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Integrated regional assessment

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1.1 The context of integrated regional assessment

Recognition that human activities have impacts on the environment at regional and global scale has a long history, including persistent questions about human effects on the environment (and the influences of the environment on mankind) from the time of Greek philosophers (Glacken 1967). Seminal publications that document concern about human impacts on the environment include the work of George Perkins Marsh, *Man and Nature* (1864), the landmark conference in 1955, *Man's Role in Changing the Face of the Earth* (Thomas 1956), and the latter's 1990 successor, *The Earth as Transformed by Human Action* (Turner *et al.* 1990a).

While humans interact with many aspects of the environment, the focus of this book is largely on the interactions with the climate system, since this issue has received considerable recent attention in integrated regional assessments.

The specter of climate change due to greenhouse gases became a public policy as well as a scientific issue in the 1970s, but human understanding of the possible effects of greenhouse gases has a much longer history (Fleming 1998; Clark *et al.* 2001a; Weart 2003). The absorption and re-emission of long-wave (heat) radiation by atmospheric gases, which has become popularly known as the "greenhouse effect," was described by Jean Baptiste Joseph Fourier in 1824; in 1862, John Tyndall identified carbon dioxide and water vapor as such gases; and in 1896, Svante August Arrhenius suggested that carbon dioxide from the burning of coal could result in atmospheric warming. In the 1930s and 1940s, Guy Stewart Callendar (1949) studied CO₂ and climate, and in the 1950s Gilbert N. Plass (1956) continued research related to greenhouse-gas warming through decades in which human-induced climate change had yet to become a popular issue. In the 1970s, the *Study of Critical Environmental Problems* (1970) and the *Study of Man's Impact on Climate* (1971) were prepared for the 1972 United Nations Conference on the Human Environment in Stockholm. From Russia, Budyko (1974) noted the threat

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Excerpt

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of rapid climate change. Evidence of increased atmospheric CO₂ concentrations, such as those of the Mauna Loa observatory (Keeling *et al.* 1976) and elsewhere, inspired researchers to alert the public to the possible impacts of global warming. Attention soon turned to the assessment of climate change impacts (Kates *et al.* 1985; Jacobson and Price 1991; Kuhn *et al.* 1992).

The Intergovernmental Panel on Climate Change (IPCC), created by the World Meteorological Organization and the United Nations Environment Programme in 1988, shared the 2007 Nobel Peace Prize, drawing ever more attention to its periodic summary and synthesis of global climate change knowledge (now moving toward a fifth cycle). Since the second IPCC assessment, regional dimensions have received increasing attention in its assessments.

Over the past two decades climate change research has been pursued within a large number of national and international programs. In parallel to the development of official bodies, numerous university-based and independent research institutes redefined their mission or were created to examine global climate change; their work is widely cited in this chapter and book. Box 1.1 lists a selection of regional climate assessments that have been carried out.

The 1994 United Nations Framework Convention on Climate Change (UNFCCC) now has 192 national signatories, although some nations failed to ratify the Kyoto Protocol (1997, coming into force from 2005), which established greenhouse-gas emission targets. Periodic reporting on emissions through greenhouse-gas inventories (industrialized nations), “national communications” (UNFCCC 2003) and “national adaptation programmes of action” (UNFCCC 2001) in the least developed countries are required (see Box 1.1). All of these documents contribute, in part, to national assessments of climate change.

Climate change is just one of the changes interacting with human development. The recognition of a wide range of global changes led to the evolution of the concept of an “Earth system science” in the 1980s. The important human role in global *systemic* change such as ozone depletion and greenhouse-gas emissions and in *cumulative* change such as soil erosion and biodiversity loss was increasingly recognized (Turner *et al.* 1990b). Research groups, whose work was at scales from local to global, examined the interactions between human agency and environmental change, including feedbacks between these components, in both conceptual/qualitative and quantitative aspects. Climate change became an increasingly important motivation for such studies, as evidenced by a number of international and national initiatives.

The International Geosphere–Biosphere Programme (IGBP) was launched in 1986 to address scientific issues of global change under the aegis of the International Council for Science (ICSU). In 1991, Diversitas was founded to address issues of biodiversity with sponsorship by the United Nations Educational, Scientific

Box 1.1

Selected regional assessments of climate change

International assessments

United States Country Studies Program (1993–1994; Smith and Lazo 2001)

- Africa and the Middle East (16 countries)
- Asia and Pacific (14 countries)
- Central and Eastern Europe and Former Soviet Union (nine countries)
- Latin America (eight countries plus seven countries in the Central American Regional Study)

United Nations Framework Convention on Climate Change (www.unfccc.int)

- National Communications (Annex 1, Organization for Cooperation and Development Industrialized Countries plus Countries in Transition)
40 initial, 39 second, 38 third, 38 fourth country submissions includes European Community Multi-Nation Report
- National Communications (non-annex 1, developing countries)
134 initial, three second, one third country submissions
National Adaptation Programmes of Action (48 UN-defined least-developed countries)
30 country submissions

United Nations Environment Programme, Country Studies on Climate Change Impacts and Adaptations Assessment (O’Brien 2000)

- Antigua and Barbuda
- Cameroon
- Estonia
- Pakistan

Intergovernmental Panel on Climate Change (www.ipcc.ch)

- IPCC Regional Impacts Studies (Watson *et al.* 1998)
Africa
The Arctic and Antarctic
Australasia
Europe
Latin America
Middle East and Arid Asia
North America
Small Island States
Temperate Asia
Tropical Asia

IPCC Third and Fourth Assessment Reports (McCarthy *et al.* 2001; Parry *et al.* 2007)
Africa
Asia
Australia and New Zealand
Europe
Latin America
North America
Polar Regions (Arctic and Antarctic)
Small Island States

Continental, national, and regional assessments

Africa

Climate change and Africa (Low 2005)

AIACC (Assessments of Impacts and Adaptation to Climate Change Regional Studies (limited sectors; Leary *et al.* 2007)

Africa (11 studies)
Asia (five studies)
Latin America (five studies)
Small Islands (three studies)

Arctic

Arctic Climate Impacts Assessment (ACIA 2005)

Asia

Asia Pacific Network (Kainuma *et al.*, Chapter 11, this volume)
Southeast Asia Regional Network (Lebel, Chapter 16, this volume)

Australia

Climate Change in the Cairns and Great Barrier Reef Region (Crimp *et al.* 2004)
Climate change impacts for Australia (Preston and Jones 2006)

Baltic Sea Region

BALTEX assessment of Climate Change (2008)

Brazil

WAVES-water availability, vulnerability of ecosystems and society in Northeastern Brazil (Ferreira *et al.* 2000; Gaiser *et al.* 2003)

Canada

Mackenzie Basin impact study (Cohen 1995, 1996, 1997; Cohen *et al.* 1997)

Canada country study (Mayer and Avis 1998)
Regional assessments (six)
Great Lakes–St. Lawrence Basin Project (Mortsch and Mills 1996; Mortsch and Quinn 1998)
Reducing Canada’s Vulnerability to Climate Change Program (Natural Resources Canada 2007)
Local and regional studies (nine with limited sectors)
From impacts to adaptation: Canada in a changing climate (Lemmen <i>et al.</i> 2008)
Regional assessments (six)
China
National assessment report on climate change (Ding <i>et al.</i> 2006; Chen <i>et al.</i> 2005)
Europe
<i>Vulnerability and Adaptation to Climate Change in Europe</i> (EEA 2005)
Adapting to Climate Change in Europe (European Commission 2007)
France
Impacts Potentiels du Changement Climatique en France au XXIe Siècle (France 2006)
India
Climate Change and India: Vulnerability Assessment and Adaptation (Shukla <i>et al.</i> 2003)
New Zealand
Vandaclim (Warrick <i>et al.</i> 1999; Warrick, Chapter 14, this volume)
Switzerland
Climate in Human Hands (Swiss Agency for the Environment 2002)
United Kingdom
East Anglia (Lorenzoni 2000a, 2000b)
East Midlands (East Midlands Sustainable Development Round Table 2000)
Regional Climate Change Impact and Response Studies in East Anglia and North West England – REGIS (Holman <i>et al.</i> 2002)
UK Climate Impacts Programme (UKCIP 2008)
United States
United States Global Change Research Program (National Assessment Synthesis Team 2000)

National Assessment of Climate Change (NACC)
Mega Regions (nine)
State and Multi-state Regions (18)
Climate Change Impacts for the Conterminous USA (Rosenberg and Edmonds 2005a)
Other US Regional Assessments
California (California Climate Change Center 2006)
Consortium for Atlantic Regional Assessment (Dempsey and Fisher 2005; Fisher *et al.* 2006)
MINK (Missouri, Iowa, Nebraska, Kansas; Rosenberg 1993a)
NOAA RISA Program (Pulwarty, Chapter 18, this volume).
Regional Integrated Sciences and Assessments (eight state or multi-state regions, additional region to be added in 2008)
Pew Center on Climate Change (Ebi 2007)
Regional Impacts of Climate Change (four regions, selected sectors)
Susquehanna River Basin Integrated Assessment (Yarnal 1998)
Union of Concerned Scientists
Northeast Climate Impacts Assessment (Union of Concerned Scientists 2006a)
Confronting Climate Change in the Northeast (Frumhoff *et al.* 2007), plus nine state-level brochures issued in 2007
Our Changing Climate, Assessing the Risks to California (Union of Concerned Scientists 2006b)
Climate Change in Pennsylvania (Union of Concerned Scientists 2008)

Some world and regional integrated regional assessment models with regional resolution

AIM – 21 geopolitical regions (Kainuma *et al.*, Chapter 11, this volume).
DICE – 13 regions (Nordhaus and Boyer 2000)
ESCAPES – four regions (Rotmans *et al.* 1994)
ICAM 3 – 12 regions (Dowlatabadi 2002)
IMAGE 2 – 17 regions (Leemans, Chapter 15, this volume)
MERGE – nine regions (Manne *et al.* 1995)
TARGETS – six regions (Rotmans and de Vries 1997)

and Cultural Organization (UNESCO), the Scientific Committee on Problems of the Environment (SCOPE), and the International Union of Biological Science (IUBS), joined by ICSU as a sponsor in 1996. The International Human Dimensions Programme on Global Environmental Change (IHDP) was established in 1996 under the sponsorship of ICSU and the International Social Science Council. The World Climate Research Programme (WCRP) was established in 1980 by ICSU and the World Meteorological Organization, joined from 1993 by UNESCO's Intergovernmental Oceanographic Commission. Global change research was thus

coordinated internationally by the four programs (IGBP, Diversitas, IHDP, and WCRP) that began to work closely together.

IGBP hosted the initial meeting in 1990 that led to START, the Global Change SysTem for Analysis Research in Training, which focuses on regional research and capacity-building activities in the transitional and developing countries (Eddy *et al.* 1991). START’s capacity-building activities were carried out under the auspices of IGBP, WCRP, and IHDP, with the START secretariat having opened in 2002 and regional committees and networks being established in 2002–2005.

The joint activities of the international global change research programs led to the organization of the 2001 Global Change Open Science Conference in Amsterdam. This conference demonstrated the emergence of a global community of researchers and stakeholders who recognized that “global change” is much more than climate change and that there is a need to consider the Earth as a system, with all of its interlinked changes. As a result of the Amsterdam conference IGBP, IHDP, WCRP, and Diversitas formed the Earth System Science Partnership (ESSP) for integrated study of the Earth system from both natural and human perspectives. In addition to four joint projects on crosscutting themes of carbon, water, food, and health, ESSP plans for a series of “integrated regional studies,” the first being the Monsoon Asia Integrated [Regional] Study (MAIRS; Jäger, Chapter 10, this volume).

This brief history of various programs at international and selected regional and national levels suggests the rapid growth of attention to global change, including climate change, and its impacts. During the same period in which these institutions and programs developed, integrated regional assessments of global climate change have multiplied in number, while being motivated and executed via a variety of routes (see Box 1.1).

1.2 Integrated regional assessment

“Integrated regional assessment”: strangely enough, a search on the world wide web generates relatively few citations for this phrase, when in fact hundreds of integrated regional assessments (or close relatives) have been done and are being done worldwide.¹ These assessments may be of a kind, but titles often mask their commonalty. Country studies, national communications, climate assessments, integrated assessments, and climate impact studies – these are among the many phrases that label integrated regional assessments. What does integrated regional assessment (IRA) mean?

¹ At the time of publication, there is no Wikipedia article on “integrated regional assessment,” nor on “regional assessment” or “integrated assessment.”

Assessment in this context means the application of scientific knowledge and human experience to important decisions, typically with a policy dimension. Usually this means mustering existing knowledge rather than undertaking new science, although an assessment may well identify knowledge gaps and call for new research. Assessment is a process, although the resulting activities (such as reports, world wide web sites, and presentations) are also referred to as assessments. In the examples described in this volume, the decisions to be made are both personal and public, involving the identification of impacts of, and vulnerabilities to, climate change, seeking ways to adapt to the changes that cannot be avoided, while contributing to mitigation of the causes of the changes.

Integrated has two connotations. Contribution from a diversity of relevant sciences and human knowledge is one of them: crossing boundaries of disciplines and experience, incorporating multiple perspectives to understand a real-world problem. The second connotation is acknowledgement that phenomena outside the laboratory do not occur in isolation, thus integration across domains of impact and influence is imperative. These are not really different, since integration across phenomena requires, *ipso facto*, collaboration among experts, those from scientific disciplines and those steeped in local knowledge and experience.

Integrated assessment is, then, “. . . the practice of combining different strands of knowledge to accurately represent and analyze real world problems of interest to decision-makers” (Dowlatabadi *et al.* 2000). Rosenberg and Edmunds (2005b, p. 1) defined integrated assessment as “. . . an analytical approach that knits together knowledge derived from a variety of disciplinary sources to gain insights from the analysis of interactions.” In particular, integrated assessment of global climate change brings multiple, complementary perspectives to understanding present and potential future impacts cascading from the climate system to terrestrial and aquatic ecosystems, and via those impacts (or directly, in some cases) to society.

Regional means that the decisions we want to inform have a spatial locus, a place or places inhabited by individuals, families, communities, societies, and nations, or places vital to the health of planet Earth (e.g., oceans or polar regions). Places provide the necessities of human life – shelter, sustenance, health, and safety – as well as values of human experience – belief, beauty, fulfillment, and pleasure. Human-induced global climate change comes from local places (and regions) and is experienced in those and other places. Places do not exist in isolation. They are linked by regional and global climatic, oceanic, atmospheric, ecological, economic and social processes. Thus, regional assessment of climate change applies science and experience to understanding climate change in a particular geographic space (Easterling 1997; Knight 2001). Regional assessments often focus on specific phenomena, such as water, ecosystems, forests, agriculture, or human health.

Integrated regional assessment, thus, is a process that uses a diversity of interrelated information and expertise to apply knowledge for stakeholder and policy-maker decisions concerning regional dimensions of global change. Integrated regional assessment extends all three component terms to cross both disciplinary boundaries for analysis and impact boundaries by making explicit the linked and cascading impacts of environmental and socio-economic change in regions. Integrated regional assessment also implies close involvement of stakeholders and policy makers in the assessment process, not just as passive recipients of what scientists think is important.

One of the fundamental approaches to studying a technical vocabulary is to ask, “What kinds of X are there?” and “What is X a kind of?” These are useful questions here. In answer to the “What kinds of” question, there are many kinds of integrated regional assessments, as we illustrate in the next section. On the other hand, integrated regional assessment is a kind of public policy tool to address important questions about global change at the interface of science and society. As such, it is part of a family of related assessment procedures and policy-development and decision-making processes (see Box 1.2). One closely related process is environmental impact assessment (EIA). Similarities include:

- both often develop future scenarios;
- both try to identify potential impacts, both positive and adverse;
- both try to suggest ways to avoid, mitigate, or adapt to negative consequences;
- both rely on expert judgment;
- both are interdisciplinary;
- both are assessments; and
- both have public and stakeholder involvement.

Differences between EIA and IRA include:

- EIA is generally limited to the local/regional scale; IRA bridges to a global scale, on both causal and impact dimensions;
- in EIA there are decision choices about causal events; in IRA such choices may not exist, at least not locally;
- in IRA, “business as usual” is not the same as the EIA “do nothing” alternative;
- EIA does not address inevitable change;
- IRA may be more truly integrated than EIA;
- IRA has no legislated process requirements, EIA does; and
- EIA focuses on inventories, IRA on (sometimes linked) models and chains of effects.

In view of these similarities and differences, it is helpful if integrated regional assessment practitioners are aware of the environmental impact assessment literature.

Box 1.2

Related assessment types and terminologies

- Climate impact assessment
- Demographic impact assessment
- Development impact assessment
- Ecological impact assessment
- Economic and fiscal impact assessment
- Environmental auditing
- Environmental impact assessment
- Health impact assessment
- Impact assessment
- Integrated ecological assessment
- Integrated impact assessment
- Participatory integrated assessment
- Project evaluation
- Public consultation
- Public participation
- Risk assessment
- Social impact assessment
- Strategic environmental assessment
- Strategic impact assessment
- Sustainability impact assessment
- Technology assessment

Source: International Association for Impact Analysis (GRDC 2004) and authors.

Finally, we need to emphasize that integrated regional assessments are *not* predictions of the future. It is important to make a clear distinction between the terms prediction, forecast, projection, and scenario (McCracken 2001). A *prediction* is a statement about the future based on current conditions and reasonably well-specified methods of anticipating the future. A *forecast* connotes prediction, the credibility of which depends on the person doing the predicting; it also implies a time frame in which the forecasts can be tested and refined. In contrast to both prediction and forecast, a *projection* is based on one of several or many initial conditions and specification of how those conditions may change in the future. In most climate change assessments, there are a number of initial assumptions and future trajectories of driving forces and mitigation actions, all used as input to a variety of different climate models. Such projections create climate *scenarios*, neither predictions nor forecasts, as bases for assessment of what *could* happen in future. General circulation models of the atmosphere are retrodictions when they account for the climate record; for the future they generate projections which