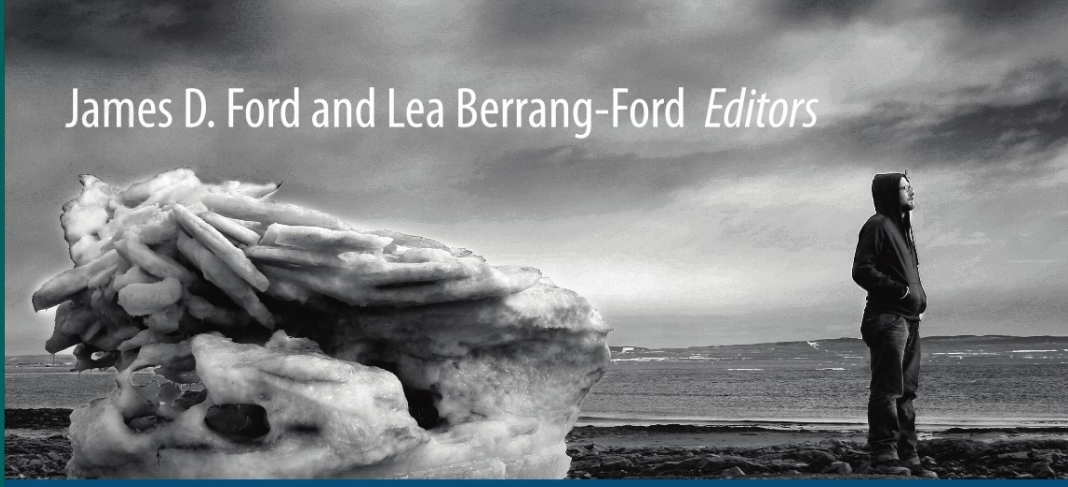


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# Climate Change Adaptation in Developed Nations

## *From Theory to Practice*

Springer

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# ADVANCES IN GLOBAL CHANGE RESEARCH

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# Climate Change Adaptation in Developed Nations

## From Theory to Practice

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# Introduction

**James D. Ford and Lea Berrang-Ford**

## Introduction

It is widely accepted that the climate is changing, with implications for human systems already documented (Fussel 2009; Smith et al. 2009; Stott et al. 2010). Climate models indicate continued and accelerated climate change in the future (Solomon et al. 2007). Research is only beginning to examine the potential implications of climate change for human systems and indicates significant vulnerabilities (Hulme 2008). Society will not be static as the climate changes, however, undergoing social, cultural, economic, and political changes that will affect how human systems experience climate change and determine adaptive capacity to respond. Some of these developments will moderate vulnerability: poverty, for instance, is a major determinant of climate vulnerability the world-over, and decreasing poverty rates with economic development offers considerable opportunity to reduce sensitivity to climatic risks and enhance adaptability. Aging populations, population growth in high-risk locations (e.g., coastal zones), increasing inequality, and weakening of social networks are trends that are likely to exacerbate vulnerability.

In light of the risks posed by climate change, climate policy has become a key area of debate and research. Reducing greenhouse gas emissions (i.e., mitigation) is central to efforts to tackle climate change. Mitigation will not be enough, however. Even with the most aggressive targets, historic emissions mean that some degree of climate warming is inevitable over the coming decades and will probably surpass the 2°C threshold held by many as indicative of "dangerous" interference with the climate system (Ramanathan and Feng 2008; Parry et al. 2009b; Smith et al. 2009). In this context, Adger and Barnett (2009) have called for a new realism on climate

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change, one that recognizes the significant likelihood that means warming will be 4°C or greater. What is clear is that adaptation is unavoidable if we are to reduce the risks of significant damage (Ford and Smit 2004; Smit and Wandel 2006; Pielke et al. 2007; Parry et al. 2008, 2009b; Adger and Barnett 2009; Costello et al. 2009; Smith et al. 2009).

The good news is that opportunities for adaptation to climate change are available, feasible, and in many cases can be mainstreamed into existing policy priorities and programming (Stern 2006; Garnaut 2008; Lemmen et al. 2008; Seguin 2008; Costello et al. 2009; Karl et al. 2009). Indeed, the challenge of adaptation to policymakers and managers is not necessarily new, as humans have lived with climatic variability for a long time and developed management decisions to cope with this variability (Glantz 1988; Burton et al. 2002; Ford and Smit 2004; Smit and Wandel 2006; Dovers 2009; Ford et al. 2010b). It is through changes in the magnitude and frequency of existing climatic variability that climate change will be experienced. As Dovers (2009) argues, we already have developed capacities and understanding in many sectors to provide a basis for addressing even significantly enhanced variability. Furthermore, the costs of adaptation, while daunting – scoping studies have suggested between $9 billion per year to greater than $300 billion per year (Parry et al. 2009a) – are only a fraction of global GDP.

Despite these opportunities, the bad news is that formidable challenges to climate change adaptation exist. First, given the scale of projected impacts and experience of climate change already, the window of opportunity for adaptation is narrow (Adger and Barnett 2009; Parry et al. 2009b). Second, social, environmental, institutional, and economic stresses are likely to further exacerbate impacts and constrain adaptive responses for vulnerable people and regions. Third, despite changes in weather extremes and increasing awareness (although not universal) of climate-change risks, adaptation activities are still poorly embedded in planning systems (Moser and Luers 2008; Tribbia and Moser 2008; Repetto 2009; Berrang-Ford et al. 2010; Ford et al. 2010c). Finally, as Adger and Barnett (2009) caution, maladaptation abounds where adaptations being undertaken today are not sustainable in the long term.

These challenges in part stem from the lack of attention given to adaptation in policy discussions on climate change at local, national, and international levels. For too long adaptation has been the poor cousin of mitigation. They also stem from the nature of adaptation research. As Barnett (2010) argues, adaptation has largely been investigated as a scientific and technical problem with little research that has sought to inform decision-makers. Thus there is a well-developed literature assessing vulnerability, identifying generic opportunities for adaptation, and examining adaptation processes, but fewer studies outlining specific adaptation entry points, developing adaptation plans, evaluating progress of adaptation plans, or profiling examples of best practice (Gagnon-Lebrun and Agrawala 2007; Barnett 2010; Ford et al. 2010b). This edited book is in response to this deficit and was conceived with the aim of profiling cases from different sectors and regions in developed nations where *specific* adaptation measures have been identified, implemented, and evaluated; the focus is "from theory to practice." The contributions provide practical advice and guidance that can help guide adaptation planning in multiple contexts.

In this introductory chapter we begin by explaining why the book focuses on developed nations and then document observed and projected climate changes affecting the developed world. We then present the book outline, review contributions of specific chapters, and finish by outlining future research directions raised by the authors.

## Why Developed Nations?

### *Definition and Characteristics of "Developed Nations"*

For the purposes of this book we define "developed nations" broadly as the 41 Parties identified under Annex I to the United Nations Framework Convention on Climate Change (UNFCCC) (Table 1.1, Fig. 1.1). This includes 28 of the 30 member states of the Organization for Economic Cooperation and Development (OECD), excluding South Korea and Mexico, and includes several Economies in Transition that are not part of the OECD. Annex 1 nations are industrialized in character, have high levels of economic development, low prevalence of poverty, aging and in some cases declining populations, well-developed institutional capacity, and have the majority of the population living in urban areas with livelihoods not directly

**Table 1.1** List of Annex I parties to the UNFCCC

| | |
|---|---|
| Australia | Liechtenstein |
| Austria | Lithuania |
| Belarus | Luxembourg |
| Belgium | Monaco |
| Bulgaria | Netherlands |
| Canada | New Zealand |
| Croatia | Norway |
| Czech Republic | Poland |
| Denmark | Portugal |
| Estonia | Romania |
| European Community | Russian Federation |
| Finland | Slovakia |
| France | Slovenia |
| Germany | Spain |
| Greece | Sweden |
| Hungary | Switzerland |
| Iceland | Turkey |
| Ireland | Ukraine |
| Italy | United Kingdom |
| Japan | United States of America |
| Lativa | |
| Estimated total population: 1,774,753,827 | |

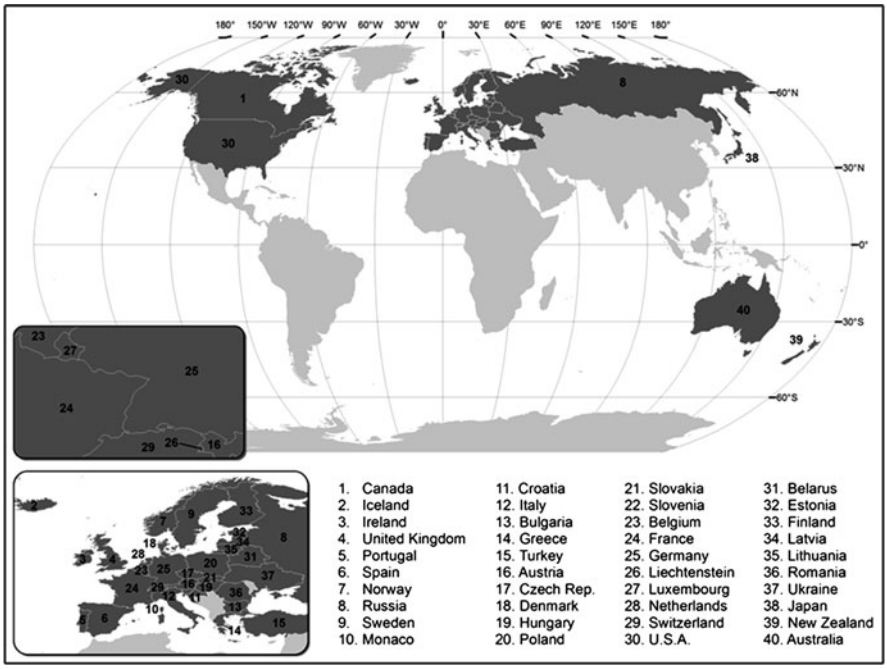


**Fig. 1.1** Map of Annex I parties to the UNFCCC

linked to climate-sensitive natural resources. They have a combined population of approximately 1.7 billion people, or 25% of the global population. We also note that we include one chapter profiling a case study from Tibet given important lessons for Indigenous populations in developed nations.

## *Observed and Projected Changes in Developed Countries*

Developed nations in the northern hemisphere have experienced some of the most pronounced changes in climatic conditions globally over the past century. In North America, the greatest warming has occurred in Arctic regions: between 1948 and 2005, for instance, winter temperatures in the Yukon and Mackenzie regions of Canada have warmed by 4.5°C and 4.3°C, respectively, with an annual warming of 2.2°C and 2.0°C (Prowse et al. 2009). The Arctic as a whole is warming at about twice the global average (Solomon et al. 2007). In Europe, the annual mean temperature has increased 0.91°C from 1901 to 2005, with a rate of warming of 0.41°C per decade from 1979 to 2005 (Solomon et al. 2007). In Japan, temperature increased by 1.0°C in the twentieth century, with estimates of 2–3°C increases for some large cities (Ichikawa 2004). In Australia, annual mean surface air temperature

has increased by 0.9°C since 1910 and 0.16°C per decade since 1950 (CSIRO and Australian Bureau of Meteorology 2007). The average maximum temperature in Australia increased by 0.6°C, while the minimum temperature increased by 1.2°C (Nicholls and Collins 2006; Solomon et al. 2007). Changing precipitation regimes have also been noted, showing greater regional variability than temperature.

Climate models project that warming will be greater than the global average for most of North America and Europe and close to the global average for more southern latitude developed countries like Australia. The greatest warming is projected to occur in Arctic regions of developed nations: over the western Canadian Arctic, for instance, median temperature changes of +6°C are projected by 2080, ranging from +3.5°C to +12.5°C depending on climate model and scenario used. Either way, Arctic regions are projected to experience the greatest changes in climate globally (ACIA 2005; Solomon et al. 2007: Timlin and Walsh 2007; Barber et al. 2008). The Intergovernmental Panel on Climate Change (IPCC) estimates that Europe will warm less than North America. Average temperatures in northern and central Europe are projected to increase a few degrees by 2050 and 3–5°C by 2090. Northern and central Europe will experience greater yearly maximum temperatures than other regions (Räisänen et al. 2004; Solomon et al. 2007; Kjellström et al. 2007). Japan is projected to experience warming in most areas, increased heat waves, increased annual precipitation, and more intense rainfall on extreme precipitation days, including those associated with typhoons (Solomon et al. 2007). Average annual precipitation increases are expected over most of northern Europe, the Arctic, Canada, northeastern United States and northern Pacific, while decreases will be experienced in most of the Mediterranean and the US Southwest. In general, there will be reduced rainfall over continental interiors during summer months due to increases in evaporation, with increased drought frequency projected for much of Australia (Solomon et al. 2007).

## *Climate Change Adaptation in Developed Nations: Reasons for Concern*

Developed nations are generally assumed to have limited vulnerability to climate change (Gagnon-Lebrun and Agrawala 2007; Solomon et al. 2007; Costello et al. 2009). On the whole, the assumption holds: individuals, communities, and governments in developed nations have access to significant resources and engage in a range of actions to manage and control climate-sensitive outcomes in a range of sectors including health, agriculture, infrastructure, business, education, and industry. Awareness of climate change is also generally high, research capacity well developed, and vulnerability and impacts assessments completed. This assumption, however, does not adequately consider the persistence of within-country socioeconomic inequities and their implications for vulnerable populations, and overlooks the fact that many observed and projected changes are considerably

greater in temperate latitudes (particularly Arctic nations). Moreover, significant vulnerabilities in developed nations have been highlighted by a number of climate-related disasters including the European heat wave, Australian drought, Mountain Pine Beetle infestation in the forests of Western Canada, and Hurricane Katrina (Hulme 2003; Lagadec 2004; Parkins and MacKendrick 2007; Ebi and Burton 2008; Ford et al. 2010a). In the United States, Repetto (2009) has argued that public and private bodies charged with adaptation have failed to deal with current risks and prepare for emerging future risks. O'Brien et al. (2004; 2006) voice concern over what they see as complacency in Norway and Europe more generally that climate change will have limited impacts, identifying significant vulnerabilities at a local level. What these and other studies demonstrate is that adaptive capacity in developed nations will not necessarily translate into adaptation; planned adaptation will be necessary.

Key concerns expressed in the literature regarding the ability of developed nations to adapt to climate change include:

- *Information deficit*: Adaptation requires recognition of the necessity to adapt, knowledge about available options, the capacity to assess them, and the ability to implement most suitable ones. Vulnerability assessment is an important first step for providing the necessary information for adaptation. Most developed nations have initiated impacts assessments, including the development of climate change scenarios, and have assessed impacts at a national level (Gagnon-Lebrun and Agrawala 2007). Some nations have also examined vulnerabilities, conducted sectoral assessments, and identified generic adaptation options. Notable progress has been made by the United Kingdom, Canada, Australia, and the Netherlands, yet comprehensive approaches to implementing adaptation and mainstreaming are lacking (Gagnon-Lebrun and Agrawala 2007). In a European context, O'Brien et al. (2006) further critique the scope of understanding, with studies disproportionately focusing on direct impacts on biophysical systems and economic sectors, with indirect effects and differential vulnerabilities often ignored. For specific sectors (e.g., industry) and at local and regional levels, the deficit between what we need to know to facilitate adaptation and what we know (the "adaptation deficit") is particularly large, especially for marginal populations (e.g., Indigenous peoples) (Ford et al. 2010a, c).
- *Economic resources*: It is widely recognized that access to economic resources directly affects vulnerability to climate change through its implications for institutional capacity and the ability of households to prevent, prepare for, avoid, and recover from climate-related hazards (IPCC 2001, 2007). Developed nations are expected to be less vulnerable to climate change on account of economic well-being. National level indicators, however, hide significant disparities, perhaps the most glaring of which are among Indigenous populations in developed nations who have been referred to as the "fourth world" on account of high rates of poverty and experience of housing, water, and food insecurity (O'Neill 1986; Ford et al. 2010a). Differential vulnerabilities exist at multiple levels and

for multiple populations. However, very little has been written on vulnerable populations in the developed world compared to the developing nations (O'Brien et al. 2006).

- *Institutional capacity*: High income nations are generally believed to have well-developed institutional capacity underpinning the ability to identify, recognize, evaluate, anticipate, and respond to climate-related risks including those associated with climate change (IPCC 2007). Institutions are generally well developed, funded, and staffed by a professional and highly educated workforce, with accountability ensuring proactive identification of future risks, planning for future burdens, and underpinning institutional learning. However, recent experience – from the 2003 European heat wave, to SARS, to Hurricane Katrina – has challenged the notion that institutions will insulate developed nations from climate-change impacts. In these instances, vertical institutional weaknesses, including flow of information between decision-makers at different scales, and horizontal challenges, including conflicting and unspecified jurisdiction, power politics, and institutional defensive routines, overwhelmed institutional capacity with dramatic consequences (Kates et al. 2006; Kovats and Ebi 2006; Boettke et al. 2007).
- *Technological capacity*: Availability and accessibility of technology at various levels will affect vulnerability to climate change. Technological capacity will play an important role in buffering developed nations against the effects of climate change and provides a strong basis for adaptive planning. Surveillance and early warning systems, for instance, play a crucial role in decreasing sensitivity to climate risks and increasing adaptive capacity, helping to anticipate and respond to risks that will become more prevalent with climate change. However, access to technology is often uneven in developed nations and technology can also create new vulnerabilities.
- *Political challenges*: Climate change will result in the emergence of risks which cross borders, extend over multiple spatial-temporal scales, and span jurisdictions of several government departments. Addressing these risks will require the creation of new governance structures, including increased participation of vulnerable peoples in decision-making, increased accountability, and financial commitments, and will entail potentially unpopular decisions by national governments (Costello et al. 2009). Political challenges exist to achieving these goals, evident by the lack of coordinated and comprehensive commitments on climate change adaptation at national and international levels, and slow progress in policy development (Pielke et al. 2007; Jinnah et al. 2009). Political will to meaningfully address climate change is also often lacking, with adaptation investments in some cases having limited short-term political benefit. Hurricane Katrina provides a case in point, where despite repeated warnings about the risks posed by flooding, decades of underinvestment in flood defenses and hazard planning and development in high-risk areas were allowed to continue. This reflected the political culture favoring low taxes and economic growth at the expense of safety, and the unwillingness of the public to see tax money spent on what were perceived as less pressing problems (Kates et al. 2006). The parallels for climate change adaptation are legion.

- *Societal trends*: Developed nations (as well as some emerging economies, e.g., China) face societal challenges associated with aging populations. For many climate-change risks, age will create unique sensitivities and challenges to adaptation. Epidemiological analysis of mortality during heat waves, for example, has highlighted that the elderly are at significantly higher risk, and in the majority of developed nations the magnitude and frequency of occurrence of heat waves is projected to increase (McGeehin and Mirabelli 2001; Brown and Walker 2008; Michelozzi et al. 2009). Research has also highlighted the greater emotional toll that climate hazards place on the elderly (Marion et al. 1999; Kovats 2004; Hajat et al. 2005). Older people and retirees are also attracted to warmer climates in general (Duncombe et al. 2003; Howard 2008). As a result, some esthetically pleasing coastal areas that are highly vulnerable to extreme weather events may become increasingly populated by older age groups. There are also unique economic challenges to aging populations. For example, a shrinking workforce will have to support a growing dependent population, and this will place increasing pressure on government expenditure (Leibfritz et al. 1995; Bryant et al. 2004; Guest 2006). In such a circumstance, funding allocated to climate-change adaptations may be constrained.

With these challenges in mind, examining successful initiatives and learning from failed ones offer important insights on the adaptation process and how we can integrate adaptation planning in policy programming at multiple levels. Herein, this book documents examples of adaptation in practice from across developed nations. The practical focus reflects the urgency of the adaptation challenge. It also reflects the maturation of adaptation science: while theoretical and methodological debates continue, and vulnerability assessments are ongoing, in a number of sectors and regions we are beginning to know enough to begin adaptation planning.

## Book Organization

This book is organized into seven themed parts:

- Part I: Introduction and overview
- Part II: Adaptation in the public health sector
- Part III: Adaptation in the industrial sector
- Part IV: Adaptation in the urban environment
- Part V: Adaptation in the agricultural sector
- Part VI: Adaptation in rural and resource-dependent communities
- Part VII: Future directions

Chapters in Part I review progress on adaptation in developed countries at a national level. Parts II–VI have between three and seven chapters, with each theme beginning with a summary chapter outlining the key contributions of the chapters, evaluation of progress toward the development of adaptation interventions,