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.

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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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