presence in the Arctic. Since its establishment, the twin pillars of environment protection and sustainable development have supposedly jointly directed the undertakings of the body. In reality, however, the former has been given far greater attention than the latter within the Arctic Council's various working groups. Over the course of the last several national Chairmanships, however, the increased desire of Arctic governments to address the economic, health and social needs of the human populations of Arctic has become increasingly evident. So too has an enhanced interest in considering new opportunities for business and resource development in the region.[13] The manner in which the Arctic Council seeks to strike an acceptable balance between these competing priorities of concern will say much about its ability to foster cooperative interaction between its various members and its capacity to suggest *what* is to be governed in the region.

Potentially equally troublesome for the Arctic Council has been the question of *where* it should focus its efforts at governance. Should they be terrestrially based or maritime focused? Initial undertakings were directed toward the land. A number of scientific studies of environmental degradation and transboundary pollution were undertaken under the APES and during the first years of the Arctic Council's operation. These were supplemented by additional surveys of plant and animal populations across various circumpolar landscapes. Only in the most recent years, however, have significant inquiries into the health, education and employment needs of the peoples of the Arctic lands been undertaken. This hesitancy to move into these areas reflects the reluctance on the part of the Arctic Council to infringe upon the sovereign rights of the Arctic governments to exercise full control over the design and

[12] Byers (2009).

[13] Heininen (2011).

delivery of human and social services within their territories. However, with the rise of a new concern over the human presence in the North it is likely that such research inquiries will expand.[14]

The maritime interests of the Arctic Council came a bit later. Initial efforts were directed towards the effects of transboundary maritime pollution and coastline degradation. Some surveys of threatened maritime species and stocks were also undertaken. Again, however, concerns over the sovereign rights of some member states precluded most studies related to the utilization of Arctic Ocean fishery resources and claims to offshore mineral and energy resources. Both matters still remain as "sensitive" issues for discussion within the Arctic Council.

Perhaps the most serious challenge to the Arctic Council's ability to foster a system of effective governance for the region was the emergence towards the end of the past decade of a separate decision making forum for Arctic maritime matters—the so-called " Arctic Five." Led initially by Denmark and Canada, the governments of the five littoral states of the Arctic Ocean briefly met in Greenland in 2008 and Quebec in 2010 to voice their respective claims to the resources of that body of water and to affirm their collective sovereign jurisdiction over it under the existing Law of the Sea. However, they failed to include in these discussions the three non-Arctic Ocean states—Sweden, Finland and Iceland—and none of the Permanent Participants or Observers of the Arctic Council. For a time, it looked like efforts at governance within the region would be split in two spheres. Fortunately, it soon became apparent to all members that such an arrangement would not work very effectively. Since that time, there have been no additional meetings of the Arctic Five and most Arctic matters, both maritime and terrestrial, have been addressed under the auspices of the Arctic Council and within its subsidiary working groups.[15]

The response of the Arctic Council to the question of *when* Arctic governance should operate has been clear and consistent from the outset. It has contended that any system of regional governance should come into operation only as a supplement to the efforts of the individual states of the area and only upon their request. From this perspective any form of collective Arctic management needs to take place in a limited number of domains where particular problems may transcend state sovereignty or cannot be dealt with effectively on a unilateral basis. Recent initiatives by the Arctic Council in the areas of Arctic search and rescue and preparation for potential pollution emergencies can be seen to fit within this framework.[16] So too are cases when there is a need to share specialized knowledge or technology to adequately address persistent pollution hazards found within particular states.

This approach, however, is not to be interpreted as a general commitment to collective action across a wide number of issue areas or variety of domains. Arctic governance is not to be the first response to any identified environmental, social or

[14] Nord (2013).

[15] Nord (2010).

[16] Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (2011), Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (2013).

economic problem within northern communities. That remains largely the responsibility and prerogative of the individual governments of the states of the Arctic Council and to a certain extent the Permanent Participants. There exists no substantial base of political will or commitment of financial resources within the body to operate any more widely at this time despite the wishes of some external advocates.

The Arctic Council's vision of *how* a system of collective governance within the region might be established stems precisely from this latter recognition. At present, there appears to be little interest in creating a broad array of regional agreements and regulations that might guide the conduct of the Arctic states or residents. Likewise, many on the Arctic Council question whether it is wise for the body to address major questions such as climate change and sustainable development solely from a regional vantage point. Additionally, as an "inter-governmental forum" rather than an empowered international organization, the Arctic Council lacks the capacity to promote such measures solely on its own.

Given these circumstances, the Arctic Council has chosen the more limited path of first seeking to promote greater awareness and understanding of a certain number of northern concerns both within the circumpolar world and the broader global community. These include matters like the rapid rise in Arctic temperatures, the melting of polar seas and the challenges of developing natural resources in fragile ecosystems. In some instances, solutions to these problems are deemed to best handled within broader frameworks such as the International Climate Change Negotiations or in other bodies like the United Nations Environmental Program. Sometimes it has been suggested that by utilizing already existing global guidelines such as the Law of the Sea important Arctic concerns can be best addressed.[17] In other instances, the Arctic Council has chosen to sponsor international agreements that address more narrow and specific regional concerns such as the recently adopted conventions on Arctic Search and Rescue and Maritime Pollution, Preparedness and Response. While recourse to these regionally-oriented agreements can be seen as a new initiative on the part of the Arctic Council to establish a foundation for collective management of pressing issues in the area, it should not be interpreted as the first step in creating a broad structure for regional governance in the Arctic.

The question of *why* some system of governance is necessary for the Arctic has been answered by the Arctic Council in multiple ways. At times it has cited the commonality of the conditions faced by the lands and peoples of the region and the need to share information, insights and best practices between them. At other times it has pointed to the dramatic changes coming to the region, chief among them being climate change, globalization and the "race for resources" in the area. Also cited are the ongoing challenges of preserving the delicate ecosystem of the region, protecting indigenous cultures and languages and providing a distinctive "voice for the Arctic" in broader global discussions and negotiations.[18]

[17] Hoel (2009).

[18] Arctic Council (2013).

Regardless of the motivation, there is expressed the opinion that the Arctic can best respond to such concerns through expanded collective action and mutual support. While the members of the Arctic Council can and do differ among themselves as to the necessary extent and forms of cooperation required—now and in the future—all are agreed that some framework for the coordination of effort and management of Arctic affairs is required. Many suggest that it will be an evolving Arctic Council that will provide this framework.

On the whole, the Arctic Council has endeavored to address and engage each of these governance questions. Over its relatively short term of existence the body has sought to provide focus and direction for a region that has long existed on the margins of international affairs and which is being now thrust into its core by the impact of climate change, resource development and globalization. Its future success, as well as the region it represents, will be dependent upon its ability to operate from a clear set of guiding principles that are expressive of the chief needs and aspirations of the region and are likely to form the foundation for successful governance in the Arctic.

22.3 Principles to Guide the Future of Arctic Governance

Despite some continuing disagreement among certain Arctic governments and residents with regard to the pace and direction of governance in the region, there remains a surprising degree of consensus among these various participants as to the central goals and objectives that such an undertaking needs to embrace. From their beginnings in the final years of the twentieth century, proponents have embraced five central principles that have directed and energized their efforts. These include the protection of the natural environment, the sustainable development of resources of the region, enhanced benefit to the local northern residents from such efforts, broad participation in decision-making processes affecting Arctic affairs and, finally, the importance of cooperation rather than conflict as the means for realizing these objectives. It is worth briefly examining how each of these principles has framed this enterprise.

From the outset of the AEPS through the current efforts under the Arctic Council, the commitment to protecting the fragile Arctic environment has been a motivating factor behind most of their endeavors at Arctic governance. It has provided a firm focus for the ongoing initiatives of both researchers and policymakers. As one of the "twin pillars" of the Arctic Council it has guided its projects and agenda for nearly two decades. All indications suggest that it will continue to do so in the future. Whether it be in addressing the major consequences of climate change in the Arctic or protecting its flora and fauna from the impact of pollution or unsafe development, a continuing dedication to environmental protection will—and should be—a continuing feature of regional cooperation and action.[19]

[19] Hernes (2012).

Sustainable development is also likely to be an ongoing and guiding principle for the development of regional governance in the Arctic. The second of the “twin pillars” around which the Arctic Council was established in 1996, its concerns continue to direct that body’s undertakings. Perhaps this is even more apparent today than was the case at the time of the issuance of the Ottawa Declaration. With the expanding efforts of governments and international businesses to exploit additional resources in the Arctic, it has become ever more necessary that a system for evaluating and managing this development in a responsible and sustainable fashion be established. Over the past several years the Arctic Council has endeavored to provide this oversight. It has sought to reconcile the desired need to access new resources from the region with the important requirement that this be done in a sustainable manner. It has suggested ways in which the Arctic and the broader global community can act as responsible stewards of these resources and embody these values within their approaches to management and governance.[20]

Closely associated with the latter, is the belief that the pursuit of both environmental protection and sustainable development should have particular benefit to the residents of the Arctic. From the outset of the Arctic Council’s operations, there has been a regularly expressed view that the indigenous peoples of the Arctic should have a significant claim to any benefits derived from any alterations in their traditional lands. It has also been recognized that they—and increasingly the settler communities residing in the Arctic and near-Arctic regions—should have their concerns, needs and aspirations addressed on a priority basis. This includes ensuring that adequate health, education, employment and a variety of social services be provided to them. It also means that they should have a substantial voice in helping to design and deliver these same services. This requirement of providing particular benefit for northern residents needs to continue as an important element any further development of Arctic governance.[21]

The fourth guiding principle that should direct the future course of governance in the Arctic is that of inclusion. It is clear that both the Arctic and its governance framework benefits from securing the broadest representation of the region’s diverse views and opinions. The Arctic Council has been strengthened from the outset by the regular inclusion of indigenous and non-state actor perspectives. While it is sometimes a complicated effort to ensure that the distinctive views, opinions and priorities of each of the Arctic Eight governments, Permanent Participants and Observers are all heard and considered, the effort has resulted in the forging of a stronger sense of unity among the various members of the circumpolar north than might have been originally expected. This ongoing sense of community commitment has been able to withstand short-term disturbances in the broader international system. The recent addition of new Observers from “outside the region” should also be welcomed and continued. By expressing an interest and commitment to addressing the future challenges and needs of the Arctic these new actors are demonstrating the worth of having additional strong supporters and advocates.

[20] Young (2010).

[21] Abele (2009).

Finally, progress towards establishing a framework for enhanced Arctic governance needs to be guided by a celebration of cooperation rather conflict in the region. Far too much discussion has taken place in the media and popular press of the alleged points of irreconcilable conflict that supposedly exist between the various members of the Arctic community. While it would be naïve to suggest that differences of opinion and interests do not exist among such a diverse group of actors, it would be equally wrong-headed to argue that these will inevitably lead to direct conflict among them. Recent history suggests the opposite. For much of the period since the end of the Cold War, the Arctic has remained as a distinctive low-conflict area in international affairs. Scott Borgerson has noted in a recent article in *Foreign Affairs* that: "A funny thing happened on the way to Arctic anarchy…Proving the pessimists wrong, the Arctic countries have given up on saber rattling and engaged in various impressive feats of cooperation."[22]

22.4 Conclusions

This review of the challenges of governance in the Arctic—now and in the future—has highlighted a number of important realities that need to be kept in mind. Primary among these is that governance is not as simple and direct as one might anticipate. It is, in fact, a multidimensional and multifaceted exercise. It becomes an even more complex undertaking when it is being attempted in an area that until recently has had little experience with regional decision-making. Seen from this perspective, the progress made by the Arctic Council over the past 18 years to provide some direction for governance in the region is quite remarkable. It has not been an easy enterprise. The process of building community and instilling trust and cooperation among members of any body is always difficult. The Arctic Council has endeavored to provide creative answers to questions regarding how a process of governance in the Arctic can be best conceived and articulated during a period of tremendous change in the region.

Over the coming years, both the process and framework for governance in the Arctic will continue to evolve. Each will respond to both the new and ongoing challenges and opportunities found within the region and to forces well beyond the borders of the Arctic. It has been suggested, however, that the continued observance of certain basic principles can facilitate their future growth and development. With these as guideposts in place, continued positive results can be anticipated. In the end, the ability of the circumpolar community to fashion an effective and responsive system of governance is likely to be a significant benchmark against which overall progress toward a new Arctic can be measured.

[22] Borgerson (2013).

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Chapter 23
New Knowledge a Pathway to Responsible Development of the Arctic

Gunnel Gustafsson and Marianne Røgeberg

Abstract NordForsk is a platform for Nordic research and research infrastructure cooperation. One of its key priorities is to support research in response to Grand Challenges as defined in the Lund Declaration, produced during the Swedish presidency of the European Union in 2009. This chapter describes how NordForsk's research program *Responsible development of the Arctic* was developed and funded with a real common-pot. An important conclusion is that the fundamental and needs-driven research carried out in response to these grand challenges are, in fact, two sides of the same endeavor. Meeting the needs for knowledge that contributes to overcoming the negative and sometimes irreversible consequences of globalization in the Arctic is crucially important for the around four million inhabitants who live there. In the longer-term, some of these consequences will affect all human beings on earth because climate change is noticeable earlier in the High North than elsewhere. In this respect, the Arctic region is a global laboratory, and this type of new knowledge of importance for all living species on this planet. There are many prerequisites for accomplishing new knowledge of top quality to be acted upon by business, public service providers and other key users. It is necessary for researchers from different countries, with excellent qualifications in their respective disciplines, to work in teams that integrate perspectives and results from disciplinary research. Political backing is also crucial because politicians set policy agendas and are able to fund interdisciplinary research that involves cutting across policy communities e.g. research, innovation, health etc. Another absolute requirement is the existence of practical arrangements that make it possible to produce, spread and use evidence-informed knowledge suitable for overcoming problems and accomplishing responsible development in the Arctic region and beyond. There are lessons learned from the way NordForsk develops principles, flexible processes and organizing in order to create trust and long-term commitment to grand challenges responding research. The preconditions for meeting the urgent needs for new knowledge on the Arctic are, in short, a well-developed research program, excellent people willing to participate and a reliable platform for cooperation.

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23.1 Challenges and Opportunities in the Arctic and Beyond

The Arctic region is undergoing rapid transformation with consequences that are manifold and complex. Climate change has both direct and indirect effects on human and animal health, food and water security and the sustainability of ecosystems. It has consequences for almost all activities in the region, including the possibilities for indigenous people to preserve and develop their culture and way of living.

As the ice is melting, oil, gas and mineral resources become more easily accessible and new transportation routes possible to use. There is widespread concern that the business opportunities together with other challenges, might result in high-risk short-term actions with irreversible negative impact on the around four million inhabitants of the Arctic. In the longer term, all humans on earth will experience at least some of these consequences. This is because climate change is global and the impact noticeable earlier in the High North than elsewhere. In this respect, the Arctic region is, in fact, a global laboratory.

However, the opportunities arising from this development might be at least as important as the challenges. If the new economic opportunities are utilized in a sustainable way, it can make the Arctic region rich and influential, and thereby able to contribute to turning challenges into opportunities worldwide. Thus, decisions based on knowledge-informed scenarios regarding the future of the region is key not just for countries with part of their territory in the Arctic, but also for many others.

Despite the increase in investments in Arctic research during the International Polar Years 2007–2008, huge knowledge gaps remain especially with regard to interdisciplinary research. Simultaneously, the solid disciplinary knowledge produced during these years constitutes an important basis for integration and further development of existing fields of research.

Integration of disciplinary research results and perspectives on the interaction between drivers of change emerging from nature, such as climate change, and from society, such as governance structures and provision of education, has the potential to produce new knowledge of crucial importance for society and policy-making. Such an approach to Arctic studies can also result in higher quality of disciplinary research because integrated research has the potential to augment traditional ways of asking questions and doing research. Many have begun to perceive this win-win situation, but it remains difficult to organize and fund research programs with the purpose to integrate knowledge produced by researchers from a broad range of fields.

NordForsk's Arctic research program intends to demonstrate that such a program is possible to develop and finance. The aim is to integrate knowledge from social science and humanities, health and medicine, and science and technology in order to respond to demands emerging from both society and science. These needs for new knowledge on the Arctic was an important factor throughout the process during which NordForsk managed to formulate and fund the program.

NordForsk operates within a long tradition of cooperation and coordination. In fact, Nordic cooperation is amongst the oldest and most extensive regional cooperation in the world. The overall aim is to make it attractive to live, work and do business in the Nordic Region, as well to strengthen the Nordic knowledge society internationally.

Nordic cooperation is governed by the Nordic Council and the Nordic Council of Ministers. The Nordic Council is the Nordic parliamentary cooperation forum, and acts as an advisory body for the governments in the Nordic countries. The Nordic Council was formed in 1952, at the time when the United Nations was established, the Council of Europe created and the first steps were taken towards establishing the EU. The Nordic Council includes parliamentarians from Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and the Åland Islands.

The Nordic Council of Ministers was established in 1971 as a forum for cooperation between the national governments in the Nordic region. The Council currently consists of ten councils of ministers (for labor, business, energy and regional policy, agriculture, food and forestry, gender equality, legislative affairs, culture, health, environment, social affairs, finance and education and research). A large part of the Council of Ministers' concrete activities are carried out by the Nordic institutions.

NordForsk is the largest of these institutions. It was established in 2005 under the auspices of the Nordic Council of Ministers for Education and Research. NordForsk has an important role in developing the Nordic Research and Innovation Area (NORIA), as part of the corresponding European Research Area (ERA), inter alia by promoting free movement of knowledge in the Nordic region, pooling of national research resources and creating critical mass for excellence in research.

NordForsk's mandate is to identify and respond to strategic priorities for Nordic research cooperation and thereby add value to national research efforts in the region. Decisions on how to accomplish this are taken by the NordForsk Board, which is composed of high-level members from the research councils and universities in the Nordic countries, with observers from the Nordic Council of Ministers and the Faroe Islands, Greenland and the Åland Islands.

In the following text, it will be demonstrated in what policy context and under what organizational and other circumstances it became possible for NordForsk to combine demands from policy-makers and other users for relevant new knowledge with curiosity-driven research and development of the different disciplines involved. Finally, there will be an analysis of what can be learned from this and other previously initiated joint Nordic research programs intended to response to the grand challenges of our time.

23.2 Political Commitment to Grand Challenges-Responding Research

There is a steadily increasing interest among policy-makers in countries with territories or economic interests in the Arctic, which indicates the global importance of the region. This manifests itself in several ways. The European Union and many countries, among them all the Nordics, nowadays have Arctic strategies, and the importance of the Arctic Council as an international power player seems to be growing. This was highlighted at the Arctic Council's last meeting during the Swedish presidency (Kiruna, May 2013), when six non-Arctic states, China, India, Italy, Japan, the Republic of Korea and Singapore, were granted observatory status.

The political commitment to research on the Arctic is reflecting a broader interest, both in Europe and elsewhere, to accomplish new knowledge on societal challenges and how to respond to these during the contemporary globalization era. Thus, research on grand challenges was an important priority during the Swedish presidency of the European Union (second half of 2009).

The Lund Declaration launched during the conference "New Worlds – New Solutions; Research and innovation as a basis for developing Europe in a global context" (July 2009) articulates the needs for new knowledge in response to grand societal challenges. Among the most urgent challenges identified were climate change, energy and water supply, ageing populations and changes in the world economy. It was noted that unwanted and sometimes unexpected developments, and even shocks, seem to be interlinked in a way that calls for both a new type of knowledge, and a new risk-tolerant and trust-based approach in research funding.

Before the Lund Declaration was formulated, several other important books and reports drew the attention to the need for joint research, education and innovation efforts during the then emerging globalization era. Some examples include Nobel prize winner Elinor Ostrom's book *Governing the commons- the Evolution of Institutions for Collective Action* (1990), Anthony Giddens book *Runaway World* (1999), the Aho report "Creating an innovative Europe" (Aho 2006), the Green paper "The European Research Area: New Perspectives" as well as "The Evaluation of the Sixth Framework programme 2002–2006" (2009) (Lundvall 1992).

The Communication "Europe 2020 Flagship initiative – Innovation Union" (October 2010) was published soon after the Lund Declaration. Later the Danish presidency in the European Union (first half of 2012) followed up the Lund Declaration with the ambition to implement it. The result is that the eighth framework program, Horizon 2020, includes substantial funding for grand challenges responding research.

As part of this initiative, the Commission has put strong emphasis on completing the European Research Area (ERA), including seeking to enhance cooperation between member states by joint planning, implementation and evaluation of national research programs. This Joint Programming process was launched in a Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The overall aim of the Joint Programming process is to combine national research efforts in order to tackle common societal challenges in Europe and to make better use of Europe's public resources for research and development.

Joint Programming is a structured and strategic process whereby member states voluntarily agree on strategic research agendas in order to address major societal challenges. On a variable geometry basis, they can also commit themselves to implementation of Joint Programming Initiatives (JPIs). Ten JPIs have been established to date, focusing on inter alia agriculture, climate change, Alzheimer and other neurodegenerative diseases, healthy and productive seas and oceans, antimicrobial resistance, and global urban challenges. For an overview over the ten JPIs, see http://ec.europa.eu/research/era/joint-programming-initiatives_en.html

It was in the context of the above political actions and discussions that the Prime Ministers in Denmark, Finland, Iceland, Norway and Sweden, already in 2007 took the initiative to a large Nordic research and innovation program on "Climate, Energy and the Environment". In a joint Declaration, decided upon during their meeting in Punkaharju, Finland in 2007, they state that the vast Nordic region is in a position to pioneer efforts to combat climate change. They also emphasize that a sustainable Nordic model for meeting climate challenges will demonstrate the potential for combining reduced emissions with economic growth. In 2008, a research and innovation program in this field was started as a Nordic venture and labelled the Top-level Research Initiative (TRI). NordForsk implemented it together with two other organizations, Nordic Innovation and Nordic Energy Research, all located in Oslo, Norway.

During the same year, NordForsk started two other Joint Nordic multidisciplinary research programs with real common-pot, namely "Food, nutrition and health" and "Nordic welfare societies in transition". All these 5-year long research programs, with together 11 Centers of Excellence, are now completed and evaluated. The results are very positive. They show that most important goals have been obtained. This means that complementary specialization and critical mass of competences have resulted in quality and use of new knowledge to an extent that could not have been reached without cross-border and cross-sector cooperation. Another accomplishment is that there has been sharing of research infrastructures and improved programs of researcher training.

NordForsk's strategy states that NordForsk should identify and support research fields in which the national research councils anticipate that cooperation will add value to ongoing or future research. One of the main priorities is to initiate and participate in interdisciplinary research programs formulated in response to grand challenges. Lessons learned from Nordic R&I Cooperation (NordForsk 2010). In addition to "Responsible development of the Arctic", these now include 5-year long research programs on "Societal security", "Health and wellbeing", and "Climate change". Like the above mentioned research programs, these are funded with a real common-pot assigned to NordForsk from at least three Nordic countries. This makes competition with no "juste retour" possible. Thus, if a Nordic country, e.g. Sweden or Denmark, puts money in such a common-pot there is no guarantee that Swedish or Danish researchers will become involved. On the other hand, competition about resources is a quality driver and the research results can be openly accessed and used to overcome problems and create opportunities for progress in the entire Nordic region and beyond.

It is important that all these programs have been given political priority, and been strongly supported by the research councils with money allocated to a real common-pot for research collaboration between the Nordic countries. This makes it possible for NordForsk to involve extremely well qualified research teams, firmly based in their disciplines, in the collaborative work needed to address the grand challenges of our time. The experiences so far have, in the main, been concentrated to interdisciplinary research in one "faculty area" i.e. science and technology or social science and humanities.

The Arctic research initiative is by far the broadest joint Nordic program that NordForsk has organized. The intension is to involve all "faculty areas" and strive to produce new bold ideas with the help of integrated perspectives and research results regarding drivers of change emerging from both nature and society. This multidimensional approach to new knowledge is used in order to overcome challenges and create opportunities for users to act in a responsible way based on an evidence-informed understanding of the present situation and alternative ways of moving forward.

23.3 Establishing the NordForsk Arctic Research Program – Principles and Processes

As a rule, NordForsk's research programs are designed to respond to key societal challenges and policy priorities in the Nordic countries. During the initial **idea phase**, NordForsk cooperates closely with a wide range of stakeholders, e.g. policy-makers, research financiers, industry representatives, universities, researchers and other experts. These actors provide NordForsk with valuable input to the identification of key focus areas and overarching objectives of the programs.

Following the idea phase, a program memorandum is prepared, to outline the overarching objectives of the study, thematic framework and focus areas. The **preparatory phase** is usually performed by a so-called **NORIA-net**. A NORIA-net is a coordination activity for the national research financing agencies and policy-makers in the Nordic countries, funded by NordForsk. NORIA-nets are established to identify areas where joint Nordic research efforts could add value to efforts in the individual Nordic countries. With NordForsk as secretariat, NORIA-nets strategically plan and design joint Nordic research programs in prioritized fields. The results of a NORIA-net will normally be a proposal for a joint Nordic research program. NordForsk and the national research financiers jointly fund such a program.

The idea and preparatory phases are performed in an iterative way, comparable to innovation processes as described in the innovation literature. When a program memorandum is finalized, it is presented to the NordForsk Board, which then decides upon the initiation of the program. To assist the NordForsk secretariat during the **implementation phase**, a program committee of high-level representatives of the national research financiers is set up by the NordForsk Board. The committee assists NordForsk's secretariat in concretizing the program memorandum in a call text, which outlines thematic scope and priorities, budget, financing instruments, as well as key aims and criteria for eligibility and evaluation.

The next step will normally be a **consultation phase.** Interest among national financing bodies to invest in joint Nordic research initiatives and put their money in a common-pot is investigated during an iterative process between NordForsk and the financiers. Co-financing by Nordic research councils is an indication both of the importance of the research, its expected quality, and the added value of cross-border cooperation. In the early phases of the consultation process, the preliminary interest in contributing to the program is investigated. Those who indicate an interest are invited to comment on the focus of the program. As the consultations proceed, both funding and the more concrete contents of the program are discussed and developed. Finally, the national financiers commit to allocate funding to the program. NordForsk also contributes financially. The NordForsk grants make it possible start a program even if the committed contributions from the countries are put into the common-pot somewhat later.

The call is then launched, in one or two steps, usually with a 3-month deadline. International peers with extensive and broad expertise in the field evaluate the applications. Based on their evaluations, a recommendation for funding is presented to the NordForsk Board, which makes a decision on the applications to be funded. The Board has an important role in all stages of the development of joint Nordic research programs. The composition of the Board is key in this regard. Due to the representation, at high level, of all the main research councils in the Nordic countries, the Board can make strategic decisions on the development of joint Nordic programs in a flexible and efficient way. In addition, the Board plays an important role in facilitating the dialogue between NordForsk and the national research financiers, to identify national thematic priorities and to investigate possibilities for national co-funding.

The Joint Nordic Initiative on Arctic Research was developed according to the process described above. In February 2012, the NordForsk Board agreed that a joint Nordic research effort on Arctic issues would be timely and welcome. The NordForsk secretariat had then been promoting and facilitating Arctic research for several years, and the Board considered the time ripe to create synergies between these efforts and national initiatives in the Nordic countries by initiating a large-scale interdisciplinary joint Nordic research program.

The first steps in paving the ground for such an initiative were taken in a discussion between the National Science Foundation in the US and NordForsk on Arctic research cooperation. This dialogue continued at the IPY Conference "From Knowledge to Action" in Montreal in April 2012. The Montreal conference attracted more than 2,000 participants, and was the largest global convention on polar matters (the Arctic and the Antarctic) ever organized (http://www.ipy2012montreal.ca/). NordForsk's director invited high-level experts and representatives from all the eight Arctic countries to a discussion of the potential for cross-national collaboration in a joint research program in response to major societal challenges and opportunities in the Arctic region. The event was successful and such an initiative considered highly timely and relevant by the participants.

Later during 2012, the NordForsk Board decided to launch a NORIA-net on Arctic research, to assess the potential for a joint Nordic research program responding to the multiple grand challenges and new opportunities that the Arctic region is confronted with. They considered it important that the program took an interdisciplinary approach to the creation of excellent and policy-relevant knowledge of a new type. Some of the experiences gained from the IPY-years and from the Joint Nordic Top-level research program were important for their decision to incorporate experts from all fields of research in this preparatory action. Professor Torben R. Christensen, participant in the 2013 UN climate panel, and leader of a Nordic Center of Excellence in the Nordic Top-level Research Initiative, has highlighted the importance of filling knowledge gaps in this field. In an interview Professor Christensen concluded that "The climate system is like an engine, certain integral parts are being started, but we don't know how the engine works" (NordForsk Magazine 2013).

The NORIA-net on Arctic research was set up to cooperate closely with relevant stakeholders and take the experiences and knowledge already produced into account. To provide input to the discussions in the NORIA-net, expert groups were formed in the areas of health and medicine, social sciences and humanities as well as in natural sciences and technology. In addition, a reference group was established, consisting of broad groups of researchers and other stakeholders, such as representatives of local communities and indigenous people, the Nordic University Association, the University of the Arctic, representatives of the Nordic Council of Ministers and of the Arctic Council as well as industry representatives.

In close cooperation with the NORIA-net, the NordForsk secretariat developed the program memorandum *Responsible Development of the Arctic – Opportunities and Challenges – Pathways to action.* The program is designed to produce new knowledge about opportunities and challenges for responsible development of the Arctic region and to strengthen the knowledge base for political decision making, education, industrial and human development (Evengård and Nilsson 2013; Harvard and Stadius 2013; Sörlin 2013). Interdisciplinarity is a key objective, and the program will support integrated research efforts between teams that include broad participation of researchers with excellent track record. As in all NordForsk's activities, adding value to national research initiatives is an overarching aim of the program. Furthermore, an international research cooperation at the highest level, with Arctic as well as non-Arctic countries, will be supported. To create synergies with relevant international research and innovation initiatives, NordForsk has supported the Belmont Forum's call on Arctic Observing and Research for Sustainability.

The program memorandum was presented to and approved of by the NordForsk Board in June 2013. At the same meeting, the NordForsk Board decided to establish a program committee with high-level representatives of the Nordic research financiers to assist the NordForsk secretariat in the implementation phase. A call for proposals is now being developed.

In order to promote cooperation between outstanding Nordic researchers and research institutions in the field of Arctic research, it was decided to use NordForsk's main instrument, Nordic Centers of Excellence. This is a multisite or single site research environment with a joint research agenda, joint management, coordinated researcher training, international researcher mobility, shared communication activities, and collaboration on research infrastructure.

By providing joint access to the best research environments in the Nordic region, such centers increase the region's attractiveness and strengthen research cooperation with relevant international research initiatives. The joint communication and dissemination activities and coordinated data management conducted at the centers increase the likelihood for research results to be used both in the scientific communities and by society as a whole. Status as a Nordic Center of Excellence is granted for a 5-year period, and collaboration with public service providers and industry is encouraged.

23.4 Lessons Learned from Nordic Research Cooperation

The most important result from previous joint Nordic research programs organized in response to grand challenges is that it has been possible to achieve excellence, mobility, researcher satisfaction and a new type of knowledge of relevance for both science and society. This was obtained by common-pot contributions from national research councils. Transnational cooperation between already qualified researchers from the Nordic countries together with international partners has thereby been made possible. The prospects for accomplishing the same results within Arctic research are good even though this research program will involve higher ambitions with regard to integration of research from different fields in order to fill knowledge gaps of crucial importance for responsible development of the Arctic.

There are many prerequisites in order to make joint Nordic programs in response to grand challenges successful. NordForsk has certainly benefited from the long Nordic traditions of political cooperation. The five Nordic Prime Ministers' initiative to start the Top-level Research Initiative on Climate, Energy and the Environment was a strategic forward-looking action, which has paved the way for further successful development of new high quality knowledge of relevance for policy-makers and others in the Nordic region and beyond. The political support for grand challenges responding research at the European level has also been very important for the continued Nordic facilitation of interdisciplinary programs within which fundamental and needs-driven research can be combined to the benefit for both science and society.

When NordForsk was established by the Nordic Council of Ministers in 2005, and given the mandate to respond to strategic research priorities for Nordic cooperation, it became possible to move from policy to action relatively quickly. NordForsk's ambition has been to develop trust-building processes that can facilitate further cooperation. The consultation processes, briefly described above, indicate that this has been time-consuming and sometimes difficult. However, compared to other regions, Nordic research cooperation has been relatively successful in accomplishing common-pot funding and adding value by cooperation. Even so, there is considerable potential for further development of principles and processes. A lesson learned is that development in this regard is highly dependent on the framework conditions and continuous analysis of political and other developments in the five Nordic countries.

Nordic investments in integrated research on the Arctic signals a responsibility for the future by encouraging serious attempts to produce a new type of knowledge. In order to reach this goal, the Nordic program has to be up-scaled as the challenges of our time are global. A question is what it takes to make this happen. Can Nordic experiences of cooperation across different types of boarders, e.g. sectorial, intellectual and territorial, be repeated? Professor Jerzy Langer believes that this is possible. In an article in *Research Europe,* he argues "the Nordic approach to interregional problems combine to offer Europe a pragmatic signpost for the move from words to real efficient action" (Langer 2011). Maybe, there are lessons learned from Nordic cooperation not just for Europe, but also for many other countries. NordForsk's cooperation with, among others, the US Belmont Forum call on Arctic research is an example of how it might become possible to accomplish a slight opening of a window for transnational research cooperation followed by evidence-informed action in the Arctic region and globally.

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Chapter 24
Cryo-History: Narratives of Ice and the Emerging Arctic Humanities

Sverker Sörlin

Abstract We have reached a 'cryo-historical' moment – *cryo* signifying ice and snow, directing our attention to the historical powers of human forcing in the Anthropocene. This is a moment that demonstrates humanity's hegemony over Earth as manifested in a retreat of one of its elements as a result of human action. This paper presents a brief history of knowledge of ice in the Arctic in the light of recent science and scholarship. Its central claim is that ice has become historical, i.e., that ice is an element of change and thus something that can be considered as part of society and of societal concern. This idea is followed across a set of themes, such as the trope of an ice free Arctic Sea, ice as a systematic scientific endeavor, as a strategic element especially during the Cold War, as viewed by Arctic residents, and ice as a dimension of the emerging scholarly interest in a planetary consciousness, especially in the field of environmental humanities which in recent years have expanded into the Arctic.

Keywords Cryo-history • Environmental Humanities • Arctic Humanities • History of science, Arctic • Glaciology, History

The current reduction of Arctic ice, both sea ice and ice in glaciers, can be seen as an event of the Anthropocene: the kind of event which signals that humanity has now become, according to many scientists (Crutzen and Stoermer 2000; Steffen et al. 2007) the most significant agent of change on the planet. Storms, hurricanes, floods, fires, they happen, cause great havoc and breaking news, but then they fall into oblivion. Melting ice is, perhaps paradoxically, more lasting. It has the effect that once it has melted it may be gone for a long time and a major shift back to a colder climate over a period of many years or decades is required to restore it.

In this sense we have reached a 'cryo-historical' moment – *cryo* signifying ice and snow, directing our attention to the historical powers of human forcing in the

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Anthropocene. This is a moment that demonstrates humanity's hegemony over Earth as manifested in a retreat of one of its elements as a result of human action.[1] But at the same time it is a moment which questions human wisdom. The trope is old and speaks to the smallness of the human genius when faced with the powers of Nature. In Mary Shelley's *Frankenstein* (1818) the experimental scientist meets his own creation, 'the Creature', for a final showdown on the sea ice, the place where Enlightenment Man has to finally face his fate near the end of the world which, as it turns out, he can't subdue. Similar encounters had already happened, in a different guise, in the real world as enlightenment scientist Lapérouse and his mathematics-infused experts met with the Tlingit 'creatures' and their spiritual relation to the ice in the Pacific Northwest (Cruikshank 2005). Ice is a probing element, in which civilization is put to the test, and crisis is a core element of the narratives of ice, in recent decades reinforced by projections of climate change science.

The fate of ice as a sign of the fate of our societies invite new readings and interpretations of ice that can be provided by the social, cultural and historical sciences – the humanities, especially the now emerging environmental humanities (Sörlin 2012; Robin et al. 2013). Ice plays a role in narratives of climate change (Bravo 2009; Sörlin 2009a, b). It has come to symbolize *the ephemeral and the fugitive of human existence*. In practice modern humans do the opposite of the fugitive, we bring heavy, sometimes fatal impact – on an element that is melting, moving, fading, even disappearing (Carey 2007; Clarke 1987). At the same time the question can be asked where the authority of knowledge about this elusive material rests. Local adaptation and epistemic communities of traditional carriers of knowledge and technology have, in many continents and also on the Arctic sea ice, lived alongside with increasingly present scientifically trained ice and glacier experts (Carey 2010).

The waning ice links *excesses of modern consumer society and industrialism* to disastrous *impacts on the innocent original populations*, whose vulnerability, despite a long history of successful adaptation, is aggravated when the ice melts (Krupnik et al. 2010; Hastrup 2010, 2012). It also reflects a complex relationship between *Arctic residents and modern mainstream science* which on the one hand provides the best available knowledge of ice but still does not seem to be able to capture the full magnitude of the changes; Mother Nature does, as she certainly must, hold out surprises, nearly two centuries after the ill-fated Frankenstein.

[1] The word itself derives from the Ancient Greek word 'κρύος' [*cryos* meaning 'cold', 'frost' or 'ice']). It is the term which collectively describes the portions of the Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (which includes permafrost). http://en.wikipedia.org/wiki/Cryosphere.

24.1 Was There Ever an Ice Free Arctic?

The systematic study of ice in the Western science tradition is comparatively late. The *Journal of Glaciology*, by the International Glaciological Society, published its first issue only in 1947. By then, however, ice research had been going on for some time. Although one can always identify single comments on ice by earlier writers it is fair to say – as a general statement – that the scientific interest in ice started growing significantly with the theory of Ice Ages from around the middle of the nineteenth century. This interest was directed towards terrestrial ice. Glaciers were now not only remarkable features of natural history, but read as remnants of the major glaciation on a par with geological and palaeontological features in the landscape providing witness of a deep time, stretching thousands, if not millions of years back into the past.

At about the same time, indeed somewhat earlier, observations and skillful reflection on sea ice was started as some nations, notably the UK, were searching for the North West passage. William Scoresby was a notable presence in the early phase, the time after the Napoleonic wars, combining economic (whaling) and strategic (Northwest passage) interests with methodological rigor (astute observation) and making productive use of vernacular knowledge as scientific data collection had scarcely begun (Bravo 2009). A full century later Danish explorer Knud Rasmussen's Thule expeditions in the 1920s and 1930s also compiled vernacular knowledge (Krupnik et al. 2010). The longest historical records of ice cover exist from coastal seas accessible to shipping. This is exemplified by the Barents Sea, where a record of varying detail has been compiled covering four centuries (Vinje 1999, 2001; Divine and Dick 2006). Systematic records of the position of the sea-ice margin around the Arctic Ocean have been compiled for the period since 1870 (Walsh 1978; Walsh and Chapman 2001). These sources vary in quality and content with time. Direct observations on ice concentrations spanning the Arctic are available since the middle of the twentieth century. Coverage from early era satellites began in 1972, with the modern satellite record starting in 1979 (Cavalieri et al. 2003).

Although there was a widespread opinion in the nineteenth and twentieth centuries that the Arctic was always covered by perennial ice, both on large parts of its land mass and on the Arctic sea, it was an idea with some significant exceptions. The Arctic ice may have its gaps and holes. There was, for example, until the 1880s still some belief in the notion of a green central Greenland, fuelled by observations of floating timber in the waters near the big island (Agardh 1869; Örtenblad 1881; Nordenskiöld 1885). Ideas of an ice free Arctic were presented in the leading geographical journals and magazines in the latter decades of the nineteenth century such as *Petermann's Geographische Mitteilungen*, and they were reiterated by Fridtjof Nansen in his major history of Arctic exploration, *In Northern Mists* (Nansen 1911). As late as in 1926 one of the most reputable Russian geologists working in Siberia, Vladimir A. Obruchev used such a myth of a paradise on earth beyond the Arctic ice in his science fiction novel *Sannikov's Land*. He based his novel on scientific hypotheses from geology and anthropology and proclaimed the possibility of indigenous people living on a warm volcanic island beyond the ice. He symbolically pushed Siberia into the Arctic and in his own way justified Soviet territorial claims for Arctic islands (Frank 2010).

If the future was also taken into account new possibilities were opened up. An ice free Arctic in the future was foreboded by (possible) occurrences in the past, and although it was only a minor part of a larger enterprise among a range of geoscience disciplines in the early twentieth century (geography, palaeontology, quaternary geology, etcetera) of establishing a good chronology of the Holocene record, it is nonetheless clear that some of the energy that went into sea ice research was predicated on the potential of its going away in the future. This idea, of a future, or even imminent, reduction of the sea ice cover came up at several times in the past century, although perhaps more forcefully after year 2000. The trope had been increasingly present already in the nineteenth century (Wright 1953) and became interesting again during the period of interwar Arctic warming in the 1920s and 1930s. The interest in melting and strangely behaving sea ice resulted in a significant growth of publications in several countries, not least on research methods and terminological issues. Some of these publications also mentioned the trope of the ice free Arctic sea (Koch 1945; Kolchak 1928; Maurstad 1935; Smith 1932; Transehe 1928).

Current orthodoxy seems to be that there has been no period of a seasonally ice free Arctic in the Holocene, at least not in the last 800,000 years. “Despite 30 years of warming and ice loss, the Arctic cryosphere is still within the envelope of glacial-interglacial cycles that have characterized the past 800,000 years. … There is no paleoclimatic evidence for a seasonally ice free Arctic during the last 800 millennia” (Overpeck et al. 2005). The composite historical record of Arctic ice margins shows a general retreat of seasonal ice since about 1900, and an accelerated retreat of both seasonal and annual ice has occurred during the last five decades (Kinnard et al. 2008).

Ice free periods have been suggested to have occurred earlier, sometimes as predictions or historical hypotheses, sometimes as proposed empirical facts. On the deeper geological timescale, tens of millions of years ago, the Arctic ocean held an impressive temperature of 24 °C and giant forests stood on the shores of what is today Ellesmere Island (Francis 1988; McKenna 1980). Quarternary interglacials in the recent geological past also likely had ice free periods and the current Holocene interglacial may have had considerable reductions of sea ice in its earlier warmer phases (11,000–6,000 years ago) (Kaufman et al. 2004; Blake 2006; Funder and Kjær 2007).

A thorough understanding of detailed seasonal sea-ice history is hard to attain, even with modern scientific methods, which recent attempts also acknowledge (CCSP 2009). One way to do it is through refining sea-ice proxies in sediment taken from strategically selected sites in the Arctic Ocean and along its continental margins, and such research has now been ongoing for many years. Despite the statement above, claiming that there is no support for the idea of an ice free Arctic Sea, the more detailed analyses of historic sea ice seem to indicate that the picture is a bit more complex and that periods in both Holocene and Pleistocene have been characterized by much higher temperatures than the twentieth century average and that large areas of the Arctic were then open sea. Many proxy records indicate that early Holocene temperatures were warmer than today and that the Arctic contained less ice. Evidence in recent years has come from Northeast Greenland where well developed beach ridges and deposits of iceberg debris have been identified along a costal line of several hundred kilometers up to 83° North suggesting all open water in the early Holocene (Funder and Kjær 2007; Funder et al. 2009). Current orthodoxy seems to be, after all, that there is no complete and definitive orthodoxy.

24.2 Sea Ice and Strategic Concerns

Where did modern understanding of sea ice come from? The answer is: from many places, and not least the Arctic countries. With several thousand kilometers of Polar Sea coast and a long-standing interest in a North East Passage sea ice was for a long time a major concern in Russia. From around 1900 Russians started collecting sea ice data in a systematic way and a long series of expeditions into polar waters were conducted, aided by world leading ice breaking technology, which remained a central priority for the Bolshevik government. In the 1920s the USSR formed major research institutes for Polar science in both Leningrad and Moscow. Russian scientists collaborated intensely with Norwegian colleagues, based in the lively maritime and oceanographic research community in Bergen (Lajus 2013), and Norway turned out to be another significant provider of knowledge and data about sea ice. This was based on the work of Nansen with the Fram expedition in the 1890s and the subsequent Maud expedition in the 1920s.

In the latter the work on sea ice was led by Harald Ulrik Sverdrup who, as Director of Scripps Oceanographic Institute in La Jolla, California from 1936 to 1948, and then as the first Director of the Norwegian Polar Institute from 1948, rose to become a major actor in Arctic science planning and, subsequently, Cold War science politics. He had a broad interest in dynamic oceanography and earth-atmosphere interactions but also did considerable work on ice, especially sea ice, and he collaborated with Swedish geographer Hans Ahlmann on terrestrial glaciers in Svalbard in the 1930s. Through widely networked science politics actors and school builders such as Ahlmann and Sverdrup, and their colleagues in Bergen such as Bjørn Helland-Hansen, Scandinavian ice research served as a nexus of knowledge brokering between the Western sphere and the Soviet Union (Lajus and Sörlin 2014).

This, however, does not diminish the fact that the scientific study of ice in the twentieth century reflects distinct national and economic interests. The strategic and military component of sea ice research was significant even before the Cold War and charts and statistics were compiled by many countries (Sörlin and Lajus 2013; Doel et al. 2014). If Russia/USSR took the lead, followed by the Norwegians, with scattered contributions from other countries (e.g., Uppsala meteorologist Finn Malmgren [1927]), the Cold War saw a distinct rise of interest in Arctic ice research in the United States and Canada. This was linked to strategic considerations and the US founded Arctic related research labs and institutes related to all major branches of the armed forces in Alaska and elsewhere. The U.S. Navy established the Arctic Research Laboratory in Barrow, at the northwest tip of Alaska, to pursue "basic research in the Arctic" (Reed 1969:177). Separately the U.S. Air Force created the Arctic Aero-Medical Laboratory at Ladd Air Force Base outside Fairbanks, Alaska, with a mission to aid operations in hostile environments (including investigations of acclimatization and survival as well as physiological studies of indigenous Alaskans). These included outsourced labs in Europe (one in Sweden; Doel et al. 2014) and massive research efforts on the Greenland ice cap (Heymann et al. 2010).

In the 1950s an ice free Arctic Sea was commonly predicted by US and Canadian scientists by the year 2000 or even earlier. This was founded on research programs that had been started shortly after the war when it became increasingly clear that knowledge of the Arctic environment was of strategic importance in the face of possible conventional as well as nuclear warfare in the Arctic. Thickness and distribution of ice in the Arctic Ocean and coastal areas obviously limited the operations of surface vessels and submarines. The U.S. Navy began charting sea ice conditions from reconnaissance flights in 1947 and began a sustained ice observing and forecasting program a few years later (*Report* 1958, p. 2). Canadian agencies were asked to contribute with station based monitoring data. In the Soviet Union regular air observations of the large areas of sea ice in the Russian Arctic were organized before the War (in 1939, in the Barents Sea since 1934) under the patronage of the Main Administration of the Northern Sea Route (*Glavsevmorput*), although such observations on a smaller scale for facilitating Arctic navigation were known since 1924 and continued through the 1930s.

Among those who attempted to predict future ice conditions was the head of the Canadian Defence Research Board's Arctic division, Graham Rowley, who suggested in 1952 that there had already been a decrease in average ice thickness in the north from 365 cm in 1893–1896 to a mere 218 in 1937, and based on this speculated on 'an open polar sea' as a possibility in less than 30 years (Roberts 2014). Rowley's U.S. Army counterpart, the bio-geographer Paul A. Siple, likewise predicted, in 1953, a possible ice-free Arctic Ocean in half a century. Both of them related the vanishing of summer sea ice as related to climate change, but that change was to them nothing more than natural variation. Nonetheless, climate change was a matter of national security concern (Siple 1953). The scientific predictions spread to the public realm. The *New York Times*, presenting the news of the Soviet Union joining the International Geophysical Year 1957/58 in December 1954, connected to the idea of a global warming that might significantly affect the Arctic: 'How rapidly is the earth warming up? There are indications that the rate of warming has accelerated since 1900 and that in 25–50 years the ice may melt out of the Arctic Ocean in the summer' (NYT 1954). After the year 2000 similar projections have become increasingly frequent as evidence of global warming has grown stronger and as the Arctic Ocean summer minimum has reached record lows (Christensen et al. 2013).

24.3 Glaciers and Climate Change

From very early on ice was linked to ideas of climate change. Work in this vein was conducted right after the breakthrough of ice age theory by John Tyndall (1850s) who apart from his experimental work on the properties of gases also studied glaciers (Hevly 1996). Svante Arrhenius's productive use of the theory of the greenhouse effect (1896) was predicated on comprehensive study of glaciers in Swedish Lapland by Swedish geoscientists and was essentially an attempt to understand the dynamics of ice ages and possibly predict the arrival of next glaciation. Geographers and geoscientists in many countries worked on glaciers as archives and indicators of climate change well before the modern orthodoxy of anthropogenic carbon forcing was proposed in its current version by Guy Stewart Callendar (1938).

Despite the considerable formation of knowledge of climate variation in the glaciological community it contributed only marginally to the formation of the modern orthodoxy as this gained a more coherent form in the post WWII period. By and large it was theoretical meteorologists, atmospheric chemists in alliance with mathematicians and modelers who proposed the new understanding (Weart 2003; Sörlin 2009a, b; Edwards 2010), often in tension with the glaciological community and other strands of the geosciences who had a tendency to favor natural variations. Sometimes this was done very creatively, as in the case of Stockholm geographer Hans Ahlmann's theory of 'Polar warming', based on comprehensive multi-decadal data collection from glaciers across Scandinavia, Svalbard, Iceland and Greenland which he consistently attributed to non-human factors (Sörlin 2011).

The study of ice, a dynamic yet comparatively 'slow' indicator thus came to play a role in the debates over the causes of climate variation and change. It is quite important, especially given the current near total scientific consensus (Oreskes 2004), to observe that major scientific communities, also those that seem close to each other, such as glaciologists studying ice and climatologists studying the conditions for ice, have entertained quite different understandings and narratives until quite recently. After a long period of reasonable consensus that major climate change was unlikely tension was slowly building from the early 1950s (Sörlin 2009b). Empirical climate change scientists collecting data 'on the ground' stayed by and large with the old orthodoxy. Theorists in the physical sciences instead spearheaded the view that climate change was not only likely but that it was indeed happening and that it was anthropogenic. They later became equipped with computer based models identifying with the formation of an early 'global change science' working on a macro, indeed planetary scale. Some of their focus was put on projections for Arctic futures, an interest that would over time grow into a topic in its own right (Nilsson 2007; Wormbs and Sörlin 2015). Certainly, this work covered the entire planet, but insofar as the tension involved data on glaciers or sea ice it was geographically set in the Arctic.

24.4 Cryo-History as Part of an Emerging Environmental Humanities

What comes across as a main feature in this short sketch of an emerging 'cryo-history' is the importance of communities and narratives. The ice itself is out there, but how it is described, from what vantage point, with what purpose, and with what sense of urgency differs widely. Old geographical issues mix with economic interests, military and strategic needs, and the immediate concerns of local communities and Arctic residents. Several scientific groups studied ice from different vantage points, each with their own epistemic community and 'lifestyle' (Shackley 2001).

Moving towards a new understanding of ice we may therefore attempt a broader historical reading that speaks to major issues of environmental and global change, social and planetary temporalities, and the geopolitics of climate. This means we can now analyze and tell stories framed by what has come to be called the era of the Anthropocene, where environmental and climate change seems to be playing a larger role than hitherto in the understanding of history – and future (Pálsson et al. 2013), and the Arctic is a region where this work seems particularly important. This work can be launched against a backdrop of more than a century of attempts to enroll ice as an object of study in a range of science fields and an established tradition of researching the records of change in the physical properties of ice, its distribution, thickness, role in climate change, etcetera. In this tradition new work is constantly produced and ever more refined, as should have become evident from the previous sections of this chapter (see also e.g., Polyak et al. 2010). A core element of this is the deep time histories derived from ice-cores, drilled since the 1950s in Greenland and later in Antarctica (Lolck 2006; Martin-Nielsen 2013a; Petit et al. 1999).

What has been largely absent in this methodological and discursive widening of ice as a topic is the social sciences and the humanities (generally on the latter, see Sörlin and Warde 2009). So, although there is a cryo-history in reality, 'out there', so far there is too little work done on that history, except for some work on the history of glaciology itself (e.g., Macdougall 2004), on the role of ice and snow in the formation of national identities of (a few) northern nations (e.g., Bomann-Larsen 1996), or on ice as a fascinating element to be conquered in the quest for the poles (e.g., Lopez 1986), to mention a few. More recently, however, this has been rapidly changing and a substantive body of work is forming that can be considered as cryo-history, broadly construed.

Let me tentatively identify two main areas of research so far; a description that can surely be more differentiated as the body of work grows. One covers the historical studies of how people and institutions have studied and related to ice and is mostly carried out by environmental historians and historians of science, technology, and geography. An eminent example is a recent volume, *Media and the Politics of Arctic Climate Change: When the Ice Breaks* (Christensen et al. 2013). Departing from the surprising and much discussed Arctic sea ice minimum in 2007, it is the first broad penetration from a range of disciplines into the historical geopolitics and mediatisation of sea ice. It tells a story of one of the world's trans-boundary multi-state regions, the Arctic – on a par with the Amazon, Sahara, Antarctica – which has led a life largely unnoticed by the outside world but with climate change and an emerging new energy and resource geopolitics has moved into centre stage of science, diplomacy, and media coverage.

Work on terrestrial cryo-history appears in a recent volume edited by Sverker Sörlin, *Science, Geopolitics and Culture in the Polar Region – Norden beyond Borders* (2013a), with chapters on Hans Ahlmann's work as a science broker and diplomat in the Nordic and North Atlantic context (Sörlin 2013b), and on the role of the Nordic countries in the international polar years (Elzinga 2013). Along similar lines is a "Special Feature: Arctic Science" of the *Journal of Historical Geography* (2014) which carries several articles with historical work on ice. Also, a recent book by Janet Martin-Nielsen (2013b) problematizes science work on ice in Greenland's *Eismitte*; her work falls within the larger framework of study of science politics on and about the Greenland ice cap conducted at the University of Aarhus (Heymann et al. 2010). Related work for Canada and the United States has been conducted by e.g., Matt Farish (2010, 2013). Mark Carey's (2010) work on glacier science and local knowledge in the Andes can also be cited as an example of this category.

The second major area of work concerns local popular perceptions and practices of ice. In this category we find notably work by anthropologists such as Julie Cruikshank (2005), who has studied the relation to glaciers among the Tlingit in the Pacific North West, but also broad interdisciplinary projects from the International Polar Year 2007–2008. One of them, The *Siku-Inuit-Hila* (Sea Ice-People-Weather) project, involved Arctic residents in Barrow, Alaska, Clyde River, Nunavut, and Qaanaaq, Greenland along with scientists and anthropologists in collaborative efforts including common fieldwork, and resulted in a diverse volume entitled *Knowing Our Ice* (Krupnik et al. 2010) and also a large and generously illustrated book for a lay audience, *The Meaning of Ice* (Gearhard et al. 2013). Interesting recent work is also assembled in a volume edited by anthropologists Kirsten Hastrup and Morten Skrydstrup, *The Social Life of Climate Change Models* (2013). It is mostly Hastrup's chapter on the navigational practices of Inuit in Northwestern Greenland (Hastrup 2013), Skrydstrup's report from his field work on ice core drilling, also in Greenland (Skrydstrup 2013), and Hildegard Diemberger's paper on predictability of the snow and ice region of Tibet (Diemberger 2013) that deal fully with ice, but throughout the book glaciers and sea ice occur.

Recent science and scholarship reveal a dire situation for ice in the Arctic. But it also sends the message that we seem to finally take on board that ice is part of history – and thus part of our common responsibility. Ice has become a dimension of the emerging scholarly interest in a planetary consciousness, especially in the field of environmental humanities which in recent years have expanded into the Arctic.

This short essay has tried to demonstrate that we are now reinterpreting the role of ice, both terrestrial and sea ice. We see it more clearly as a key element in cultures, communities and economies, and we are becoming aware of the serious consequences that the loss of ice entails. We also see ice assuming key roles in new narratives of the planetary giving enhanced importance to the Arctic and to the rising Arctic humanities.

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