

# **From Pole to Pole**

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# Implications and Consequences of Anthropogenic Pollution in Polar Environments

 Springer

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# Foreword

The International Polar Year 2007–2008 was the largest joint Polar research activity ever performed. Thousands of scientist participated and thousands of papers have been published, with some still on their way. Although pollution of the Polar regions—the environment and in the Arctic, its indigenous and non-indigenous populations, was not a priority area for the IPY, some projects did cover these important topics and these have provided important new knowledge. This book summarizes some of this new knowledge.

Pollution of the Arctic and Antarctic areas by chemicals originating from industrial, agricultural and transport activities in the tropics and at mid-latitudes has been documented since the 1980s; however, huge gaps in knowledge exist about these pollution sources, and related contaminant transport pathways, bioaccumulation, and biological effects on ecosystems, animals and humans. The IPY projects presented in this book address some of these gaps.

The atmosphere, rivers and ocean currents are the three main routes for transporting pollution as well as energy. The atmosphere is by far the fastest “highway” to the Polar regions. Two chapters in this book (Kallenborn et al.; Skov et al.) provide the reader with a good overview of the role of international scientific cooperation in documenting and explaining how atmospheric transport of contaminants such as persistent organics and heavy metals occurs. These chapters also provide new results obtained from related IPY projects documenting, for example, the contribution from sources in Southeast Asia, increasing understanding of some of the process involved in long-range transport, and discussing the transformation of the chemicals and their deposition in Polar regions.

Two other chapters (Shevchenko et al.; Grannas) describe processes involving the atmosphere and snow and ice. Snow and ice provide not only a temporary storage for particle associated and gaseous chemicals but also a means by which they can be transported. It also plays a central role in some photochemical process that can transform organic pollutants.

Black Carbon (BC) is a pollutant that affects human health, especially in indoor environments. It also contributes to climate change by absorbing heat while present

in the air or when deposited on snow and ice. Some sources of BC around the world contribute to increasing temperature—also in the Polar regions. Sources of BC exist within the Arctic, including the emissions from industrial activities in northern Siberia. Chapter 10 also provides an overview of the observations and analyses made in Siberia and adjacent Arctic seas.

Persistent organics and mercury are contaminants that accumulate and in some cases bio-magnify in the marine food chain, from plankton, through fish and marine mammals, up to humans. Two chapters (Vorkamp and Muir; Dietz et al.) describe this bioaccumulation of environmental contaminants in the Arctic food chain, focusing on ringed seals and polar bear, the two key species in the Arctic marine ecosystem that are also used and as traditional food by some Arctic indigenous peoples. The chapters provide the reader with a good introduction to the subjects of contaminant bioaccumulation metabolism and toxicokinetics. They also present information on contaminant geographical and temporal trends, and biological effects of single compounds and mixtures on these animals. Concerns about new chemicals entering the Arctic with potential to further contaminate food chain are also discussed.

At the top of the Arctic marine food chain, we have Arctic indigenous peoples who for thousands of years have survived in the region by harvesting marine resources as part of their traditional diet. This diet is rich in nutrients, energy and vitamins, but in recent decades has become contaminated by chemicals that are seldom used or discharged in the Polar region. Since the early 1990s, several studies have investigated human health impacts of contamination of traditional foods in some Arctic areas and these topics are covered in two chapters in the book (Hansen et al.; Gomes and Roche). This material informs the reader about new results and new concerns—especially regarding some specific human health effects—and discusses the effectiveness of actions taken at local and global scales to address this important issue. In discussing the connection between food, diet, nutrition, contaminants and human health, Hansen et al. illustrate how risk communication must be addressed in a responsible manner to avoid unnecessary negative impacts on nutritional benefits, including post-natal nursing behaviour.

The final three chapters discuss a range of related subjects, including the effects of globalization on Arctic indigenous peoples based on investigations conducted in Greenland prior to the IPY (Sowa), security and the involvement of schoolchildren in sampling and analyses for environmental contaminants (Heimstad et al.). They illustrate the changes in the Greenlandic society over the last 40 years, from small hunting/gathering communities based on local food, to larger townships where western (Danish) food is increasingly found in the stores. The importance of local food as a significant source of nutrients and as a central part of traditional culture is discussed by Sowa, and in this context, the chapter also discusses the impacts of pollution and climate change.

The engagement of the youth in sampling and analyses of contaminants is important not just to stimulate recruitment of ‘new Polar scientists’. Even more important is the role that such engagement has in transferring knowledge and understanding about how pollution from human activities within and outside the

region can impact Polar areas and their unique ecosystems, and what this means for their human populations. More than 50 schools from 13 countries took part in the exercise that provides an example for similar educational activities, which should be conducted not only in Arctic communities but also all over the world.

The chapter written by Hoogensen Gjørvi et al. introduces the subject of security, from military security to human security, viewed from a Northern perspective. It addresses energy and environmental security—including food and water security for Arctic indigenous peoples—and themes of increasing importance in a world where large groups of people are and will continue to migrate due to war and climate change.

This book is highly relevant for readers who would like to learn more than just the headline news. For the scientific community working on Polar ecosystems and for people living in the Arctic, the chapters provide important new information and insights. The impacts of pollution and climate change on Polar regions and world as a whole will continue for many years to come. Sound science is vital in order to underpin actions that need to be taken at global, regional and local levels. This book contributes to this science, but more is needed.

Enjoy your reading.

Lars-Otto Reiersen  
AMAP Executive Secretary

## Letter from the Editorial Team

The first two International Polar Years both failed to coordinate and distribute their assembled data adequately and to ensure its proper analysis, resulting in a less than satisfactory legacy from what had been considerable international efforts. Recognizing this, the participants in the Third International Polar Year (International Geophysical Year) made extensive plans to ensure that their contributions would be both accessible and used, establishing the World Data Centres as a major new initiative. In the early preparatory stages of the latest International Polar Year (IPY 2007–2009), the importance of providing the legacy of this demanding international research effort was made clear, with priority being given to planning for a well-organized dissemination and coordinated publication of the results, data evaluations and scientific findings. It was with this in mind that we proposed our publication project (IPY Project No. 79) in the form of the book series “From Pole to Pole: Environmental Research within the International Polar Year 2007–2009”. With over 50,000 scientists involved in a myriad of projects, there was an obvious need for a guide to the principal findings and the key papers within environmental science fields.

The “From Pole to Pole” book series was conceived as a comprehensive publication framework for the documentation of environmental research activities performed during the IPY period. The book series is not intended to be a typical collection of original scientific project publications/chapters in the form of standard monographs. It is rather a bibliographic, a science-based information source and a starting point for interested scientists and public to access the summary information on the specific environmental research topics within the IPY activities. The volumes will provide scientifically sound general information on the concepts, findings and scientific motivation for the various relevant research activities and will direct the interested reader to more detailed scientific papers, web-based information and other publications which will provide the detailed data and their analyses. These compilations of citations and references within the book volumes will be important milestones for the assessment of progress in each area, and the scientific significance and value will grow as the series develops.



The volumes will also be available in e-book format which will allow continuous updating of references and information sources (including internet pages and databases) by the editorial team on an annual basis, thus keeping the works topical as living reference sources. It is expected that this documentation will provide a comprehensive picture of most of the environmental research performed within the IPY framework.

After the now ending initial phase, the “From Pole to Pole” book series will be transformed into a legacy component of IPY by widening the concept of the book series towards general coverage of recent scientific developments in environmental Polar research (Arctic and Antarctic).

With the initial published volume on the history of the International Polar Years (edited by Susan Barr and Cornelia Lüdecke), our concept has finally begun to be realized, and has been followed by the completion of other volumes. Marine biology has provided two volumes on “Adaptation and Evolution in Marine Environments—The Impacts of Global Change on Biodiversity”.

The fourth volume for the “From Pole to Pole” book series “Implications and Consequences of Anthropogenic Pollution in Polar Environments” deals with anthropogenic pollutants, their environmental, toxicological and societal implications in the sensitive Polar environments. Many of the projects and chapters described here have developed into long-term commitments since IPY, and thus illustrate the impact this relatively short period of IPY research (2007–2009) is still having on the present international research activities in Polar environmental pollutant research.

The book project describes the development, continuation and scientific impact of 11 research projects initiated or associated with IPY. Scientific aspects and research in sociology, anthropology, chemistry, physics, medicine, human toxicology, glaciology, education and many more are covered, illustrating once again the strong interdisciplinary character of the IPY research endeavours. In total 68 authors contributed to this book representing a significant fraction of environmental scientists involved in this field of IPY research.

We thus congratulate the editor and the authors not only for their outstanding efforts to document all aspects of the research on anthropogenic pollutants undertaken during the recent IPY but also for developing these research priorities further in the present context of Polar environmental pollutants.

Ås, Norway  
Naples, Italy  
Oslo, Norway  
Cambridge, UK  
January 2016

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Guido di Prisco  
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David Walton

# Acknowledgement

The book project “Implications and Consequences of Anthropogenic Pollution in Polar Environments” had developed into a long-term commitment to which many colleagues, friends and family contributed in their own way. Without their support, understanding and active help, the book would not have been possible.

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Finally, but not least, I wish to express my heartfelt thanks to my family, Berit, Magnus and Mia who had to live with me through the times when I was completely occupied with the completion of this project, in addition to my other numerous duties at the institute and abroad. Thanks for your patience, understanding and keeping up pace with me during challenging times.

Roland Kallenborn

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