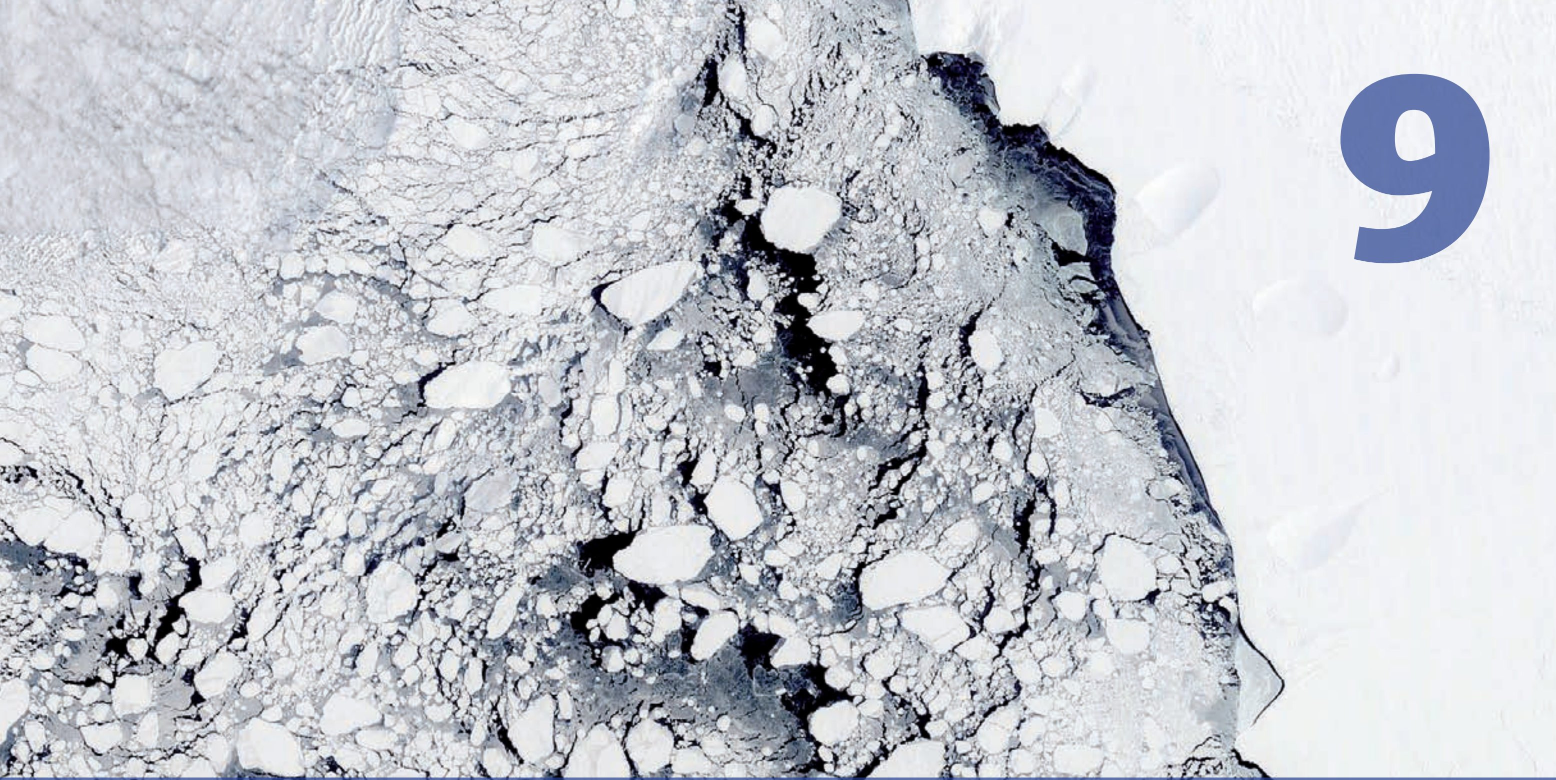

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Policy and Perspectives

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Policy and Perspectives

Photo: Christopher Uglow/UNEP/Still Pictures

Wrap up of key messages

The underlying theme in the preceding chapters is that changes are now observed in ice and snow and bigger changes are projected. The greenhouse gases from past and current emissions remain in the Earth's atmosphere for decades to centuries. Most of the extra heat on Earth caused by emissions of anthropogenic greenhouse gases is stored in the oceans. These two factors will lead to further changes in ice and snow no matter how quickly the world acts to reduce emissions. There is a danger of this time gap between policy implementation and real results leading to thinking that the situation is beyond control – but the projections for future change also make it clear that policies implemented now will have a real impact in slowing global warming in the decades and centuries to come.

Some of the impacts from changes in ice and snow are immediately visible, often showing up as increased frequencies of events that are within the range of natural variation. For example, winter roads might be open on average fewer days in the Arctic; feeding conditions might be poor for caribou and reindeer more frequently than in the past; amount and timing of runoff from snowmelt in the Andes, Alps or Himalayas might result in local water shortages in more years. Over time these short-term events lead to longer-term consequences including changes in biodiversity, ecosystems and regional economies.

In several chapters the theme of gradual and abrupt changes is discussed. Projections for future change are built on climate models, incorporating to the extent possible the complexity of interactions and feedbacks among atmosphere, oceans and land. The results are projections of incremental change – a bit warmer each decade, on average a bit more ice melting from the Greenland ice sheet each year. This type of change is somewhat predictable, as long as one takes into account the natural year-to-year variability in climate conditions. In discussing changes in ice and snow in the preceding chapters, authors reference the possibility of another type of change – abrupt, 'catastrophic' and unpredictable change that results in a jump in the line on the graph, a shift from one state to another. We know from ice cores in Greenland that abrupt climate change may happen naturally. These 'tipping points' can be related to the cryosphere itself. For example the break up of a section of an ice shelf in Antarctica may remove the plug at the end of glaciers draining the ice sheet, leading to a sudden increase in the rate of movement of land ice to the sea, directly translated into sea-level rise. Some of these abrupt changes are related to ecosystems, biodiversity

Sea-ice research in the Fram Strait between Greenland and Svalbard. *Photo: Sebastian Gerland, Norwegian Polar Institute*

and human well-being. When there is no more summer sea ice in the Arctic, some ice-adapted animal populations and species could be driven rapidly to extinction, from the ice algae and crustaceans that are key components of polar marine food webs to polar bears whose life cycles are built around the existence of year-round sea ice. There are potential cascading effects from these abrupt changes, including on the people whose livelihoods and cultures are tied to the affected resources.

The chapters in this book are built around components of the cryosphere, and the impacts are considered one by one. But in the real world, these impacts interact with one another, often in unexpected ways, in some cases resulting in greater impacts, in some cases partially compensating for one another. This is further complicated by negative and positive feedbacks altering the rates of change. This theme of complexity is introduced in the discussion of feedbacks and interactions in Chapter 3 and picked up in the subsequent chapters in discussions of impacts. The chapter on sea-level rise (Chapter 6C) discusses the complexity of interactions associated with assessing and responding to the impacts from sea-level rise.

Another message from the preceding chapters is the need for a concerted effort to improve research and long-term monitoring to address the gaps in our knowledge about what is happening with ice and snow. Some of the biggest questions, of most significance for the long-term future of human societies on Earth, are related to the fate of the ice sheets and the consequences to sea-level rise. But there are many other questions that need to be answered about how the changes in ice and snow affect climate and oceans, biodiversity, and human well-being. It is clear from these chapters that there is optimism that the research and monitoring campaigns initiated through International Polar Year 2007–2008 will address these questions and reduce uncertainty about the outlook for ice and snow.

Policy responses and options

How will these changes in ice and snow affect human well-being? What policy issues will arise from these impacts? How are policymakers likely to frame these issues for public consideration and to evaluate the benefits and costs of the policy responses and options they identify? In order to answer these questions, we address a selection of key policy issues arising at the global, regional and local or community levels.

Global policy issues

From understanding to addressing climate change

Throughout the 1980s, a growing body of scientific documentation on the potential threat anthropogenic climate change could pose to ecosystems and human societies led the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to establish the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCCs mandate is to assemble the best understanding and knowledge on climate change, its potential impacts and options for adaptation and mitigation (see box on the IPCC process).

The first IPCC assessment report in 1990 triggered the negotiation of the United Nations Framework Convention on Climate Change (UNFCCC). Thereafter, the momentum towards addressing climate change has further increased leading to the adoption of the Kyoto Protocol in 1997 which set targets to reduce greenhouse gases emissions and mitigate climate change.

Complementary to mitigation, adaptation measures are needed to respond to the impacts of past and on-going greenhouse gas emissions. Adaptation policy and measures, being region-specific, require increased resolution in scientific knowledge and call for regional climate impacts assessment. In 2000, the Arctic Council, the organization for governmental cooperation among the eight Arctic states, decided to conduct a full impact assessment for the Arctic region. Completed in 2004, the Arctic Climate Impact Assessment (ACIA) was submitted to the ministerial conference of the Arctic Council. The ACIA is the only regional impact assessment conducted for ice and snow covered areas.

Under the Norwegian Chairmanship (2006–2009), the Council is working on follow up on the ACIA's recom-

The Intergovernmental Panel on Climate Change

The mandate of the IPCC is to "assess the scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation." The IPCC does not carry out research, nor does it monitor climate-related data or other relevant parameters. Rather, it bases its assessment mainly on peer-reviewed scientific and technical literature that has already been published. The comprehensive assessment process involves the input of hundreds of scientists in compiling, analysing and synthesizing existing scientific publications to draw conclusions about the status of our scientific understanding of climate change.

One of the factors that have made IPCC successful is that it strives to be policy relevant but not policy prescriptive. IPCC reports benefit from a process founded on scientific integrity, objectivity, openness and transparency. Confidence in the results is enhanced through a rigorous review process and an adoption and approval process that is open to all member governments.

mendations by producing status reports on the impacts of vanishing sea ice, possible meltdown of the Greenland ice sheet, and on changes in permafrost. A study on adaptation challenges will also be carried out with the aim of enhancing the adaptive capacity of Arctic residents.

Options to mitigate climate change

One of the main conclusions of the fourth IPCC assessment report is that it is very likely (more than 90 per cent) that most of the global warming during the last 50 years is due to the observed increase in human-made greenhouse gas concentrations, and that continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century[1].

Today, the CO_2 level in the atmosphere has increased by 40 per cent over pre-industrial levels. Under a business-as-usual scenario for emissions from human activities, a doubling will occur in 50–80 years, depending on the rate of increase in emissions and how much nature will absorb, which would most probably lead to a global temperature increase of 3 °C.

A global temperature increase of more than 2–3 °C will constitute dangerous climate change with unacceptably high risk of:

- Significant negative impacts on global food production and water supply;
- Large-scale changes in ecosystems and biodiversity that will negatively affect ecosystem services;
- Melting of parts of the Greenland and Antarctic ice sheets with subsequent devastating sea-level rise;
- Irreversible abrupt climate changes, such as large-scale changes in ocean currents.

To avoid such temperature increases, greenhouse gases must be stabilized at a level below a doubling of pre-industrial levels. Achieving this means that no later than 15 to 25 years from now emissions will have to stop increasing and start decreasing significantly – to about 10–50 per cent of currents levels by 2050[2]. In the longer term, emissions must be cut by as much as 70–80 per cent in order to stabilize the Earth's climate system.

Recent comprehensive assessments and reports[2,3,4] indicate that such emission cuts can be achieved over the next few decades without significant welfare losses. The cost is estimated to be less than 2 per cent of the gross domestic product (GDP), well below the rate of growth in the economy. Many of the needed technologies exist, and the potential for improving them and developing new technologies is high. It is the sum of many small and medium contributions to reductions in emissions through the use of several different kinds of technologies for energy efficiency, renewable energy, and carbon capture and storage (CCS) that is likely to constitute the solution in the end.

At the political level, there is a wide variety of policies, measures and instruments that could be applied to stimulate the use of alternative existing technologies, improve them and develop new technologies. According to the IPCC[2], "A positive 'price of carbon' would create incentives for producers and consumers to significantly invest in lower carbon products, technologies and processes." A carbon price of US$20–50 per tonne of CO_2 equivalent could largely decarbonise power generation and make many mitigation options in the end-use sectors attractive[2–4]. A uniform carbon price must be globally accepted to ensure equal conditions for competition in a globalized economy. In addition, incentives related to direct governmental funding and regulations are required. For example, the development of new technologies will depend on large-scale governmental funding of research and development.

Regional policy issues

It is natural to turn first to the polar regions in thinking about regional policy issues. But the impacts of changes in ice and snow are not limited to the high latitudes. In mountainous areas where glaciers are prominent features of the landscape and the annual snow pack is an essential source of fresh water, changes in ice and snow will produce substantial impacts on human well-being. In this discussion of regional policy issues, we look at selected issues in three regions: the Arctic, the Antarctic, and the Himalayas.

Arctic: jurisdiction, oil, and minerals

In the Far North, the key policy issues centre on the prospects that retreating sea ice will open up the Northeast and Northwest Passages for commercial shipping and increase access to commercially significant deposits of oil and gas located in shallow waters of the Arctic littorals. If current forecasts regarding the navigability of Arctic waters (such as ice-free navigation along the Northern Sea Route for up to 120 days per year during this century) hold, incentives to ship a variety of goods – especially between Europe and the Far East – will grow rapidly in the coming decades. The combination of large recoverable reserves of oil and gas (25 per cent or more of the Earth's untapped reserves according to the US Geological Survey) and the relative security of the Arctic in geopolitical terms can be expected to make the extraction of hydrocarbons in this area irresistibly attractive.

These developments will give rise to two sets of policy issues that cannot be avoided even in the short run. The first set concerns jurisdiction. Already, Canada and Russia are taking steps to assert extended Exclusive Eco-

Arctic sea ice.
Photo: Andrea Taurisano, Norwegian Polar Institute

nomic Zones and enhanced control over continental shelves in the Arctic Basin. These jurisdictional issues will require resolution under the terms of Parts V (Exclusive Economic Zone) and VI (Outer Continental Shelf) of the UN Convention on the Law of the Sea (UNCLOS), even though the United States has never formally ratified UNCLOS. Article 234 on "ice-covered areas" may provide a point of departure for some initiatives relating to these matters. One option that may prove attractive is an agreement on jurisdiction in the Arctic Basin settling competing claims among the five littoral states, granting primacy in the region to these states, and making some provision for navigation in Arctic waters on the part of others.

The second set of issues concerns rules governing shipping and oil and gas development. The creation of regulatory regimes will be the first order of business. Some existing agreements, such as the International Convention for the Prevention of Pollution from Ships (MARPOL), already apply to the Arctic Basin. Designation of the Arctic as a Special Area under MARPOL was proposed by the Arctic Council's working group on the Protection of the Arctic Marine Environment several years ago, but the proposal did not receive the necessary consensus from the eight Arctic nations.

Other potential mechanisms include the development of a regional regime intended to articulate and codify standards for environmental protection in the Arctic under UNEP's Regional Seas Programme. The US and probably Russia are likely to oppose such a move. To the extent that oil and gas development occurs in areas under coastal state jurisdiction, national regimes governing such activities will apply. Even so, the fact that the Arctic Basin is a single system with its own biophysical dynamics will almost certainly stimulate efforts on the part of some coastal states to develop a regional regime to minimize adverse impacts of oil and gas development on Arctic ecosystems.

Antarctic: tourism expansion

Antarctic annual sea-ice extent is projected to decrease by 25 per cent by 2100 (Chapter 5), and this will bring easier access to the Antarctic continent by ship. This is likely to affect not only research, which is a main activity in a continent designated as a "natural reserve devoted to peace and science", but also commercial activities, such as tourism.

Tourism activities are expanding tremendously with the number of shipborne tourists increasing by 430 per cent in 14 years and land-based tourists by 757 per cent in 10 years (Figure 9.1). The majority of the seaborne voyages are to the Antarctic Peninsula region where the open sea condition in the summer season makes those voyages feasible and safer. Parallel to the growth in tourism is a substantial increase in tour-

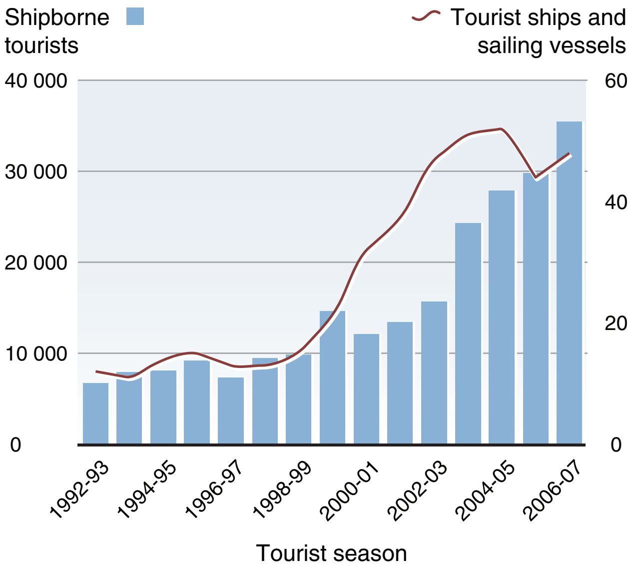

Figure 9.1: Growth of tourism in Antarctica.

Source: IAATO 2007[6]

ism vessels, some with large passenger capacities and without ice-strengthened hulls, such as the *Golden Princess* which has a capacity of 3700 persons, exceeding the estimated peak in personnel based in all Antarctic stations[5].

The projected retreat of sea ice is likely to lead to an expansion of tourism activities, as more sites will become accessible by sea and the season will lengthen. This, in turn, is likely to increase the risk tourism presents to the marine environment, as well as to terrestrial ecosystems, as over 80 per cent of the tourists land during their journeys. This will also present new challenges in maintaining the unique characteristics Antarctica presents for scientific monitoring and research on processes of global and regional importance. The growth in tourism has the potential to affect national research programmes through increased demand for services such as weather forecasting and search and rescue services.

In order to address these challenges, a comprehensive regime on tourism should be developed, complementary to the Madrid Protocol on Environmental Protection to the Antarctic Treaty, which provides a regulatory framework for human activities in Antarctica.

River in Nepal.
Photo: Christian Lambrechts

These changes are exacerbated by unsustainable natural resource management practices which lead, for example, to substantial deforestation and overgrazing in most watersheds[7,8].

Addressing these issues will require strategies and policies related to land-use and water management, for example:

- Watershed management and protection: In most of the countries only 1-5 per cent of the watersheds are protected, leaving little in the way of natural buffers against flash flooding.
- Poverty alleviation and financial mechanisms to support development of more sustainable grazing and wood-cutting practices. In particular, improved house-