EARTH SYSTEM GOVERNANCE PROJECT REPORT NO. 1.

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People, Places, and the Planet

Science and Implementation Plan of the
Earth System Governance Project

International Human Dimensions Programme on Global Environmental Change

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Frank Biermann, Michele M. Betsill, Joyeeta Gupta, Norichika Kanie, Louis Lebel, Diana Liverman, Heike Schroeder, and Bernd Siebenhüner

With contributions from: Ken Conca, Leila da Costa Ferreira, Bharat Desai, Simon Tay, and Ruben Zondervan

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EXECUTIVE SUMMARY

Humans now influence all biological and physical systems of the planet. Almost no species, no land area, no part of the oceans has remained unaffected by the expansion of the human species. The four main global change research programmes, affiliated in the Earth System Science Partnership, see evidence today that the entire earth system now operates 'well outside the normal state exhibited over the past 500,000 years', and that 'human activity is generating change that extends well beyond natural variability—in some cases, alarmingly so—and at rates that continue to accelerate'. Given this situation, the Earth System Science Partnership has declared an 'urgent need' to develop 'strategies for Earth System management'. Yet what such strategies might be, how they could be developed, and how effective, efficient and equitable such strategies would be, remain unspecified. It is apparent that the institutions, organizations, and mechanisms by which humans currently govern their relationship with the natural environment and global biogeochemical systems are not only insufficient—they are also poorly understood.

This is the rationale for the Earth System Governance Project, a new long-term research programme developed under the auspices of the International Human Dimensions Programme on Global Environmental Change. This Science Plan elaborates upon the concept of earth system governance and on the central questions, methods and processes of a global research effort in this field.

Earth system governance is defined in this project as the interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating, and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development. The notion of governance refers here to forms of steering that are less hierarchical than traditional governmental policy-making (even though most modern governance arrangements will also include some degree of hierarchy), rather decentralized, open to self-organization, and inclusive of non-state actors that range from industry and non-governmental organizations to scientists, indigenous communities, city governments and international organizations.

Based on this general notion, the Earth System Governance Project advances a science plan that is organized, first, around five analytical problems:

(1) The first analytical problem—the *architecture* of earth system governance—includes questions relating to the emergence, design and effectiveness of governance systems as well as the overall integration of global, regional, national and local governance. Core questions include: How is performance of environmental institutions affected by their embedding in larger architectures? What are the environmental consequences of non-environmental governance systems? What is the relative performance of different types of multilevel governance architectures? How can we explain instances of 'non-governance'? What are overarching and crosscutting norms of earth system governance?

(2) Second, understanding effective earth system governance requires understanding the *agents* that drive earth system governance and that need to be involved. The research gap is here especially the influence, roles and responsibilities of actors apart from national governments, such as business and non-profit organizations, the ways in which authority is granted to these agents, and how it is exercised. Core questions advanced in this Science Plan are: What is agency? Who are the agents of earth system governance (especially beyond the nation state)? How do different agents exercise agency in earth system governance, and how can we evaluate their relevance?

(3) Third, earth system governance must respond to the inherent uncertainties in human and natural systems. It must combine stability to ensure long-term governance solutions with flexibility to react quickly to new findings and developments. In other words, we must understand and further develop the *adaptiveness* of earth system governance. But what are the politics of adaptiveness? Which governance processes foster it? What attributes of governance systems enhance capacities to adapt? How, when and why does adaptiveness influence earth system governance?

(4) Fourth, the more regulatory competence and authority is conferred upon larger institutions and systems of governance—especially at the global level—the more we will be confronted with questions of how to ensure the *accountability* and *legitimacy* of governance. Simply put, we are faced with the need to understand the democratic quality of earth system governance. What are the sources of accountability and legitimacy in earth system governance? What are the effects of different forms and degrees of accountability and legitimacy for the performance of governance systems? How can mechanisms of transparency ensure accountable and legitimate earth system governance? What institutional designs can produce the accountability and legitimacy of earth system governance in a way that guarantees balances of interests and perspectives?

(5) Fifth, earth system governance is, as is any political activity, about the distribution of material and immaterial values. It is, in essence, a conflict about the *access* to goods and about their *allocation*—it is about justice, fairness, and equity. The novel character of earth system transformation and of the new governance solutions that are being developed, puts questions of allocation and access, debated for millennia, in a new light. It might require new answers to old questions. But how can we reach interdisciplinary conceptualizations and definitions of allocation and access? What (overarching) principles underlie allocation and access? How can allocation be reconciled with governance effectiveness?

Crosscutting Themes.

In addition, the Earth System Governance Project emphasizes four cross-cutting research themes that are crucial for the study of each analytical problem but also for the integrated understanding of earth system governance: these four themes are the role of *power*; the role of *knowledge*; the role of *norms*; and the role of *scale*.

Flagship Activities as Case Studies.

Finally, the Earth System Governance Project advances the integrated, focused analysis of case study domains in which researchers combine analysis of the overall governance architecture, the role of different agents in this governance architecture, the overall adaptiveness of the governance system, mechanisms of accountability, and modes of allocation. Four flagship activities of the Earth System Governance Project have been identified: research on the *global water system*, on *global food systems*, on the *global climate system*, and on the *global economic system*.

Policy Relevance.

The Earth System Governance Project, while being essentially a scientific effort, is also designed to assist policy responses to the pressing problems of earth system transformation. All analytical problems studied in the project have profound policy implications. For example, the problem of the architecture of earth system governance is a key concern of current negotiations and political processes that are often faced with 'treaty congestion' and complex interlinkages between different institutions, for instance between multilateral environmental agreements and the World Trade Organization. 'Fragmented' governance architectures are also an increasing problem for decision-makers, particularly in climate policy. A related concern is the reform of the United Nations, for example with a view to the debate on a United Nations Environ-

ment Organization. At national and local levels, architecture is a key concern for decision-makers dealing with policy integration, the comparative effectiveness of policy instruments, and the integration of decision-making from international, national and local levels. Research on agency within the project will generate novel ideas on the integration of civil society actors in earth system governance, and on the advantages and disadvantages of private and public-private governance arrangements. Research on governance of adaptation and the adaptiveness of governance arrangements will inform policy-makers who have to deal with adapting politics and policies to a changing world. The accountability and legitimacy of decision-making, from local to global levels, is equally a key problem for public policy. Finally, the research on allocation and access will help to improve governance outcomes and advance philosophical and ethical discourses on an equitable approach to earth system governance.

Process.

The drafting of this Science Plan of the Earth System Governance Project has been mandated in March 2007 by the Scientific Committee of the International Human Dimensions Programme on Global Environmental Change (IHDP), the overarching social science programme in the field. The project builds on the results of an earlier long-term research programme, the IHDP core project Institutional Dimensions of Global Environmental Change (IDGEC). The Science Plan was written by an international, interdisciplinary scientific planning committee, which drew on a consultative process that started in 2004. Several working drafts of this Science Plan have been presented and discussed at a series of international events and conferences, and numerous colleagues in the field, as well as practitioners, have offered useful suggestions, advice, and critique.

LIST OF REVIEWERS

Earlier versions of this Science Plan have been reviewed, in parts or in whole, by a number of colleagues, from both academia and political practice. We have tried to consider all comments and suggestions to the extent feasible, and thank all reviewers for their time and efforts:

- Arun *Agrawal*, University of Michigan, United States of America
- Aslaug *Asgeirsdottir*, Bates College, United States of America
- Harro *van Asselt*, Vrije Universiteit Amsterdam, The Netherlands
- Jeffrey *Broadbent*, University of Minnesota, United States of America
- Harriet *Bulkeley*, Durham University, United Kingdom
- Shobhakar *Dhakal*, Global Carbon Project, Japan
- Klaus *Dingwerth*, University of Bremen, Germany
- Katharine Nora *Farrell*, The Helmholtz Centre for Environmental Research—UFZ, Germany
- Michail *Fragkias*, Urbanization and Global Environmental Change Project, United States of America
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- Peter M. *Haas*, University of Massachusetts at Amherst, United States of America
- Claudia *ten Have*, United Nations University Institute of Advanced Studies, Japan
- Klaus *Jacob*, Freie Universität Berlin, Germany
- Paul *Joffe*, National Wildlife Federation, United States of America
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- Tobias *Langanke*, Global Land Project, Denmark
- Elizabeth L. *Malone*, Joint Global Change Research Institute, United States of America
- Alberto *Martinelli*, University of Milano, Italy
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- Peter *Newell*, University of East Anglia, United Kingdom
- Annika *Nilsson*, Stockholm Environment Institute, Sweden

- Claudia *Pahl Wostl*, Global Water System Project, and University of Osnabrück, Germany
- Philipp *Pattberg*, Vrije Universiteit Amsterdam, The Netherlands
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- Christian *Webersik*, United Nations University Institute of Advanced Studies, Japan
- Linda J. *Yarr*, George Washington University, United States of America
- Oran R. *Young*, University of California at Santa Barbara, United States of America.

In addition, numerous comments and suggestions have been raised during the many presentations of the concept of earth system governance and of its conceptualization in the Earth System Governance Project. The scientific planning committee is very grateful for all comments from the community, and has included many. Even though one cannot list all discussants and commentators here, the scientific planning committee thanks the following colleagues: Achala Chandani Abegsekara, John Adams, Jörg Balsiger, Livia Bizíková, Martina Chidiak, Morgan Fairbrother, Maria Falaleeva, Zsuzsanna Flachner, Neil Gunningham, Inge Kaul, Marleen van de Kerkhof, Bronwen Morgan, Linda Kvalvik, Piotr Matczak, James Meadowcroft, Paul Isolo Mukwaya, Michael Nelson, Chuckwumerije Okereke, Lennart Olson, Per Olsson, Jacob Park, Matthew Paterson, Matteo Roggero, Karsten Sach, Agus Sari, and Atanu Sarkar.

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INTRODUCTION

Since prehistoric times, people have altered their environments around the places where they lived. For several centuries they have been altering their planet. Today, key parameters of the earth system are changing due to human influences. The atmospheric concentration of carbon dioxide has increased by one third since pre-industrial times, and global mean temperatures are rising. Stratospheric ozone depletion through emission of chlorofluorocarbons since the 1920s has increased ultraviolet radiation. Six billion humans now use one tenth of the renewable freshwater available in lakes, rivers or glaciers worldwide. Material cycles have changed: the amount of biologically available nitrogen from human activities has increased nine-fold in the last hundred years, and eighty per cent more nitrogen now reaches the oceans than in 1860. The flow of phosphorus to the seas is today three times higher than historical background rates. Marine resources are depleted, and human-made persistent chemicals have spread throughout the ecosystems up to unsettled polar regions. Humankind today uses about forty per cent of the terrestrial biomass production. Most other living species of the planet are affected. Over the past centuries, humans have increased the species extinction rate a thousand times.

The scientific knowledge about the earth system and its current transformation becomes more confident every day. Humans now influence all biological and physical systems of the planet. Almost no species, no land area, no part of the oceans has remained unaffected by the expansion of the human species. Presently, the four global change research programmes, affiliated in the Earth System Science Partnership (ESSP),[1] see evidence that the entire 'earth system'[2] now operates 'well outside the normal state exhibited over the past 500,000 years':

> 'Human activity is generating change that extends well beyond natural variability—in some cases, alarmingly so—and at rates that continue to accelerate. (...) Human activities could inadvertently trigger severe con-

1 These four programmes are: the integrated programme of biodiversity science Diversitas, the International Geosphere-Biosphere Programme, the World Climate Research Programme, and the International Human Dimensions Programme on Global Environmental Change. See www.essp.org.

2 The 'earth system' is defined in a recent comprehensive multi-authored study as 'the suite of interacting physical, chemical, and biological global-scale cycles (often called biogeochemical cycles) and energy fluxes which provide the conditions necessary for life on the planet.' The authors emphasise that 'human beings, their societies and their activities are an integral component of the Earth System, and are not an outside force perturbing an otherwise natural system.' See chapter 1 in Steffen, Sanderson, et al. 2004, in particular the complex definition provided there by Frank Oldfield and Will Steffen on p. 7.

> sequences for Earth's environment and habitat, potentially switching the Earth System to alternative modes of operation that may prove irreversible and inhospitable to humans and other life.'[3]

Given this situation, the Earth System Science Partnership has declared an 'urgent need' to develop 'strategies for *Earth System management*'. Yet what such strategies might be, how they could be developed, and how effective, efficient and equitable such strategies would be, remain unspecified. It is apparent that the institutions, organizations, and governance mechanisms by which humans currently regulate their relationship with the natural environment and global biogeochemical systems are utterly insufficient—and at the same time, poorly understood. Few will disagree that more fundamental and applied research on the institutions and governance systems that regulate human interactions with natural systems is needed.

Yet such research is no easy undertaking. It must span the entire globe because only integrated global solutions can ensure a sustainable co-evolution of natural and socio-economic systems. But it must also draw on local experiences and insights that offer solutions to local and broader governance problems. In other words, research on institutions and governance in times of earth system transformation must be about *people* who are drivers of global environmental change and at the same time part of any solution. It must be about *places* in all their variety and diversity, yet seek to integrate place-based research within a global understanding of the overall challenge to steer human interaction vis-à-vis earth system transformation. Eventually, this research will need to be about our *planet*. It is the task of developing *integrated systems of governance*, from the local to the global level, that ensure the sustainable development of the coupled socio-ecological system that the Earth has become.

We call this research programme the analysis of 'earth system governance' (DRAWING ON BIERMANN 2005, 2007). This Science Plan elaborates upon this concept and lays down central questions, methods, and processes of a global long-term research effort in this field: the Earth System Governance Project.

THE CONCEPT

The Earth System Governance Project uses the term 'governance' instead of the term earth system 'management' that is advanced by the Earth System Science Partnership. Even though there are diverse definitions of the term 'governance', the concept generally refers in the social sciences to modern forms of steering that are often decentralized, open to self-organization and

3 See www.essp.org/essp/about_essp.htm. The text is based on the 2001 Amsterdam Declaration on Global Change (www.sciconf.igbp.kva.se/fr.html). For a comprehensive scientific treatment, see Steffen, Sanderson, et al. 2004.

less hierarchical than traditional governmental policy-making (even though most modern governance arrangements will also include some degree of hierarchy). Governance includes usually also non-state actors, ranging from industry and non-governmental lobbying groups to scientists, indigenous communities, city governments and international organizations (see chapter 2 in more detail).

Earth system governance is first and foremost a political challenge. In this regard, we observe processes and also success stories of earth system governance at all levels of politics. Many more people now respond to the challenge of earth system governance than they did a decade ago. Climate change and ozone depletion have become a staple of the headlines of daily newspapers and mass media. Nongovernmental activist groups, but also industry associations and scientific networks, are mushrooming in industrialized and developing countries alike. The major global summits, from Rio de Janeiro in 1992 to Johannesburg in 2002, each set a new record in terms of participation by diplomats, politicians, activists, and media representatives. Many new international institutions have been created, and some of them—for example the Montreal Protocol on Substances that Deplete the Ozone Layer—have been successful in the global regulation of substances that threatened vital systems and processes of our planet. Yet as the research programmes of the Earth System Science Partnership contend, current efforts in earth system governance, at local and global levels, are laudable yet as a whole, insufficient. They do not ensure the sustainable co-evolution of natural and socio-economic systems. More effective systems of governance are needed.

the questions

This turns the political challenge of earth system governance into a major analytical challenge for the social sciences, especially for those disciplines that study institutions and governance. For these researchers, the development of theories to understand, and of strategies to advance, earth system governance evolves today into one of the most important but possibly also most difficult tasks. It involves questions of the emergence, design and effectiveness of governance systems as well as the overall integration of global, regional, national and local governance—that is, the quest for effective *architectures* of earth system governance (see chapter 3). It also requires understanding the actors that drive earth system governance and that need to be involved—that is, the question of *agency* in earth system governance (see chapter 4). Third, earth system governance must respond to the inherent uncertainties in human and natural systems; it must combine stability to ensure long-term governance solutions, with flexibility to react quickly to new findings and developments, and to learn. In other words, we must understand and further

develop the *adaptiveness* of systems of earth system governance (SEE CHAPTER 5). Fourth, the more regulatory competence and authority is conferred upon formal and informal institutions and systems of governance—especially at the global level—the more will we be confronted with questions of how to ensure the *accountability* and legitimacy of the governance systems that are created or strengthened. Simply put, we are faced with the need to understand the democratic quality of earth system governance (SEE CHAPTER 6). Fifth and finally, earth system governance is, as is any political activity, about the distribution of material and immaterial values. It is, in essence, a conflict about the *access* to goods and about their *allocation*—it is about justice, fairness, and equity. The novel character of earth system transformation and of the new governance solutions that are being developed, puts questions of allocation and access, debated for millennia, in a new light. It might require new answers to old questions (SEE CHAPTER 7).

This Science Plan suggests these five A's—the analytical problems of architecture; agency; adaptiveness; accountability and legitimacy; and allocation and access—as the key questions of a new research effort on the theory and strategies of earth system governance. The core research interest of the Earth System Governance Project is the question of how integrated systems of governance can support a co-evolution of nature and human societies that leads towards sustainable development. The five A's are the central analytical problems of the Earth System Governance Project. This Science Plan develops these analytical problems in more detail.

A research programme on earth system governance is no easy task. The Earth System Governance Project must build on the interaction and collaboration of many colleagues in the social sciences all over the world. On the one hand, it will need to build on the achievement of the individual researcher or of small teams that succeed in shedding new light on one or another aspect of the theory and practice of earth system governance. On the other hand, cumulative progress in the social sciences can only occur when individual research efforts draw on a common set of questions, concepts, and methods. This Science Plan is meant to provide such an overarching outline, as a common set of questions for the study of earth system governance.

THE CONTEXT

The Earth System Governance Project is but one element in a larger scientific network of global change researchers. First, the drafting of its Science Plan was mandated by the Scientific Committee of the International Human Dimensions Programme on Global Environmental Change (IHDP), which is the overarching social science programme in the field under the auspices of the International Council for Science, the International Social Science Council

and the United Nations University. IHDP also appointed the scientific planning committee for this Science Plan, which served from May 2007 until October 2008, when the plan was accepted after extensive peer review. Since 1 January 2009, the Earth System Governance Project is operational as a core project under the IHDP.

Second, the Earth System Governance Project builds on the results of an earlier long-term research programme, the IHDP core project Institutional Dimensions of Global Environmental Change, which was led for most of its duration by Oran Young (IDGEC 1999, YOUNG 2002). IDGEC lasted from 1998, when IHDP approved its science plan, until December 2006, when the project held a major Synthesis Conference in Bali, Indonesia. IDGEC research focused on three research foci of institutional research, namely causality, performance, and design; three analytical themes, the problems of fit, interplay, and scale; and concentrated its efforts empirically on two regions, South-East Asia and the Polar regions. IDGEC's core findings—four book volumes and a series of journal articles—are published (YOUNG, KING AND SCHROEDER 2008, BIERMANN AND SIEBENHÜNER 2009) or under review for publication. The Earth System Governance Project builds upon, and further develops, the legacy of this successful predecessor (ON THIS RELATIONSHIP SEE IN MORE DETAIL YOUNG 2008, BIERMANN 2008).

Third, the Earth System Governance Project is part of the overarching Earth System Science Partnership. Although the Earth System Governance Project is social science-oriented, it will also be relevant for natural scientists and the entire global change research community. For one, this Project will be the central activity to initiate, compile and disseminate research on the crucial political questions within the broader effort of earth system analysis. In addition, the project will contribute to methodological progress in integrated assessments through investigating methods for the integration of governance mechanisms in modelling exercises. Yet the Earth System Governance Project shall strengthen also the critical role of the social sciences in global change research. An inherent part of the research agenda is the study of global change research in itself, and the analysis of science as a social activity. Core questions will be how scientists frame their problems and how particular worldviews shape scientific research, for example in the construction of models or scenarios; or how scientists deal with problems of uncertainty and lack of quantifiable knowledge of human behaviour; or how the governance of science influences the production of knowledge.

For these reasons, the Earth System Governance Project envisages and supports direct collaboration with colleagues from other global change programmes in the joint projects of the Earth System Science Partnership. It is in these issue-specific research networks where practical interaction between different disciplines is most likely to bear fruit, hopefully leading back to general methodological progress in interdisciplinary research. The scientific

planning committee thus included members of, and made every effort to collaborate with, the many joint projects in the Earth System Science Partnership. Particularly close were the links with the Global Environmental Change and Food Systems Project, the Global Water System Project, and the Global Carbon Project (see chapter 11).

THE PROCESS

This Science Plan was written over the course of a year by an international committee of scientists with interest in the field of governance. Given its crosscutting task, this scientific planning committee integrated a variety of disciplines in the social sciences, including political science, sociology, policy studies, geography, law, and economics, as well as expertise on all levels of governance, from local governance to global agreements. The group included representatives from most continents, and some members had, in addition to their academic work and affiliations, a strong background in the practice of politics, public administration, and business.

In addition, the drafting group drew on a consultative process that started in 2004, when the IHDP core project Institutional Dimensions of Global Environmental Change entered its synthesis phase and mandated a New Directions initiative, chaired by Frank Biermann, to develop proposals for a new research activity.[4] Initial ideas derived from this initiative were presented and discussed at the IDGEC Synthesis Conference in December 2006, as well as at other venues. A report from the New Directions initiative resulted in March 2007 in the mandate from the Scientific Committee of IHDP to draft this Science Plan and to develop the Earth System Governance Project.

The scientific planning committee functioned largely through electronic communication, along with three intense drafting meetings in Europe (May 2007 in the Netherlands), Asia (December 2007 in Indonesia) and North America (March 2008 in the United States). In addition, the group organized a variety of roundtables and conference side-events to solicit the views from the research community and from practitioners. Among other things, the 2007 Amsterdam Conference on the Human Dimensions of Global Environmental Change was held under the theme of 'Earth System Governance: Theories and

4 E-mails over the IDGEC list-server informed the community about this IDGEC New Directions initiative, and additional information was published in the IDGEC newsletter and on a specialized website. Members of the community have been invited to contribute short Viewpoints on what they see as the major new questions, and many colleagues have responded to the call for participation through personal e-mails or through comments during conferences and workshops. Intensive discussions have also taken place at meetings of the IDGEC Scientific Steering Committee and its Synthesis Conference Planning Group.

Strategies for Sustainability' and served as the launch event of the planning for the Earth System Governance Project. More than 350 researchers participated in these deliberations. In addition, the group organized four roundtable consultations at the 2007 Amsterdam Conference: with keynote speakers; with conference participants from developing countries; with conference participants from Central and Eastern European countries; and with graduate student participants.[5] A series of annual Earth System Governance summer schools, alternating between Amsterdam and Berlin and having global attendance, also started in 2007. Further insights and comments on this Science Plan were solicited from the academic community and practitioners at numerous other events, including side-events at the 2007 Conference of the Parties to the United Nations Framework Convention on Climate Change, at the 2008 Berlin Conference on the Human Dimensions of Global Environmental Change, and at the 2008 Annual Convention of the International Studies Association; along with numerous presentations and lectures by members of the scientific planning committee.

Generous funding for the drafting of this Science Plan has been provided by the IHDP (for meetings in the Netherlands and in Indonesia); by the International Studies Association (for a meeting in the United States); and by the Institute for Environmental Studies of the Vrije Universiteit Amsterdam (which hosted the secretariat and website of the scientific planning committee).

THE STRUCTURE

This Science Plan is organized as follows: Chapter 2 develops the concept of earth system governance. It relates the concept to the discourse of governance in the social sciences and to the larger programme of earth system analysis. Chapters 3-9 then elaborate on the analytical problems, research questions, their interlinkages, and crosscutting research themes of the Earth System Governance Project. Chapter 10 discusses questions of methodology in this challenging field, including the promise and perils of incorporating governance research with integrated assessments, computer-based modelling and scenario building, and the critical role of social science in the larger global change community. Chapter 11 outlines possible applications of the Science Plan for several joint projects of the Earth System Science Partnership. Finally, chapter 12 discusses questions of research practice and the implementation of the Earth System Governance Project.

5 Reports of these roundtables are available at www.earthsystemgovernance.org.

2

EARTH SYSTEM GOVERNANCE

The concept of earth system governance—first developed in Biermann (2005, 2007)—reflects a large-scale transformation from traditional problems of environmental policy to an inherently new governance challenge: earth system transformation. Earth system transformation describes the current situation in which almost all biogeochemical systems of the planet are influenced in one way or the other by human activities. Many systems might undergo fundamental, and irreversible, change. In the words of the Earth System Science Partnership:

> 'Human activity is generating change that extends well beyond natural variability (...) and at rates that continue to accelerate. (...) [and] could inadvertently trigger severe consequences for Earth's environment and habitat, potentially switching the Earth System to alternative modes of operation that may prove irreversible and inhospitable to humans and other life.'[6]

The Earth System Science Partnership propagates here the concept of 'earth system management' and calls upon social scientists to develop appropriate strategies for this management task. The concept of 'earth system management' is found more and more often in the literature. One finds the term mostly in relation to natural science programmes, for example when it comes to providing data on earth system parameters that are influenced by human action. Notwithstanding this discourse on earth system 'management', this Science Plan uses the term 'governance'. The concept of governance is broader than management, and it has become a key notion in the social sciences, with a large body of theoretical and empirical literature dealing with issues that are at the core when it comes to finding responses to earth system transformation.

Governance has been defined in a variety of ways, and there is no consensus among scholars on the core elements of this concept (OVERVIEWS IN ALCÁNTARA 1998, VAN KERSBERGEN AND VAN WAARDEN 2004, ADGER AND JORDAN 2008, JORDAN 2008). In most bodies of literature, the term governance denotes new forms of regulation that go beyond traditional hierarchical state activity. It usually implies some form of self-regulation by societal actors, private-public cooperation in the solving of societal problems, and new forms of multilevel policy. (Other usages less relevant here are normative in the sense of 'good governance' and management-oriented in the sense of 'corporate governance').

At the international level, the term 'global governance' is often used to describe processes of modern world politics, although here, too, no consensus on the appropriate definition has been reached (YOUNG 1994A AND 1999, COMMISSION ON GLOBAL GOVERNANCE 1995, FINKELSTEIN 1995, ROSENAU 1995, GORDENKER AND WEISS 1996, SMOUTS 1998, RITTBERGER 2002, KANIE

6 See www.essp.org/essp/about_essp.htm.

and haas 2004, biermann 2006a, dingwerth and pattberg 2006). In addition to its analytical usage, the term governance is also used prescriptively as a political programme to cope with problems of modernity, for example in calls for global governance as a counterweight to globalization and for new and more effective international institutions, organizations, or financial mechanisms.

Importantly, from the local to international levels, the concept of 'governance' is not confined to states and governments as sole actors, but is marked by participation of myriad public and private non-state actors at all levels of decision-making, ranging from networks of experts, environmentalists and multinational corporations to new agencies set up by governments, such as intergovernmental bureaucracies. For example, governance systems also include widely shared belief systems and actor networks such as public-private partnerships.

The concept of governance encompasses institutions, which stood at the centre of the IHDP core project 'Institutional Dimensions of Global Environmental Change' (idgec). Institutions were defined in this project as clusters of rights, rules and decision-making procedures that give rise to social practices, assign roles to participants in these practices and govern interactions among players of these roles (idgec 1999, young 2002). Governance adds to the concept of institutions a dynamic perspective that looks at processes of governing; that focuses on governance systems and integrates research on interlinkages of single institutions; and that brings a stronger emphasis on actors and especially on non-state actors. Governance thus covers a wider area of phenomena that are crucial for understanding steering systems in the field of human dimensions of global environmental change, which are not completely addressed through the notion of institutions. On the other hand, governance systems generally include one or several institutions. Therefore, much of the IDGEC legacy on institutions remains integral part of its successor, the Earth System Governance Project (young 2008, biermann 2008).

Taken together, earth system governance is defined here as: The interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating, and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development.

Four points are important to clarify this definition further.

First, earth system governance is as much about environmental parameters as about social practices and processes. Its normative goal is not purely environmental protection on a planetary scale—this would make earth system governance devoid of its societal context. Environmental targets in earth system governance—such as control of greenhouse gases at a certain level—can

be reached in global and local governance practice through different means with different costs for actors in different countries and regions. Earth system governance is thus about social welfare as well as environmental protection; it is about effectiveness as well as global and local equity. The normative aspiration of earth system governance hence is sustainable development—within its triangle of ecological, economic and social sustainability.

Second, earth system governance is more than a problem of the regulation of the 'global commons' through global agreements and conventions. Earth system governance is first and foremost about people who take decisions in their daily lives or in their various professional positions. Earth system transformation affects people as much as it is driven by the individual decisions that people make. As such, earth system governance is happening not only at the global level but in a variety of places where humans shape their interaction with nature. Earth system governance happens in Delhi, where buses now run on natural gas. It is happening in Amsterdam, where people encourage politicians to promote the use of bicycles and to ban sport utility vehicles from inner city roads. It is happening in Chiang Mai, where residents are demanding more control over city planning and water management.

Third, earth system governance goes beyond the traditional study of environmental policy but instead bridges levels of analysis and disciplinary foci. The current anthropogenic transformation of the earth system encompasses more puzzles and problems than scholars have traditionally examined in environmental policy studies, now ranging from changes in biogeochemical systems to the global loss of biological diversity. Key questions—such as how Bangladesh could adapt to rising sea levels, how deterioration of African soils could be halted and climate refugees resettled or how land-use changes in Brazil could be analyzed—have barely been covered by traditional environmental policy research. Yet they are inevitably part of the study of earth system governance. The analysis of earth system governance thus covers the full range of social science disciplines across the scales, from anthropology to international law. It covers local regulatory systems to address problems ranging from air pollution to the preservation of local waters, waste treatment or desertification and soil degradation. Yet at the same time, it includes also the study of the hundreds of international regimes that now regulate the environmental behaviour of governments and corporations. Earth system governance therefore requires the integration of all these strands of research and must bridge scales from global to local. This need for integrated multilevel analysis is widely agreed upon in principle. It requires further efforts in practice.

Fourth, earth system governance is defined here by the intention to prevent, mitigate and adapt to earth system transformation with harmful effects for human societies. This definition allows for varied degrees of effectiveness; effectiveness is not part of the definition but a variable to be studied in further research. On the other hand, this definition excludes governance systems

that have other policy goals and targets, but that may cause environmental degradation. These other governance systems—for example global economic governance—are nonetheless of utmost importance for research on earth system governance. The Earth System Governance Project will thus focus also on institutions in other domains, such as trade and investment regimes (SEE CHAPTER 3, ON THE PROBLEM OF ARCHITECTURE); or on the relationship of earth system governance with global economic governance as one flagship activity of this Project (SEE CHAPTER 11).

EARTH SYSTEM GOVERNANCE AND EARTH SYSTEM SCIENCE

This concept of earth system governance takes cognizance of recent developments within global change research, in particular the evolution of integrating concepts such as earth system analysis, earth system science, or sustainability science. Especially in the natural sciences that build on quantification and computer-based modelling, efforts have long been underway to combine and integrate models of different strands of research to gain understanding not of isolated elements of global change, but of the totality of processes in nature and human civilization. Integrated earth system analysis as a scientific enterprise is the consequence of these efforts. Hans-Joachim Schellnhuber (1998; 1999), a key proponent of the concept, ascribes earth system analysis even the status of a science in statu nascendi, because, as he writes (WITH VOLKER WENZEL), it has '1. a genuine subject, namely the total Earth in the sense of a fragile and 'gullible' dynamic system, 2. a genuine methodology, namely transdisciplinary systems analysis based on, i.a., planetary monitoring, global modelling and simulation, 3. a genuine purpose, namely the satisfactory (or at least tolerable) coevolution of the ecosphere and the anthroposphere (vulgo: Sustainable Development) in the times of Global Change and beyond' (SCHELLNHUBER AND WENZEL 1998, VII).

Earth system analysis relates to 'sustainability science', a closely connected concept to integrate different disciplines and communities in the larger quest for a transition to sustainability (SCHELLNHUBER ET AL. 2004, CLARK, CRUTZEN AND SCHELLNHUBER 2005). As Robert Kates, William Clark and colleagues argue, the challenge of sustainable development is so complex that it requires a 'sustainability science' as a new integrative field of study (KATES ET AL. 2001). A sustainability science shall improve collaboration of natural and social scientists as well as deliver research designs that better integrate all scales from local to global.

These integrated notions are reflected in the Earth System Science Partnership, an initiative of four global change research programmes: the biodiversity sciences programme Diversitas, the International Geosphere-Biosphere Programme, the World Climate Research Programme, and the International

Human Dimensions Programme on Global Environmental Change.[7] The Partnership builds on a holistic concept of the earth as a complex and sensitive system regulated by physical, chemical and biological processes and influenced by humans. It focuses on anthropogenic change, including through integrated approaches and advanced modelling technologies. To this end, the Partnership supports joint projects that cut across the various global change research programmes.[8] A better understanding of governance mechanisms and institutions is crucial for the success of these joint projects within the Earth System Science Partnership.

There is thus a growing concern for organizing research on institutions and governance as a crosscutting theme that would run through most programmes and projects under the Partnership. Furthermore, many researchers in the field of integrated earth system analysis and sustainability science have become interested in incorporating governance and institutions into their models and research programmes. These developments therefore advise linking institutional and governance research better to the overarching concerns of the Earth System Science Partnership, and to recognize this link through developing a research theme that focuses explicitly on earth system analysis and governance.

But how can earth system governance, as a social science research programme, relate to the broader notion of earth system science? From the perspective of integrated earth system analysis, research on institutions and governance mechanisms is often viewed as part of the integrated effort and is formally included in most theoretical conceptualizations in this field (FOR EXAMPLE, SCHELLNHUBER 1999, C20-C22). Likewise, the Earth System Science Partnership asserts that 'the core' of its activities will be the 'in-depth analysis and advanced modelling of the Earth System as a whole, incorporating data and information from the diverse fields represented by the four global change programmes'.[9]

In practice, however, it remains a major research challenge to establish to what extent institutional and governance research can contribute to, and integrate with, the more model-driven research programmes. At present, quantifiable hypotheses and computer-based modelling are difficult or problematic for many students of institutions and governance (YOUNG ET AL. 2006, BIERMANN, HEIRES AND PATTBERG 2007). Only a few social scientists have attempted to use computer modelling and quantification as a tool for integrat-

7 See the Partnership's website at www.essp.org.

8 For example, the Global Carbon Project, the Global Environmental Change and Food Systems Project, the Global Water System Project, or the Global Change and Human Health Project. Another recent type of crosscutting activities are the regional integrated programmes, such as the Monsoon Asia Integrated Regional Study. See www.essp.org with further links.

9 See the Partnership's mission statement at www.essp.org.

ing governance research into larger models. Qualitative modelling projects to analyze international governance are in their infancy (EISENACK 2003, EISENACK, KROPP AND WELSCH 2006). Major problems in modelling governance remain, to name a few, the complexity of relevant variables at multiple levels, human reflexivity, and difficulties in quantifying key social concepts such as 'power', 'interest', or 'legitimacy', and their relationships with biogeochemical variables.

Given this mismatch between formalized methods and fuzzy social realities, proponents of an integrated earth system analysis at times relegate governance research to an auxiliary, advisory, and essentially non-scientific status. Quite typical is the conceptualization of social science in the 23 questions that the Global Analysis, Integration and Modelling task force of the International Geosphere-Biosphere Programme has put forward as overarching questions for the earth system analysis community (SCHELLNHUBER AND SAHAGIAN 2002). Some of these questions relate to the social sciences. However, these social science questions are not viewed as part of the 'analytical' questions (which are exclusively related to natural science), but as part of the 'strategic' questions (for example question no. 23, 'What is the structure of an effective and efficient system of global environment and development institutions?'), or 'normative' questions (for example, question no. 18, 'What kind of nature do modern societies want?'). The value of governance research as an *analytical* programme of inquiry is relegated to its policy-oriented, advisory dimensions.

Conceptually, only a few approaches have emerged so far that provide avenues for bridging social and natural science research related to the earth system. Most of those build on complex and dynamic systems theory that allows conceptualizing social and natural systems as coupled and highly interdependent systems (FUNTOWICZ AND RAVETZ 1994, BERKES AND FOLKE 1998, WILSON 2002, BERKES ET AL. 2003, OLSSON ET AL. 2004A). Likewise, the co-evolutionary approach (NORGAARD 1988; 1994) focuses on the interdependencies of socio-economic and ecological systems and their often poorly adjusted temporal development paths. However, most of these approaches have been applied to local or regional systems such as river basins, cities and terrestrial or aquatic ecosystems, yet not to the earth system as such. Moreover, governance and steering capacities in these systems at different levels have only marginally been captured by these concepts.

Consequently, there is still a major research agenda ahead. This methodological challenge is also a core challenge for the Earth System Governance Project. On the one hand, participants in the Project will need to continue pursuing research that is interdisciplinary across the social sciences and that follows the internal logic and particular theoretical, epistemological and methodological approaches of the social sciences and the humanities, which are often qualitative, case-based, context-dependent, and reflexive. On the other hand, however, it is important, and timely, for the Earth System Gov-

ernance Project to explore also integrated approaches that seek novel ways of incorporating research on governance and institutions in computer-based models and scenarios (e.g., in the Dutch ModelGIGS Project, SEE FRANTZI AND PATTBERG 2008). One main experimenting ground for such integrated approaches and for issue-specific cooperation are the various joint projects of the Earth System Science Partnership, such as the Global Environmental Change and Food Systems Project, the Global Water System Project or the Global Carbon Project.

Some of these joint projects serve therefore in the Earth System Governance Project as flagship activities in which natural science and social science theories, methods and approaches are combined to analyze real world problems. At the same time, these areas of focused cooperation will serve as breeding, experimenting, and testing ground for methodological progress in the issue-specific combination of natural and social science approaches (SEE CHAPTER 10).

ANALYZING EARTH SYSTEM GOVERNANCE: A RESEARCH PROGRAMME

Earth system governance can be analyzed with a variety of methods, at a variety of levels, and from a variety of perspectives and disciplines. While the research programme advanced in this Science Plan is not the only way to increase understanding of earth system governance, the conceptual model underlying the Earth System Governance Project may help integrate different strands of research, different disciplines, and different research interests. This Science Plan outlines a research programme organized around five analytical problems with four crosscutting research themes and four flagship activities (FIGURE 1).

1. Analytical Problems.

First, the five analytical problems suggested are the problem of the overall *architecture* of earth system governance, of *agency* beyond the state and of the state, of the *adaptiveness* of governance mechanisms and processes and of their *accountability* and legitimacy, and of modes of *allocation and access* in earth system governance—in short, the five *A's* of earth system governance research. These five analytical problems are derived from an analysis of the current state of research and of theoretical developments as well as from societal demands on the academic community (BIERMANN 2007, 2008).

This Science Plan elaborates on each of these five A's in chapters 3 (architecture), 4 (agency), 5 (adaptiveness), 6 (accountability), and 7 (allocation and access).

2. Crosscutting Themes.

Second, the Earth System Governance Project will focus, in studying the analytical problems of architecture, agency, adaptiveness, accountability and legitimacy, and allocation and access, on four crosscutting research themes that are of crucial relevance for the study of each analytical problem but also for the integrated understanding of earth system governance. These four crosscutting research themes are the role of power; the role of knowledge; the role of norms; and the role of scale (SEE CHAPTER 9 IN MORE DETAIL).

3. 'Flagship Activities' as Case Studies.

Third, the Earth System Governance Project will advance the integrated, focused analysis of case study domains in which researchers combine research on the overall governance architecture, the role of different agents in this governance architecture, the overall adaptiveness of the governance system, and mechanisms of accountability and modes of allocation. Chapter 11 outlines the application of the 5-A model for a variety of pressing problems of global change that promise to be the most fruitful flagship activities. At the same time, integration of the findings from different issue areas on each of the five analytical problems—for example the combination of findings on allocation problems in water, climate, and food governance—will increase theoretical knowledge on the core elements of earth system governance.

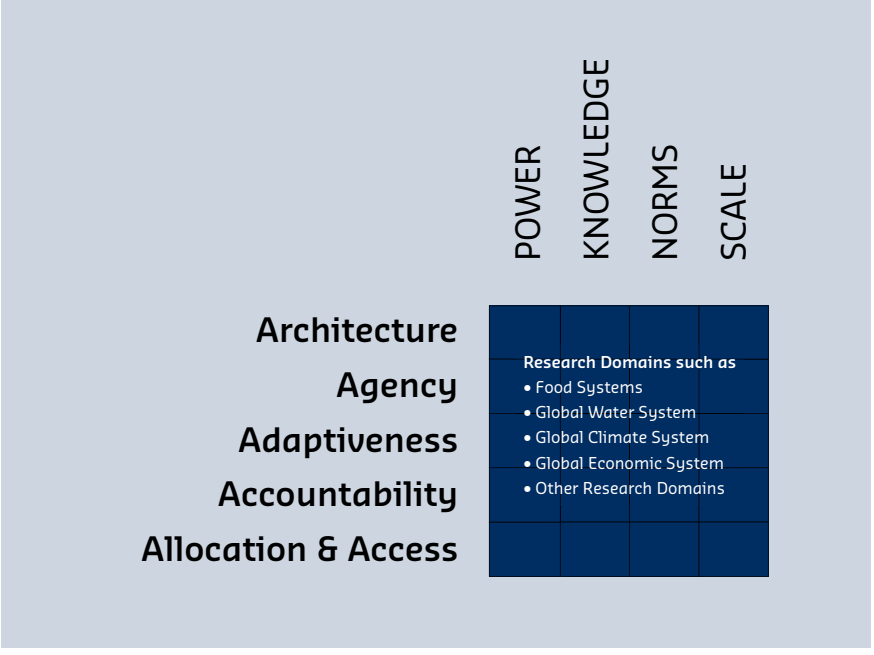

Figure 1: The Overall Design of the Earth System Governance Project

3

THE PROBLEM OF ARCHITECTURE

The first major research and policy concern of earth system governance is its overall 'architecture', defined as the interlocking web of widely shared principles, institutions and practices that shape decisions at all levels in a given area of earth system governance.[10]

So far, most institutional research in the field of earth system governance has focused on single institutions, especially in the international realm of regulation. We now have a better understanding of the creation, maintenance and effectiveness of international environmental regimes and national policies, as well as better methodological tools to study these questions.[11] It has been shown, for example, that different international norms and verification procedures, compliance management systems, modes of regime allocation as well as external factors, such as the structure of the problem, all influence regime effectiveness (MITCHELL 2008, UNDERDAL 2008). Most of these studies have focused on the effectiveness of single institutions, often within larger comparative projects.[12]

More recently, the increasing number and scope of international environmental institutions has led to new research on their interaction, for example in studies on regime interlinkages, regime 'clusters' or regime 'complexes', and broader consequences of regimes.[13] Institutional interplay was also one of the three research themes of the IDGEC project (SCHROEDER 2008; ON THE RESULTS, SEE OBERTHÜR AND GEHRING 2006, AND GEHRING AND OBERTHÜR 2008), with the general agreement that despite all progress, more research in this area is needed.

At the national and local levels, too, interactions and interlinkages between different institutions have been a concern for many years, for example in the analysis of (environmental) policy integration (JORDAN AND LENSCHOW 2009) or in the analysis of environmental governance in federal systems in which different jurisdictional competences at times overlap. One important research tradition that requires further attention is here the vertical interaction of

10 The following builds on Biermann 2008, 287-290.

11 For recent overviews and discussions, see R.B. Mitchell 2002a and O.R. Young 2001. See also Bernauer 1995, Brown Weiss and Jacobson 1998, A. Gupta and Falkner 2006, Haas, Keohane and Levy 1993, Helm and Sprinz 2000, Keohane and Levy 1996, Mitchell 1994, Mitchell and Bernauer 1998, Underdal 2002, Young 1994a, 1997 and 1999, Young, Levy and Osherenko 1999.

12 For example, Haas, Keohane and Levy 1993, Keohane and Levy 1996, Miles et al. 2002, Victor, Raustiala and Skolnikoff 1998, Young 1997, Young, Levy and Osherenko 1999, Stewart 2007.

13 For example, Asselt, Gupta and Biermann 2005, Velasquez 2000, Chambers 2001, Oberthür and Gehring 2006; Rosendal 2001a and 2001b, Stokke 2000, Underdal and Young 2004, Hey 2007.

governance mechanisms and the notion of multilevel governance (HOOGHE AND MARKS 2003, BETSILL AND BULKELEY 2006, ADGER 2006B, CASH ET AL. 2006, CONCA 2005). For instance, federal systems of governance often delegate responsibilities to lower governance levels, which complicates coordination at national level. Where local stakeholders are given responsibilities in policy formulation and implementation, the potential for implementation may increase, but could also decrease as regards harmonization.[14]

Most approaches to understanding the effectiveness and the interaction of different institutions had to be methodologically reductionist to be successful. Distinct institutions, sometimes distinct institutional elements of larger institutions, have been analyzed regarding their effectiveness and their relationship to other institutions or institutional elements. Only very recently have scholars begun to investigate larger systems of institutions and governance mechanisms in particular areas.

The Earth System Governance Project conceives of such larger systems as 'governance architectures'. The concept of architecture includes situations of both synergy and conflict between different institutions in an issue area; between the overarching norms and principles that govern these interactions; and between norms and principles that run through distinct institutions in the area. It may include for example the principle of common but differentiated responsibilities and respective capabilities that is common to many modern institutions in the field of earth system governance.

The notion of governance architecture is useful in particular because it allows for the comparative analysis of (the many) policy domains in earth system governance that are not regulated, and often not even dominated, by a single (international, national or local) institution in the traditional understanding. Many policy domains are at present instead marked by a patchwork of institutions that are different in their legal character (organizations, regimes, implicit norms), their constituencies (public and private), their spatial scope (from local to global) and their subject matter (from specific policy fields to universal concerns). In such situations, the notion of governance architecture helps to conceptualize the overarching system of public or private institutions, principles, norms, regulations, decision-making procedures and organizations that are valid or active in the issue area. Architecture can thus be described, in other words, as the *meta-level* of governance.[15]

RESEARCH QUESTIONS

A renewed research effort on the analytical problem of architecture will continue and expand the current lines of research in a number of ways:

14 Angel et al. 1998, Bulkeley and Betsill 2003, Deangelo and Harvey 1998, Rezessy et al. 2006, Gupta et al. 2007.

15 See here also Biermann, Pattberg, van Asselt, and Zelli 2007.

How is performance of environmental institutions affected by their embedding in larger architectures?

First, the problem of architecture entails looking beyond single environmental institutions. This includes much work under conceptual headings such as institutional interplay, institutional interaction, institutional complexes, and institutional constellations (GEHRING AND OBERTHÜR 2008). Yet more work is needed to understand the performance of single environmental institutions within larger architectures, and to understand the performance of entire clusters of institutions, described here as governance architectures. The recent advances in understanding the performance of single environmental institutions—in terms of both conceptual progress and empirical knowledge—will naturally be relevant and highly useful in this extended research programme as well.

What are the environmental consequences of non-environmental governance systems?

Second, the problem of architecture requires looking beyond environmental institutions. This includes, for one, an increasing focus on the environmental consequences of institutions that do not cover environmental policy. One example of local non-environmental institutions with tremendous influence on environmental governance are systems of land tenure. At the international level, the environmental consequences of the world trade regime or of World Bank programmes have been debated for long, but are still insufficiently understood. New areas of interest are for instance the environmental consequences of bilateral investment treaties (TIENHAARA 2006). Research in this area is, on the one hand, research on the consequences of single institutions, such as the specific agreements under the world trade regime. To the extent that the environmental consequences of these non-environmental institutions are covered by environmental institutions at the same time, the problem of non-environmental institutions becomes a problem of institutional interaction, and hence a problem of the architecture of environmental governance (SEE GEHRING AND OBERTHÜR 2008 ON THE STATE OF THE ART IN THIS FIELD; CHAMBERS AND GREEN 2005; AS WELL AS CHAPTER 11, OUTLINING THE FLAGSHIP ACTIVITY 'EARTH SYSTEM GOVERNANCE AND THE GLOBAL ECONOMIC SYSTEM').

What is the relative performance of different types of multilevel governance architectures?

Third, the problem of architecture entails looking at vertical institutional interaction and the role of institutions within multilayered institutional systems. In international relations and political science research, this prob-

lem is generally understood as the problem of multilevel, or multilayered, governance. The increasing global institutionalization of world politics is not conceivable without continuing policy-making at national and subnational levels. Global standards are implemented and put into practice at the local level, and global norm-setting requires local decision-making to set the frames for global decisions. This results in the coexistence of policy-making at the subnational, national, regional and global levels in more and more issue areas, with the potential for both conflicts and synergies between different levels of regulatory activity. The international regulation of trade in genetically modified organisms is as a prime example for such multilevel governance, where the 'global is local' (A. GUPTA 2001, 2004). Multi-level governance has been intensively researched, and at least three themes within the IHDP Institutional Dimensions of Global Environmental Change project have dealt with questions of policy level: The first was the 'problem of fit', that is, are existing institutional arrangements well-matched to the properties of the biophysical systems to which they relate (EBBIN 2002, PRITCHARD ET AL. 1998, YOUNG 2002)? The second was the 'problem of scale', that is, to what extent can findings about the roles institutions play be generalized across levels on spatial, temporal and jurisdictional scales (ALCOCK 2002, GIBSON, OSTROM AND AHN 2000, A. GUPTA 2001 AND 2004, J. GUPTA AND HUITEMA, FORTHCOMING, OSTROM ET AL. 1999, SAND 2004, YOUNG 1994B). The third was research focused on 'interplay' that included the notion of vertical interplay. These three concepts of vertical interplay, scale, and fit set the scene for further research in this area, which is subsumed in the Earth System Governance Project as part of the problem of architecture.

Related to this point is the analysis of variability in performance of spatial and functional architectures. It is plausible that certain characteristics that make one type of architecture more effective might hold only for spatial architectures, or only for (specific) functional architectures, such as issue-specific institutions as opposed to geographically defined institutions.

How can we explain instances of 'non-governance'?

Eventually, the problem of architecture goes beyond the study of institutions and of their interaction. It also covers, first, the inquiry into non-institutions, that is, conflict areas where no institutions have been agreed upon. This inquiry addresses the recurrent problem in social science of case selection on the dependent variable, in this case, on the explanation of the emergence and performance of institutions through the analysis only of issue areas where institutions, in fact, have been agreed (SEE UNDERDAL 2008 IN MORE DETAIL ON THIS PROBLEM; ALSO DIMITROV 2002; 2006).

What are overarching and crosscutting norms of earth system governance?

Finally, given the density of institutions, and the emerging overarching system of institutions as the 'architecture' of earth system governance, there is an increasing need to better understand the principles and norms that run through all, or through a large number of, institutions. In a more general sense, this is the problem of deciding on constitutional principles and basic norms in earth system governance. The political behaviour of states is guided not merely by calculations of material interest and power, but by international norms that prescribe and prohibit types of behaviour and create an international society that 'socializes' states—including new governments that have not participated in the original creation of norms.[16] For such norms to be effective, they must be relatively simple, cross-culturally appealing, and sufficiently clear and unambiguous. For example, the success of the world trade regime in liberalizing trade and phasing out most custom duties within half a century is partially attributed to the simplicity and general acceptability of its basic principles, notably reciprocity and the most-favoured-nation clause. Another example is the development of human rights norms in the course of the 20th century (RISSE, ROPP AND SIKKINK 1999). Similar basic norms for earth system governance are emerging, such as the principle of common but differentiated responsibilities. Others are still disputed, such as the notion of interstate liability in the area of global environmental change. Identifying such widely accepted constitutional principles is hence a key research challenge for scholars of both international relations and international law, and one of the core research challenges regarding the problem of architecture.

BOX 1: THE PROBLEM OF ARCHITECTURE—RESEARCH QUESTIONS

- How is performance of environmental institutions affected by their embedding in larger architectures?
- What are the environmental consequences of non-environmental governance systems?
- What is the relative performance of different types of multilevel governance architectures?
- How can we explain instances of 'non-governance'?
- What are overarching and crosscutting norms of earth system governance?

16 This is largely linked to the theoretical strand of sociological institutionalism. See, among many others and with further references, March and Olsen 1989, 1996 and 1998, Finnemore 1996, Barnett and Fin-nemore 1999, Finnemore and Sikkink 1998.

4

THE PROBLEM OF AGENCY

From the analytical problem of architecture, we now turn to the analytical problem of agency. This area of research builds on the assumption that credible, stable, adaptive, and inclusive earth system governance requires the consent and involvement of national governments, their bureaucracies, and the growing population of non-state actors.

The problem of agency lies at the core of effective earth system governance. Global environmental change challenges the capacity of traditional state structures to respond to increased demands to mitigate and adapt to these changes. Moreover, this capacity varies greatly among nation-states. Cooperation with other states, but also with local, domestic and transnational non-state actors, may become imperative. Whether nation-states can fulfil their core functions under the pressures of earth system transformation, and to what extent non-state actors are filling new governance demands, remain open questions (BIERMANN AND DINGWERTH 2004, MARAUHN 2007).

Many vital institutions of earth system governance are today inclusive of, or even driven by, non-nation-state actors. At the local level, a plethora of parallel initiatives has emerged. In the context of climate change, regions and cities have set their own greenhouse gas emission reduction frameworks and rationalities, such as the Chicago Climate Exchange and action plans of major global cities. These often cut across public-private divides (BULKELEY AND BETSILL 2003, SELIN AND VANDEVEER 2005). At the international level, actors span the entire spectrum from public non-state, such as intergovernmental bureaucracies, to public-private, such as environmentalist alliances or scientific networks, to purely private actors, such as business associations.[17]

Importantly, the activities of non-nation-state actors in earth system governance are not confined to lobbying and advising national governments in the creation and implementation of rules. Rather, these actors frequently become *agents* of earth system governance in that they substantively participate in and/or set their own rules related to the interactions between humans and their natural environment. Private actors have joined governments to put norms into practice, for example as quasi-implementing agencies for development assistance programmes administered by the World Bank, bilateral agen-

17 See on intergovernmental bureaucracies, Biermann and Siebenhüner 2009, on environmentalist alliances Arts 1998 and 2002, Betsill 2006, Betsill and Corell 2001; 2008; Conca 1995, J. Gupta 2003, Lipschutz with J. Mayer 1996, Newell 2000, Princen and Finger 1994, Raustiala 1997, Spiro 2007, Wapner 1996, on scientific networks, Andresen et al. 2000, Haas 1992 and 1993, Jasanoff 1996, Jasanoff and Long Martello 2004, Litfin 1994; on business associations, Clapp 1998, Falkner 2003, Grijp and Brander 2004, Haufler 2000, Levy and Newell 2004, Rowlands 2001. For the argument that increases in participation of some actors may result in disenfranchisement of others, and related governance challenges, see Green 2006.

cies or national governments. Non-state actors at times negotiate their own standards, as in the Forest Stewardship Council or the Marine Stewardship Council, two standard-setting bodies created by major corporations and environmental advocacy groups without any direct involvement of governments (CASHORE 2002, PATTBERG 2005, 2006A AND B). Public-private cooperation has received considerable impetus since the 2002 World Summit on Sustainable Development in Johannesburg and its focus on partnerships of governments, non-governmental organizations and the private sector. More than 300 such partnerships have been registered with the United Nations around or after the Johannesburg summit (ANDONOVA AND LEVY 2003, GLASBERGEN ET AL. 2007, BIERMANN, PATTBERG, CHAN AND MERT 2007B).

As a result of these activities, there is a reconfiguration of authority in the realm of earth system governance, making it necessary in the Earth System Governance Project to distinguish between actors and agents. Here, *actors* refer to the individuals, organizations, and networks that participate in decision-making related to the earth system. An *agent* of earth system governance is an actor who possesses the ability to prescribe behaviour and to obtain the consent of the governed. Hence, an agent is an *authoritative actor*. Authority here is understood as the legitimacy and capacity to exercise power, while power refers merely to the capacity to influence outcomes, with or without the legitimacy to do so. Legitimacy is conferred through social consent, given formally or informally. Whether authority may be claimed unequivocally by an agent is an open question; it is here where the concepts of power and authority blend together. Agents may contribute to the purposeful steering of constituents either indirectly (by influencing the decisions of other actors) or directly (by making steering decisions). They are thus a constituent part of the cumulative steering effort toward preventing, mitigating or adapting to earth system transformation.

Research on the problem of agency is closely linked to four broad areas of social science inquiry that address questions of *who* governs and *how*.

1. Non-state actors in governance.

First, this area of research builds on fruitful work that calls attention to the range of actors beyond the state that participate in governance processes and forces us to examine whether and how this development is changing the nature of the state. The proliferation of non-state actors and their involvement in earth system governance has led some to question the relevance of the state (E.G. MATHEWS 1997). Others argue the state remains a central (if not necessarily the central) actor (E.G. BIERMANN AND DINGWERTH 2004, BARRY AND ECKERSLEY 2005, RAUSTIALA 1997). It is essential to understand the roles both state and non-state agents play in this effort and how each is shaped by the continual reconfiguration of authority (PIERRE AND PETERS 2000, SASSEN

1996, SENDING AND NEUMANN 2006, MARAUHN 2007). There is a move away from a paradigm of competitiveness between state and non-state agents to a new understanding of the relationship between them. This new relationship is based on an understanding of power not as zero-sum but as multiple and relational, and the state as not being unitary but consisting of multiple centres of political activity (OKEREKE, BULKELEY AND SCHROEDER 2009).

2. Actors, authority and agency.

This leads to a second question: by what means do actors become authoritative? What is the basis of authority, especially when it occurs outside the public sphere? Authority does not have to be based solely on the apparatus of the state. Also, one cannot assume that all public actors have authority and all private actors do not. Organizational theory from sociology and its application to political science has helped in understanding the internal formation of agency within collective actors within their institutional environments (SEE FOR EXAMPLE ZUCKER 1983, DIMAGGIO AND POWELL 1991, MEYER AND ROWAN 1991, BARNETT AND FINNEMORE 2004). However, the particular processes of the emergence of authority in the earth system governance context, require further research. In addition, much of the social science literature on the question of authority emphasizes its relational nature. That is, some actors become imbued with authority to act on behalf of others. In principal-agent theory, principals (actors) delegate authority to an agent or agents to act on their behalf (HAWKINS ET AL. 2006). An alternative approach suggests that authority is derived through social interactions in which the fundamental understanding of what it means to be an agent is constructed and may change over time and across contexts (BOURDIEU 1977, FEARON AND WENDT 2002).

3. Structure-agent debate.

Third, research on agency in earth system governance is embedded in the *'structure-agent' debate* in the social sciences (ARCHER 2003, DESSLER 1989, GIDDENS 1984, WENDT 1999). From Weber and Durkheim to the present, social scientists have long debated whether social outcomes are primarily a product of individual actions by agents or broader social structures. For many scholars, structure and agency are seen as two sides of the same coin where agents both constitute and are constituted by structure. The question of agency in earth system governance is thus intricately related to the analytical problem of architecture. How does agency relate to structure and how does an actor exercise agency within an architecture? The norms of participation, participatory processes of decision-making, and stakeholder participation practices that are prevalent in a specific context will, as the 'structure', frame the ability of the various actors to exercise agency. The specific set of norms

prevalent in a situation, would give certain actors authority that they would not have had in their absence. The study of agency for earth system governance requires understanding how agents' decisions about the co-evolution of coupled human-natural systems shape and are shaped by those very systems.

4. Agency in the multilevel context.

Fourth, agency in the realm of earth system governance must be considered in a multilevel context. Environmental problems transcend national boundaries and occur not only in national but in local, regional or global spaces. The natural level of response is therefore often not simply, or even primarily, the national level. Rather, it is likely to be a combination of levels from local to global. It is possible that the more levels of governance are involved in addressing large-scale environmental problems, the more effectively the problem is addressed. This refers also to sectors of governance, including the private and the public spheres. It is important to recognize that key agents are likely to frame a problem in a certain way and locate it at a certain level of governance to best fit their own vested interests, in addition to pursuing the goal of solving the problem at hand (GUPTA AND HUITEMA FORTHCOMING, SCHROEDER, KING AND TAY 2008). Forum shopping—choosing the most beneficial level of governance and sector—is a way to maximize power and influence. Multilevel governance is therefore of central importance when focusing on the human-environment interface (HOOGHE AND MARKS 2003, BETSILL AND BULKELEY 2006, ADGER 2006B, CASH ET AL. 2006, CONCA 2005). Actors at all levels of governance have stepped in to fill the gap where the national government has not been able to effectively respond on its own. This has widened the space for agency to unfold in multiple spheres and tiers of governance.

RESEARCH QUESTIONS

This Science Plan identifies four main research questions on the analytical problem of agency for earth system governance. Each question is closely related to the broader social science debates outlined in the previous section.

What is agency for earth system governance?

Before identifying the agents of earth system governance, we must have a better understanding of the concept of agency, of how agents differ from actors, and what constitutes agency in the context of earth system governance. The term 'agency' is widely used across the social sciences and humanities, and it would be useful to draw on these fields to consider the core elements

of agency for earth system governance. For example, how is agency for earth system governance defined? It could be understood as the capacity to act in the face of earth system transformation or to produce effects (positive or negative) that ultimately shape natural processes. Agency may also involve the ability to understand and reflect on the relationship between human and natural systems. It may be useful to consider agency as a dynamic trait that can be created and lost and to explore how this is shaped by environmental change. If agency is dynamic, is it zero-sum in that as some actors gain agency in a policy domain others lose agency? Or can agency be shared across actors? These studies could investigate individual features and the internal workings of particular actors as well as the relations between actors as sources of agency in earth system governance. It is also important to consider the possibility of non-human agency in the realm of earth system governance. In some fields, non-human entities such as technology are considered to have agency. This is particularly relevant for energy technology and infrastructure choices that will have life times of two to three decades and can create path-dependency and carbon lock-in, thereby limiting the agency of future generations. In a coupled human-natural system, does the natural world exercise or influence agency and if so how?

Who are the agents of earth system governance?

Who ultimately governs the earth system? We need to go beyond identifying the myriad actors that participate in governance processes related to the earth system and instead focus on those actors that exercise agency. To do so, we need to gain insight into the following questions: How is agency configured in different policy domains related to earth system governance? And is it configured differently at different levels of governance? Who are the key agents in a particular issue area and how are they related to one another? To what extent is the state (at all levels) an agent of earth system governance? Are all states agents of earth system governance or does it vary according to broader structures in the international system (e.g. the North-South divide)? How is the agency of states reconfigured as non-state actors become agents, especially at local, regional and international levels of governance? What broad types of agents are central in the area of earth system governance? Can we develop a useful typology? And in doing so, can we also advance understanding of what non-state actors are, other than that they are not state actors? Do elements of the coupled human-natural system such as ecosystems and markets exercise agency in establishing and undertaking earth system governance?

How do different agents exercise agency in earth system governance?

We can expect that different agents become authoritative on different grounds, so it is important to enquire into the source of authority. Does the source of authority differ across policy domains and levels of governance? If so, why and how does it differ? Is there for instance a relationship between gender and authority? Research in this area could explore how power and authority are configured in types of governance arrangements as well as the changing nature of state-based power and authority as new actors become agents of earth system governance. This research question also highlights new forms of governance beyond typical state-based institutions. These include markets, certification schemes, self-regulation, public-private partnerships, and transnational networks. There is a need to document these various forms of governance through which actors exercise agency and to understand how the process of governing varies across governance architectures. To do so, we need to better understand the following: What are the conditions for the emergence of agency at different levels and within different architectures? Does agency change over time, and, if so, how does this change occur? What are the drivers of changes in agency? Are they internal to the agent, external, or a combination of the two? What is the relationship between governance as a process and agency?

How can we evaluate the significance of agents and agency?

The effectiveness of different agents and their various means of exercising agency (for example through public-private partnerships) is insufficiently understood. Most advances in the study of earth system governance have focused on states as core actors and on intergovernmental forms of cooperation. This leads us to ask the following: How can we assess the effectiveness of different agents and their various means of exercising agency? Can we apply approaches developed in the study of institutions, such as output-outcome-impact, to agency? Should an evaluation of agent effectiveness focus on environmental outcomes, behavioural changes or effects on knowledge and discourse? Are there other useful approaches? How should we evaluate agency that is used for blocking purposes? Can we arrive at a Pareto efficiency of agency? In other words, can we decipher what the optimal number of different agents would be to achieve the highest level of effectiveness in terms of preventing, mitigating or adapting to global environmental change while, at the same time, protecting human livelihoods?

BOX 2: THE PROBLEM OF AGENCY—RESEARCH QUESTIONS

- What is agency for earth system governance?
- Who are the agents of earth system governance?
- How do different agents exercise agency in earth system governance?
- How can we evaluate the significance of agents and agency for earth system governance?

5

THE PROBLEM OF ADAPTIVENESS

CONCEPTUALIZATION

Adaptiveness is an umbrella term for a set of related concepts—vulnerability, resilience, adaptation, robustness, adaptive capacity, social learning and so on—to describe changes made by social groups in response to, or in anticipation of, challenges created through environmental change (ADGER 2006A, FOLKE 2006, GALLOPIN 2006, SMIT AND WANDEL 2006). Changes may turn out to be beneficial; but they may also lead to mal-adaptations. Within the framework of earth system governance, the term adaptiveness includes the governance of adaptation to social-ecological change as well as the processes of change and adaptation within governance systems. The term was chosen to allow scope for governance issues to be explored in a variety of frameworks and theories of social-ecological change. Adaptiveness includes at least three kinds of social-ecological change: (1) 'narrowing' perceived gaps between current responses and imagined best responses, where the latter does not shift, (2) 'pursuing or tracking' changes in what is 'best' when that itself changes; (3) 'transforming or re-organizing' when what is seen as 'best' requires a leap across thresholds from one regime to another.

Adaptiveness supports a collective or social actor, or a social-ecological system, to maintain those functions essential for the survival of that actor or system. Lacking adaptiveness thus jeopardizes the existence of the system. The focus here is in the relationships between adaptiveness, in its diverse conceptualizations, with governance of large-scale environmental changes and earth system challenges, such as climate change (IPCC 2007), overuse of ecosystem services (MILLENNIUM ECOSYSTEM ASSESSMENT 2005), and the loss of biodiversity (SCBD 2007).

RESEARCH QUESTIONS

The problem of adaptiveness is addressed by policies, programmes, projects, institutions and actions at different levels. An analysis of alternative approaches to earth system governance must grapple with both overtly contested political and more nuanced and subtle problems of social control and fairness within these responses (and failures to respond). There are thus four main questions under the analytical problem of adaptiveness: First, what are the politics of adaptiveness? Second, which governance processes foster adaptativeness? Third, what attributes of governance systems enhance capacities to adapt? Fourth, how, when and why does adaptiveness influence earth system governance? Question 1 is broad and prompts critical inquiry into the creation, pursuit and abandonment of initiatives and queries into who benefits from such actions. Questions 2 and 3 underline the two-way relationship between governance and adaptiveness within and of social-ecological systems.

Question 4 seeks to deepen inquiry, where possible, into better understandings of human behaviour and causality, treating adaptiveness as both a factor, and quality, of governance.

What are the politics of adaptiveness?

Adaptation can create winners and losers, by, for instance, shifting the distribution of benefits, of involuntary risks, or of power (BLAIKIE ET AL. 1994, LEBEL ET AL. 2007). The procedures and networks that foster adaptive capacity may reproduce prior injustice, for example when actions in the logic of protecting national assets and interests make some disadvantaged groups more vulnerable than they were before (LEBEL 2007). Securing access to resources by one nation may make another more vulnerable (PAAVOLA AND ADGER 2006). How institutions that are meant to help societies adapt to global environmental changes actually end up distributing the burdens and risks (ELSTER 1992) from earth system changes is an issue of social justice (ADGER 2001, THOMAS AND TWYMAN 2005). We should therefore ask of adaptiveness: *For whom and who benefits?*

Adaptive capacity is often specific to the social-ecological system in question (CARPENTER ET AL. 2001, FOLKE ET AL. 2003). One society or social group may be very capable when it comes to dealing with shortages of water, but hopeless in tackling unusual floods. Another may have all the food it needs but lack secure access to energy resources; without trade such a society may be in great difficulty. Societal responses (and associated investments) which address some challenges are often contested both implicitly and overtly (PRITCHARD AND SANDERSON 2002, LEBEL, ANDERIES ET AL. 2006). Moreover, the characteristics of a challenge may change with spatial and temporal level. The impacts of changes in land-use on run-off and sedimentation, for example, can change with scale. At present, different environmental changes such as climate change and biodiversity loss are often dealt with in different governance arenas and by different institutions. And most governance systems are largely unprepared for the expected magnitude and diversity of increased environmental challenges. In addition, most governance responses to single environmental challenges have often unintended repercussions in other fields and might also be highly detrimental to other environmental, social or political goals (SHNAIBERG ET AL. 2002). We should thus also ask of adaptiveness: *To what and with which side-effects?*

Who benefits from adaptation may not be identical to who has to do the adapting. If, as is typical, the assumption is that the state, as a set of institutions, is the most relevant level for tackling environmental changes, then we need to look at issues of state capacities and interdependencies. The dependence on other states in combating global environmental problems, the limited legitimacy of states to implement effective policies against environ-

mental change problems and the lacking state capacities in particular in the developing world pose novel challenges on the state (BIERMANN 2007). If, on the other hand, it is assumed that most adaptation will be of much finer level, in firms, civil-society groups and neighbourhoods, or in behaviour of individuals, then possibilities for learning, innovation, selection and aggregation must be added to conventional concerns with fit and interplay (YOUNG 2002). Alternatively, international regimes on environment or trade might be seen as contributing to adaptiveness of particular states (or to its deficit). Adaptiveness at any level may be uncertain and dynamic (ADGER AND VINCENT 2005) and requires particular types of conditions and circumstances to emerge and thrive (OSTROM 2003, OSTROM ET AL. 2007). Cross-level interactions might compensate for adaptiveness within a particular level. We should also ask: *By what, under which conditions and at what scales?*

The appropriate degree of responsiveness to change, and consequently, timeliness, is contested. How societies construct and perceive risks and their own capacities to manage them is not independent of the different interests involved. Some people benefit from rapid and early responses, whereas others would much prefer to see a slower (perhaps more certain) ground for reaction. Thus debates on adaptation struggle with trade-offs between present and future costs and benefits as well as ethical imperatives. Societies differ in how they explore, deliberate and act upon perceptions about alternative futures and crises. We should probe the discursive strategies and practices around *'By when?'* In sum, these questions about objectives, beneficiaries, responsibilities, scales, and timing underline the complexity of decision-making, the dynamics of institutions, and the centrality of *politics to adaptiveness.*

Which governance processes foster adaptiveness?

Earth system challenges are complex. From the perspective of national governments it is often not clear what they can do. State capacities to adapt may be quite limited (BIERMANN 2007). The extent to which governance systems are adaptive and evolve in response to earth system challenges is not empirically clear in many problem domains.

Creative responses to small changes, such as gradual sea-level rise or changing migration patterns of species, for example, by tinkering with the resources and connections in hand may appear to demonstrate adaptiveness. However, continuing to do so over decades and millennia may trap a society in a set of dependencies and vulnerabilities such that a different sort of challenge or surprise, even not a very big one, may have profound or catastrophic consequences (REDMAN 1999, ERICKSON AND GOWDY 2000, DIAMOND 2005, GUNDERSON AND HOLLING 2002). The ways insurance or structural flood protection measures affect subsequent risk-taking behaviour are good examples. Not only does society need to respond but somehow it must do so at an

appropriate magnitude often allowing some disturbances to run their course (HOLLING AND MEFFE 1996). On the other hand, environmental changes unprecedented in scale or speed—like those associated with climate change, loss of biodiversity, or changes to ocean circulation patterns—may bring about or demand changes to the very criteria, scope and procedures of how power is allocated and decisions are being taken in a particular society or in the global community. Trying to reduce discrepancies between, for example, electoral cycles and timeframes of action needed for adaptiveness, could easily create risks for the pursuit of democratization objectives.

The issue of timing and magnitude of responses are connected. Risk and disaster management are a practical and increasingly common way of framing some earth system challenges (SOCIAL LEARNING GROUP 2001A, THOMALLA ET AL. 2006, BERKES 2007). Among and within states key discourses and institutionalized practices to manage disasters are frequently technocratic (BLAIKIE ET AL. 1994, LEBEL, NIKITINA ET AL. 2006). Action research may be needed to re-politicize risk management so that issues of power which often underlie differences in social vulnerability become visible (LEBEL AND SINH 2007). Many studies, and most policy processes, concerned with adaptiveness are conservative in the sense that increasing resilience is seen as invariably positive and maintaining or returning to a recent system configuration as desirable (LEBEL, ANDERIES ET AL. 2006). As a consequence, opportunities for transformation emphasized in resilience-approaches to crisis (FOLKE ET AL. 2005, BERKES 2007) are often overlooked. One reason is the politics associated with transformative change (SMITH ET AL. 2005, LEBEL, ANDERIES ET AL. 2006). Another reason is the uncertainty and the novelty of future living conditions and potential new governance systems.

Important are here also processes of social learning that go beyond the production of new and additional knowledge but include shifts in collective perceptions and paradigms about understanding of wellbeing, happiness and development goals. This includes a reflection and re-evaluation of the cultural foundations of human behaviour and the resulting removal of barriers to sustainable development. Social learning to encounter global environmental stresses includes the active engagement of numerous actor groups with varying degrees and interaction patterns (SOCIAL LEARNING GROUP 2001A AND B, PAHL-WOSTL ET AL. 2007). In processes of social learning, these roles and relationships between actors become subject to change. Science is central in this respect, but it is by far not the only knowledge generating mechanism, since knowledge and related action patterns are formed, diffused and institutionalized by different actor groups including nongovernmental organizations, political agencies, the media and networks formed out of those, for example within epistemic communities (HAAS 1992, 2001, RISSE 2000). Governance can be designed as a learning process, for example in a reflexive governance mode (VOSS ET AL. 2006). Learning takes place on different scales such as

individuals, organizations, social groups, entire societies or even the world community. Drawing from other, more disciplinarily focused approaches such as organizational learning, social learning could proceed along different forms such as single-, double-loop or deutero learning (ARGYRIS 1977, FIOL AND LYLES 1985, ARGOTE 1999, BERTHOIN ANTAL ET AL. 2001, BAPUJI AND CROSSAN 2004). It can also provide far-reaching insights about key factors for collective learning processes and the barriers to change. Findings from these studies need to be applied to the practical design of mechanisms that foster social learning towards adaptiveness vis-à-vis global, regional and local environmental challenges (E.B. HAAS 1990, P.M. HAAS AND E.B. HAAS 1995, P.M. HAAS 2004, PARSON AND CLARK 1995, SMITH ET AL. 1999, SIEBENHÜNER 2005 AND 2008, WADDELL 2005).

In sum, governing transitions is a major challenge in itself (OLSSON ET AL. 2004B, SMITH ET AL. 2005, OLSSON ET AL. 2006). We need to understand better how transformations towards adaptiveness can be fostered at various levels, including that of the nation state.

What attributes of governance systems enhance capacities to adapt?

As already implied in asking *'to what?'*, parts of society do not just face one well-known environmental challenge at a time but may have to adapt to a range of challenges. Adequate governance mechanisms are thus necessary. Do some forms of governance enhance capacities to adapt to environmental changes? While both adaptiveness and governance have associated with them large bodies of scholarly debate, there is relatively modest theorizing at their intersection in the context of earth system challenges (FOLKE ET AL. 2005, ADGER 2006A, LEBEL, ANDERIES ET AL. 2006). Here we review a few specific propositions that link governance attributes to adaptiveness.

First, some suggest that *participation* is important to building and maintaining such a capacity because it creates trust. This might be, for example, through social networks that link actors together across organizational and other barriers (OLSSON ET AL. 2004B, FOLKE ET AL. 2005). Multiple, interactive and often cumulative environmental stresses can successfully be addressed through means of actors' participation by including a broad knowledge base that also includes traditional and indigenous knowledge (WYNNE 1996). This particularly applies to local and place-based vulnerability and impact studies (KATES ET AL. 2001). One important class of such governance arrangements is *adaptive co-management* and its variants (IMPERIAL 1999, BERKES ET AL. 2003, BERKES 2004 AND 2006, TOMPKINS AND ADGER 2004). These governance arrangements combine the ongoing generation of ecological knowledge on specific local and regional social-ecological systems with the flexible testing and iterative development of governance responses to these problems (OLSSON ET AL. 2004A). One of the most common challenges as-

sociated with management of natural resources done in cooperation with local communities is to make participation of all relevant stakeholders meaningful (AGARWAL 2001). Women, the elderly, ethnic minorities and low-income households are often excluded from key decisions that affect them even where participatory or representative processes are claimed.

Others have suggested that *polycentric and multilayered institutions*, because they improve the fit between knowledge, action, and social-ecological contexts in ways that allow societies to respond more adaptively at appropriate levels, should enhance capacities to adapt (BERKES 2002, YOUNG 2002). This proposition builds on the insight that applied knowledge and local solutions are best developed in decentralized and localized contexts. Yet, domestic and global challenges require applied approaches on more aggregated levels that also necessitate a broad coordination among local and regional concepts and solutions (URWIN AND JORDAN 2008).

Sometimes adaptiveness arises because key institutions are highly resilient and robust (ANDERIES ET AL. 2004). However, *resilient institutions* may also be barriers to successful adaptation when their scope of flexibility is exceeded by the challenges posed to them. The policy constraints to adaptation can be large (URWIN AND JORDAN 2008).

Governance to enhance adaptiveness needs to address large uncertainties, surprises and shifting knowledge and interests (FUNTOWICZ AND RAVETZ 1994, SOCIAL LEARNING GROUP 2001A AND B, LEEUWIS AND PYBURN 2002, SCHUSLER ET AL. 2003). Deliberative processes that bring in alternative perspectives could improve adaptiveness to the extent that responses are based not only on the relative influence and power of the actors involved (DRYZEK 2000, I.M. YOUNG 2001, TALISSE 2005, PAHL-WOSTL AND HARE 2004). These processes particularly address the generation of solution-oriented knowledge on tackling environmental challenges (FIORINO 1990, JOSS AND DURANT 1995, WEBLER ET AL. 1995, FORRESTER 1999, JOSS AND BELLUCCI 2002, SIEBENHÜNER 2004). Dynamic modes of governance also recognize the need for negotiations to move from deliberation to decisions that may then rest on a more solid and widely accepted knowledge base (ELSTER 1998, FAUCHEUX 2000, RISSE 2000, O'NEILL 2003).

These propositions are not anticipated to be universal (OSTROM 2003, OSTROM ET AL. 2007); nor is it clear if they are relevant at the multiple levels of earth system governance. But they illustrate the kinds of hypotheses that need to be explored under this overarching research question on attributes. A better understanding of what attributes of governance are associated with capacities to adapt or not, or at least ways to diagnose prospects under different circumstances, would be of practical significance to institutional design.

How, when and why does adaptiveness influence earth system governance?

The final research question calls for deeper investigation of individual and collective behaviours that underlie adaptiveness, and, in particular, those related to the exercise, allocation and shaping of power. The boundary between this question and the previous three is not sharply defined, but it is included as a separate item to explicitly encourage research that aims to identify and understand causal chains (ELSTER 2007). This line of inquiry should continue and extend the emphasis on causality (of institutions) articulated in the IDGEC Science Plan (IDGEC 1999, YOUNG 2002) to the broader set of processes captured in notions of governance.

Comparative and synthetic research of governance initiatives and routines could help to draw and test inferences about at least the gross prevalence of different mechanisms. It is likely that such investigations will need to take into account power, knowledge, norms and scales (SEE CHAPTER 9). In some cases, it may also be possible to gain insights into the circumstances and conditions under which particular mechanisms are likely to be triggered or invoked. A deeper understanding of mechanisms could help refine the now diverse notions and conceptualizations of adaptiveness, in particular with respect to their value for understanding and shaping earth system governance.

BOX 3: THE PROBLEM OF ADAPTIVENESS—RESEARCH QUESTIONS

- What are the politics of adaptiveness?
- Which governance processes foster adaptiveness?
- What attributes of governance systems enhance capacities to adapt?
- How, when and why does adaptiveness influence earth system governance?

6

THE PROBLEM OF ACCOUNTABILITY

Most institutional research has focused on the assessment and explanation of institutional performance. Equally important is increasingly the question of the accountability and legitimacy of institutions and systems of governance, both in its own right with regard to the theory of democratic earth system governance, and with a view of accountability and legitimacy as intervening variables that affect overall institutional effectiveness. In the 20th century, legitimacy and accountability was a problem of national governments. In the 21st century, with its emerging trends of governance beyond the state along with new needs of earth system governance, accountability and legitimacy appear in a different context.

There are two broad types of research needs: First, a theoretical one. In purely intergovernmental norm-setting processes, legitimacy derives indirectly through the accountability of governments to their voters. Likewise, international bureaucracies can derive legitimacy through their principals, the governments, which are accountable to their voters. However, such long lines of accountability have been questioned in recent years.[18] Many authors see a solution in the participation of private actors in global governance. David Held, for example, recognizes ''new' voices of an emergent 'transnational civil society' ... in the early stages of development ... [that] point in the direction of establishing new modes of holding transnational power systems to account, that is, they help open up the possibility of a cosmopolitan democracy' (HELD 1999, 108).

Problematic is, however, the accountability and legitimacy of private actors themselves.[19] In the domestic context, private organizations may derive legitimacy through their members or donors, or from the environmental good they seek to protect. In the international context, however, with its high disparities in wealth and power, accountability and legitimacy of private actors is more complicated. Most philanthropic organizations are headquartered in industrialized countries, and most funds donated to their cause stem from the North, both public and private. Disparities in representation exist also within countries. Few citizens have the means to donate time and money to philanthropic organizations. Given the financial requirements of participation, more rights and responsibilities for non-state actors in earth system governance could also privilege representatives of industry and business at the cost of other groups.

18 On the democratic deficit of inter- and transnational politics and on attempts to conceptualize democratic governance on the transnational level see, for instance, Archibugi and Held 1995; Archibugi et al. 1998; Bodansky 2007; Commission on Global Governance 1995; Dingwerth 2005; Dryzek 1999; Held 1995, 1997; Scholte 2002; South Centre 1996.

19 The following text builds on Biermann 2008, 294-296.

This leads to a second, practical challenge: Because of these disparities, researchers need to design, and practitioners to develop, institutions that guarantee participation of civil society in earth system governance through mechanisms that vouchsafe a balance of opinions and perspectives. For example, networks of transnational private actors can seek to balance views and interests through self-regulation, including financial support for representatives from developing countries. This is done for instance through North-South quotas in meetings and alliances of non-state activists within the UN Commission on Sustainable Development, or in the Intergovernmental Panel on Climate Change. Another option to increase legitimacy and accountability of earth system governance by strengthening private participation in a balanced way could be a 'quasi-corporatist' institutionalization (SPIRO 1994). For example, the representation of labour unions and employers associations in the International Labour Organization (ILO) has been discussed as a model for achieving a balance in participation of private actors from North and South in order to make earth system governance more representative and legitimate. In the ILO, each state is represented with four votes, two of which are assigned to governments and one each to business associations and labour unions. Concerning more far-reaching proposals, the Commission on Global Governance (1995, 258) for instance has proposed an international Forum of Civil Society within the United Nations, which would comprise of 300-600 'organs of global civil society' to be self-selected from civil society. Some far-reaching proposals even envisage a global parliamentarian assembly, which would bring together parliamentarians from all over the world (COMMISSION ON GLOBAL GOVERNANCE 1995, 257).

The Earth System Governance Project does not seek to propose or to reject one of these policy proposals regarding the institutionalization of accountability and legitimacy in novel types of earth system governance. Yet it emphasizes the general relevance of further research in this area, both on the theoretical foundations and the practical implications of different mechanisms for addressing accountability and legitimacy in earth system governance.

RESEARCH QUESTIONS

The problem of accountability comes down to four specific research questions:

What are the sources of accountability and legitimacy in earth system governance?

First, it is important to better identify the sources of accountability and legitimacy in earth system governance. While the accountability and legitimacy

of state actors remains of vital importance, there is a special need to study the accountability and legitimacy of new and emerging systems of governance that function without state actors, or in which state actors play only a marginal role (KINGSBURY 2007, MASON 2008).

Both legitimacy and authority are difficult to define, and the Earth System Governance Project does not seek to promote one exclusive definition. Core elements of the concept of legitimacy are the acceptance and justification of authority (SEE HERE ALSO CHAPTER 4). Acceptance relates to the way in which rules or institutions are accepted by a community as being authoritative. Justification relates to the reasons that justify the authority of certain rules or institutions (BERNSTEIN 2005).

Klaus Dingwerth (2007), for example, has distinguished three dimensions of democratic legitimacy beyond the state, which he described as participation and inclusiveness, democratic control, and discursive quality. The core standard underlying participation is to what extent those who are subject to a decision have been included in decision-making. Democratic control entails that those who are governed should be able to control those who govern them. Discursive quality of decision-making is related to participation and inclusiveness, as it demands that there are no barriers that exclude groups from decision-making and deliberations. Deliberations should not be limited to elite negotiations and provide room to include critical opinions (DINGWERTH 2007, 27-29).

These standards of participation, democratic control and deliberation are not the only ones possible, but examples of how legitimacy can be analyzed. It will be important to further continue this research, taking into account the interlinkages with other analytical problems of earth system governance and experiences in the flagship activities that are outlined in chapter 11. Accountability and legitimacy are also core themes to be studied under the analytical problem of agency (SEE CHAPTER 4).

What is the effect of different forms and degrees of accountability and legitimacy for the performance of governance systems?

Accountability and legitimacy are important factors that influence the eventual performance of mechanisms of earth system governance. In general, institutions and governance can be expected to be more effective when their rules and representatives are perceived as accountable and legitimate. However, institutions and governance mechanisms—in particular in the realm of private and public-private cooperation—have established different types of accountability systems and different forms of legitimacy, as outlined above. It is important to understand how these relate to different degrees and types of

performance of governance mechanisms. Equally important is to understand potential trade-offs between requirements of (environmental) effectiveness and high standards of accountability and legitimacy.

How can mechanisms of transparency ensure accountable and legitimate earth system governance?

Transparency has been emphasized as one mechanism to secure accountability and legitimacy of earth system governance. Yet the exact role and relevance of transparency is still insufficiently understood and requires further research (FLORINI 2007, FUNG, GRAHAM AND WEIL 2007, A. GUPTA 2008). Does it matter, for example, whether transparency is voluntary or mandatory, whether it hinges on information disclosure by states, private actors or from international organizations, or what kind of information is disclosed? Analyzing the promise and the perils of what could be termed a 'transparency turn' in global governance can thus contribute to both the theoretical and practical dimensions of the quest for a more democratic earth system governance.

What institutional designs can produce the accountability and legitimacy of earth system governance in a way that guarantees balances of interests and perspectives?

Earth system governance must eventually involve actors at all levels of decision-making, and in all countries. Thus, systems of earth system governance must generate this legitimacy for a large variety of actors, from the local level to the global level. Globally, legitimacy is particularly a problem with a view to the North-South divide: Both North and South, rich and poor, must accept the rules and regulations of the current and future systems of earth system governance as legitimate, and see their representatives as accountable. However, what kind of systems can generate this type of balance of interests and perspectives that ensures a high degree of global, comprehensive legitimacy? This—eventually normative, policy-oriented—question will likely remain on the agenda of the earth system governance research programme for quite some time.

BOX 4: THE PROBLEM OF ACCOUNTABILITY—RESEARCH QUESTIONS

- What are the sources of accountability and legitimacy in earth system governance?
- What is the effect of different forms and degrees of accountability and legitimacy for the performance of governance systems?
- How can mechanisms of transparency ensure accountable and legitimate earth system governance?
- What institutional designs can produce the accountability and legitimacy of earth system governance in a way that guarantees balances of interests and perspectives?

7

THE PROBLEM OF ALLOCATION AND ACCESS

Who gets what, when, where and how is a key question of politics (LASSWELL 1936). Different disciplines refer to this challenge differently: lawyers speak of equity, economists of distribution, resource analysts of access, political scientists of fairness and sociologists of social justice. The Earth System Governance Project conceptualizes these issues as the analytical problem of allocation and access. This problem is a key concern of earth system governance. For example, more than a billion people do not have access to drinking water and sanitation facilities, and two billion to proper energy services. The most vulnerable to earth system transformation will be those who live in the marginalized lands and coastal zones of the developing world.

In a socially just society, the distribution of benefits, burdens and involuntary risks is perceived as fair by all of its members and any non-members affected by those allocations. Each person has equal opportunities for education, health or employment. Differences, whether due to gender, wealth, age, sexual preferences, ethnicity or religion are not a basis for discrimination, but tolerated and often celebrated. The institutions and procedures which shape what is to be divided and how, and the perceptions of weaker groups, is not dominated by any individual or group. There is no such place on Earth. So the pursuit of fair allocation and access, and the un-doing of perceived injustices, is a never-ending, but meaningful goal for many in society (BARRY 2005). Fair allocation and access is, like sustainability, something almost everyone agrees with, at least until it is carefully defined and one starts working on achieving it. The core research problem of allocation and access is ultimately a pragmatic one: how? The impacts of global change pose additional challenges, for instance in the way environmental risks are distributed across peoples and places (BANURI ET AL. 1996) or in the way that responses are favoured and supported by stronger societies (THOMAS AND TWYMAN 2005).

The analytical problem of allocation and access is difficult also because of what constitutes fair allocation and access is tangled up in details of both objectives and means to achieve them; these vary widely, reflecting beliefs about how the world is, or should be, as well as being path determined. A research programme tackling these issues will therefore need to be open-minded, critical and pragmatic (RORTY 1992, BLOMLEY 2007). Likewise, the problem of measurement (broadly construed) of social justice will need to be taken seriously. Related ideas of fairness, equality of opportunity, tolerance of difference, reciprocity and cooperation, freedom to choose and happiness or well-being may be helpful (BARRY 2005, ELSTER 2006). But innovation is also needed. There is some limited research to date on international environmental regimes emphasizing justice at the level of nation states. Although this needs

to be strengthened in itself, it also needs to be complemented by research into allocation and access issues within states. A multi-level approach is needed in which individuals are not rendered invisible.

Research on allocation and access will have to tackle moral and ethical issues, resisting temptations of instrumentalism. But it will also have to tangle with issues of cultural imperialism and be sensitive to the contexts in which injustice and justice are framed (RORTY 1992, ELSTER 2006). Social justice is a discourse that may even stand in the way of its own pursuit. Research on allocation and access will also need to address long-term institutionalizing. It is here that social justice may need reframing from proximate analyses that allocation can easily become trapped into not forgetting the shaping contexts that empower and disenfranchise from the start (RAWLS 1997, DRYZEK 2000, YOUNG 2001). Finally, the positive side should not be forgotten: opportunities, freedoms and so on. Much allocation and access writings and actions are inspired by gross injustice; it would be even more inspiring if we could reframe at least part of the response to global environmental change into a positive tool in pursuit—as a way to address histories of unfairness by creating new options.

The Earth System Governance Project defines access as meeting the basic needs of humans to live a life of dignity (CHOWDHURY ET AL. 1992). Access is dealt with in legal literature in terms of human rights, freedom of information and access to adjudication and in economic literature in terms of human needs and subsidies. Mechanisms of access provide some minimum amount of resources to all humans commensurate with the climatic and cultural conditions that operate in specific contexts. Problems of access differ from issue to issue. In water, this might mean guaranteeing a right to a minimum amount of water per individual to ensure a dignified life (SMETS 2000, MCCAFFREY 1992). In climate change, it could be interpreted in terms of the 'luxury versus necessity' emissions (AGARWAL AND NARAIN 1991), or in terms of a minimum right to energy—both of which are not very dominant in global discourses.

The Earth System Governance Project defines allocation in terms of allocating benefits, responsibilities, and involuntary risks between countries and actors. As opposed to economic theory, where allocation is broadly understood as allocation of input factors for production processes, the more general, interdisciplinary notion of allocation advanced here refers to the allocation of resources and rights among individuals and groups within societies and between societies. In the language of economics, this understanding of allocation refers to the distribution rather than to the efficiency problem.

Mechanisms of allocation must deal with three dimensions of the problem.

1. Outcomes.

The first dimension, which is the most frequently analyzed, focuses on the outcome of divisions. For example, in climate governance the key allocation problem focuses on how to share responsibilities regarding the reduction of emissions and how to compensate countries and actors for the involuntary risks they take (RAJAMANI 2000, BATRUCH 1988-89, WEISSLITZ 2002). Allocation in energy governance is also central (ROSE AND KVERNDOKK 2004), especially as the debate on bio-fuels has major impacts on food production, prices and access. In water governance, the problem of allocation includes the sharing of water in accordance with the principles developed within the UN Convention on the Law of the Non-Navigable Uses of International Watercourses 1997 (SEE ALSO FUENTES 1999, BENVENISTI 2003).

2. Pathways.

The second dimension examines the pathways or governance processes through which allocation is reached. For example, state-led governance tends to use regulatory tools to achieve its goals. Principles of allocating water have been developed within the UN Watercourses Convention, representing state practice. Yet such principles do not exist, for instance, in the Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on Biological Diversity or the climate agreements. Instead, these three regimes focus more on funding through contributions to multilateral funds. Increasingly, market mechanisms are adopted at national and international levels, for example in the flexibility mechanisms in the climate agreements (GUPTA ET AL. 2007, BIERMANN 2008) or policies to invite private sector participation in water services (GLEICK ET AL. 2003). Market-led governance tends to use pricing, advertising, lobbying and advocacy mechanisms to allocate responsibilities. Court-led governance at national and international level leads to reallocation of resources especially within common law countries. Such governance may be in the form of the more public judgements of the national courts and the International Court of Justice or in the form of confidential judgements of the investment law arbitration courts (TIENHAARA 2006). Finally, public resistance, protest and lobbying can be an important part of the emergence of different allocation and access mechanisms (YOUNG 2001).

3. Reallocation.

The third dimension is reallocation. Reallocation is the only way to deal with initial allocations that no longer meet current ecological limits or social norms. Some reallocation has followed, for instance, regulatory changes in water laws in South Africa or Brazil, or through court decisions and through

pricing previously non-priced commodities (BOND 2004). Reallocation challenges the notion of property rights, for example in the area of water, land and forestry governance, where ownership rights go back centuries and hence may be contested in courts or on the streets. Reallocation of benefits, burdens and risks can come about without explicit deliberation, contests or politics. For example, construction of physical infrastructure to divert water between different basins or protect a part of town from flooding can occur as part of a development discourse which completely ignores allocation questions related to, for instance, impacts on fisheries or residents of informal settlements (LEBEL, ANDERIES ET AL. 2006, LEBEL AND SINH 2007). Indeed, because of political sensitivities, 'reallocations' are usually veiled. Thus, research on earth system governance also needs to address the ways in which reallocation has been attempted, the success of different approaches, and the factors that are important in these processes.

RESEARCH QUESTIONS

The Earth System Governance Project proposes, under the analytical problem of allocation and access, four sets of questions:

How can we reach interdisciplinary conceptualizations and definitions of allocation and access?

First, given the breadth of debates on allocation and access, it seems important—as for other analytical problems—to improve interdisciplinary understandings of allocation and access. So far, allocation and access are defined in different disciplines differently. Is there a way to unify these different definitions? Can the concept of allocation and access form a bridge between different social science disciplines, ranging from law and economics to political geography, sociology and international relations? For example, lawyers deal with water access using notions of human rights, and economists using pricing and markets (GUPTA 2004). Related to this is the question of how the concept of allocation and access can be operationalized for the governance of large-scale environmental changes with uncertain, heterogeneous and partly delayed social implications. How can success in achieving fair allocation and access be measured?

What is the relevance of questions of allocation and access to earth system governance?

Second, it appears important to increase understanding of the influence of allocation and access on processes of earth system governance, as well as

to advance understanding of how earth system governance, and processes of earth system transformation, affect allocation and access. For example, to what extent is poor access and unequal allocation at local or global levels a cause of increased vulnerability to global environmental change, and to what extent is such poor access and unequal allocation a cause of global environmental change? Important here is also the analysis of differences. Which differences—gender, class, ethnicity, age, disability, religion, race or nationality—are most relevant to the increased and new vulnerabilities created by global environmental change? How can they be addressed? Who should be empowered and who held responsible for addressing them? How can vulnerable communities be empowered in different contexts to protect themselves?

What (overarching) principles underlie allocation and access?

Third, it seems important to advance understanding to what extent principles of allocation and access are similar across issue areas, and to what extent successful principles can be adapted from one issue area to another. What contextual factors enhance the strengths and reduce the weaknesses of principles of allocation and access, and under what circumstances can instruments that provide for fair allocation and access be scaled up and down?

How can allocation and access be reconciled with governance effectiveness?

Finally, it is important to analyze the implications of current and alternative initiatives to improve allocation and access within earth system governance. How can these be redirected to the pursuit of fair allocation and access without reducing their effectiveness in addressing environmental consequences and drivers of global change?

BOX 5: THE PROBLEM OF ALLOCATION AND ACCESS—RESEARCH QUESTIONS

- How can we reach interdisciplinary conceptualizations and definitions of allocation and access?
- What is the relevance of questions of allocation and access to earth system governance?
- What (overarching) principles underlie allocation and access?
- How can allocation and access be reconciled with governance effectiveness?

8

INTERLINKAGES AMONG THE ANALYTICAL PROBLEMS

The five analytical problems outlined in the previous chapters depend on each other. For instance, the problems of architecture and agency are linked through questions of how institutions and other governance mechanisms emerge, change or, conversely, are able to remain static for long periods. The stickiness of institutions is expected to be, in part, a property of their design, and in part, the possibilities for, and constraints on, agency. Also, the links between the problems of architecture and allocation are a recurrent theme in earth system governance. Questions about equity, justice and fairness remain at the core of much of the political debate over the design and implementation of large-scale environmental and development institutions. As another example, the problems of architecture and accountability are linked because the multilevel characteristics of earth system governance extend beyond the central government but also require local responses.

Similarly, the analytical problems of agency and architecture in earth system governance are related as part of the broader agent-structure debate in the social sciences. Agents shape, and are shaped by, the broader architecture of earth system governance. The question of agency also raises questions about accountability, particularly as more and more non-state actors emerge as central agents of earth system governance. Likewise, the study of agency raises a number of questions regarding allocation and access: for example, the fact that not all actors are able to exercise agency begs the question of who becomes an agent of earth system governance. How does access to resources shape agency?

As another example, the analytical problem of allocation and access is closely related to the other four problems: Questions of allocation and access can only be resolved if integrated into the larger architecture of earth system governance. Allocation and access are related to agency, for instance since disadvantaged communities are often not empowered to participate in decision-making as fully effective agents. Allocation and access is also linked to accountability and legitimacy, since systems of accountability often do not take into account the needs of marginalized communities.

Likewise, the problem of adaptiveness has important links to those of allocation (risk management) and agency (by whom?). The significance of the politics of adaptiveness is largely in how it allocates risks and benefits from earth system transformation and societal responses to it. The allocation of burdens to act upon also raises questions about capabilities, motivations, and influence. Agency in the governing mechanisms of adaptiveness is poorly understood. Finally, at the intersection of the problems of allocation and accountability (monitoring and sanctions) lie issues critical to performance. If outcomes in terms of social-ecological sustainability and human wellbeing are not achieved, authorities need to be held accountable. It requires further analysis, in the specific context of addressing earth system challenges, through what regular procedures and other more ad hoc social processes this happens.

At this stage, it appears difficult to conclusively prioritize the multitude of possible interactions in terms of relevance. Instead, the Earth System Governance Project rather views this prioritization as a key research challenge in the implementation of this Science Plan.

9

CROSSCUTTING THEMES: POWER, KNOWLEDGE, NORMS, AND SCALE

The five analytical problems are the basis of the Earth System Governance Project. They all share a number of crosscutting themes, that is, core concerns of the social sciences that are of fundamental relevance for the analysis of each analytical problem. Four crosscutting themes have been selected, in consultation with colleagues and reviewers, for closer examination within the Earth System Governance Project: these are power, knowledge, norms, and scale.

POWER

First, in the exploration of each analytical problem, participants in the Earth System Governance Project will have to deal with the role of power. As ubiquitously as the term power is used, as difficult it is to conceptualize it, and despite its centrality, how power is conceived in studies of governance and institutions is often left undiscussed (BARNETT AND DUVALL 2005, LEBEL 2006A). What is the nature of power, for example, in multilevel and network arrangements of earth system governance? Where does it lie? What are its sources? How is it exercised in earth system governance?

Drawing on Max Weber, power is conventionally defined as getting others to do one's bidding against their own interests and even resistance. But it can be exercised or expressed in many ways, and that is where complexity and nuances enter. There is power *to* and power *over.* Power is about the capacity to take away or to grant freedoms, and thus, temper the control others have over their own fate. This does not mean that actors have to meet physically. Power may involve manipulating circumstances for others (LUKES 1974). Drawing on Albert Hirschman (1945), asymmetrical interdependence is sometimes used to describe sources of power: if you are more dependent on someone than they are on you, you are less powerful. Perceptions about relative power, however, may be inaccurate. Moreover, much about power is about gaining the right to speak on behalf of others, which may require strategies of the powerful that underplay power. The higher and more subtle dimensions of power can lead to deceptively peaceful settings in which consent has been manufactured and dissent vaporized. The way power is exercised in earth system governance is also highly context-specific. Power might be assumed and confirmed in one setting, but be completely rejected by another social system which cannot read it. The respected village elder coming down from the mountains is assumed to be a street-cleaner or beggar on the plains.

Power needs to be distinguished from other, often closely related concepts. Important among these are authority and influence. Influence and power are often conflated although they have different roots and are used constructively together. Influence can be defined as 'the socially induced modification of a belief, attitude or expectation effected without recourse to sanctions' (WILLER ET AL. 1997). Influence can lead to power, and power to influence. Legitimacy

and power are interrelated too, and this is where this crosscutting theme intertwines in particular with the analytical problem of agency (SEE CHAPTER 4), which relates to authority, and the analytical problem of accountability and legitimacy (SEE CHAPTER 6). The source and degree of legitimacy as the recognized right to hold and use power is an important focus for exploring merits and limitations of different forms of governance. Legitimacy is about moral claims. Authority's hallmark, according to Arendt (1970), is 'unquestioning recognition by those asked to obey'. Because of the central role of accountability and legitimacy in all governance systems, the Earth System Governance Project conceptualizes legitimacy and accountability as a separate analytical problem (SEE CHAPTER 6).

Finally, language itself, may be a way of not just defining but also producing and exercising power (FOUCAULT 1982, LATOUR 2000). Knowledge—the second crosscutting theme identified in the next section—and power are inextricably linked. The making of governable subjects by authorities, often through various technologies and knowledge production and controlling procedures, is also an important way in which power is expressed (FERGUSON 1994, FOUCAULT 1991, SCOTT 1998). By making the activities of individuals more legible to states they are also more controllable.

Given the broadness and duration of the Earth System Governance Project, no exclusive definition of concepts as broad as power is advisable. One approach to defining this concept could be, drawing on Lukes' (1974) definition, to see power in earth system governance as the capacity to prevail over others with conflicting interests in contests and decision-making, to change the agenda or rules of the game by which winners and losers are decided, and to shape or re-define the context in which actors are engaged (even, what game is to be played, if at all). Other definitions or approximations are equally possible, and this Science Plan does not attempt to foreclose future debates in earth system governance research on a concept as central as power.

The role of power is key in understanding all five analytical problems of the Earth System Governance Project.

For example, power is central in analyzing the emergence, maintenance and influence of the overall governance architecture at local, national, and global levels. By large measure, one could define a governance architecture as codified power relationships and power conflicts. The role of power is thus obviously a key concern when analyzing architectures. Agency, too, is intricately linked to questions of power. Not all actors are agents; agents have power relative to other actors in earth system governance, and there are differences in power between agents. To better understand the dynamic interactions between actors and agents as well as between agents, it would be helpful to look at questions about the sources of authority and power in earth system governance. How important are material sources of power? What is the significance of knowledge as a source of authority?

Power is important also when it comes to adaptiveness of governance mechanisms. Most writings treat adaptation with a glow of collective action for the benefit of all. But such widespread assumptions of cooperation and win-win are unrealistic, given huge disparities in wealth and influence within and among countries. Attention to framing, agenda setting, for instance through financing mechanisms, should thus be particular amenable to study, and worthwhile arenas for conducting research on adaptiveness intended to elucidate power. Power might also be usefully explored through notions of bargaining power (AGARWAL 1997, 2001). Such explorations should look more explicitly at how women's agency influences adaptiveness. While reference is frequently made to the importance of leadership to transformative changes (OLSSON ET AL. 2006), the implications for governance more broadly of dominance and dependence on individuals rather than institutions, in the long-term, are rarely examined critically. Doing so may help us understand procedures that promote fairness and justice and those that do not (ELSTER 1992).

Power is also closely related with accountability and legitimacy, in particular because the normative notions of accountability and legitimacy change the character of power. Power without legitimacy is brute force; instead of the consent of the governed, it then relies purely on coercion. Power with legitimacy, however, is authority (SEE CHAPTER 4), regardless of whether private or public actors hold it. Accountability and legitimacy are thus the linchpins that define the character of power. They lend justification to the use of power.

Finally, the analytical problem of allocation and access is closely related to power in earth system governance. Power shapes which norms of allocation are selected, articulated and implemented. Important questions are here, for example, how power in earth system governance affects allocation, and whether modes of allocation differ among issue areas as power constellations also differ? Within national and sub-national levels, it is also important to study what factors can empower marginalized and vulnerable people to participate in earth system governance.

KNOWLEDGE

Second, in studying each of the five analytical problems of the Earth System Governance Project, the role of knowledge will be important. Knowledge is relevant, first, in the form of scientific information that plays a major role in most processes of earth system governance. Research on earth system governance is thus inevitably also research on the role that science plays in these processes, and eventually must be reflexive, in allowing for improved understanding on the underlying theories, methods, and assumptions of earth system governance research. The boundary between research-based knowledge and decision-making is not hard and fixed, but rather semi-permeable,

moveable and negotiated (JASANOFF 2003, JASANOFF AND WYNNE 1998). Earth system governance thus requires a reflexive and carefully designed approach to organize and utilize some boundary functions, like mediation or translation, for example through creating specific boundary organizations (CASH ET AL. 2003, GUSTON 2001). Some research suggests that boundary organizations do best when they are dually accountable to both the research and policy communities. In some situations, the two community views may not be very accurate: there are policy savvy and connected researchers, scientifically literate policy makers or well-informed stakeholder groups (VAN KERKHOFF AND LEBEL 2006). Science is not free from politics nor politics from science (MITCHELL 2002B). Competing knowledge claims may be sorted out through joint fact-finding, assessment or validation exercises (CASH 2000, MITCHELL ET AL. 2006, KARL, SUSSKIND AND WALLACE 2007). These issues have been analyzed recently also with explicit reference to the concept of earth system governance (VAN DE KERKHOF ET AL. 2008).

Knowledge is pertinent also in the role of scientific assessments in earth system governance. Research suggests that assessments that are perceived by all key stakeholders to be legitimate, credible and salient, are those that have the most influence (MITCHELL ET AL. 2006). Assessments that are overly driven by science easily become trapped by their framing of issues, for example, into what is easily measured (RAYNER 2003). Tacit, practice-based, experiential and research-based knowledge may be complementary and usefully hybridized (FORSYTH 1998 AND 2003), but they can also be pitted against each other and against other systems of belief.

The relevance of knowledge cuts through all five analytical problems of the Earth System Governance Project.

For one, different governance architectures produce different kinds of knowledge, regarding the type of knowledge (technical, scientific, political), its content and the processes for the generation of new knowledge. Scientific knowledge or political discourses also influence the emergence of governance architectures, and the very discourse on architectures at the global level is a reflection of the overall global governance discourse. The relationship of knowledge and agency is also important. How important is access to information for the exercise of agency? What is the difference between scientific and indigenous knowledge in this context? Do actors and agents process information or develop or access knowledge differently? Do epistemic communities have agency? If so, how is their agency constituted?

Knowledge is central also in the area of adaptiveness. Adaptation research and policy illustrates some of the challenges of the politics of knowledge. Research agendas on adaptation have privileged certain issues and levels of analysis without much debate about the consequences for how policy responses are framed (JASANOFF 2003). The study of adaptiveness will need to

pay careful attention to the intersection of power and knowledge and how this shapes the way earth system challenges are framed and potential policy response agendas set.

Knowledge also informs accountability and legitimacy. Likewise, knowledge generation, synthesis and dissemination requires its own mechanisms and processes for accountability and legitimacy. This is particular the case with environmental or sustainability assessments (MITCHELL ET AL. 2006). The study of these assessments has shown that their salience and credibility, and overall their influence on processes of earth system governance, depended greatly upon the overall perceptions of accountability and legitimacy that the assessment could generate. This has led to significant changes in assessment systems in the past, for example in the case of the Intergovernmental Panel on Climate Change, which first suffered a substantial lack of legitimacy from the perspective of the developing countries (BIERMANN 2002, SIEBENHÜNER 2002A AND B).

Finally, knowledge is a crosscutting theme in understanding allocation and access in earth system governance. For example, knowledge is influenced by funding and institutional frameworks (JASANOFF 2003, RAYNER 2003, VAN KERKHOFF AND LEBEL 2006). While there is substantial funding for the natural sciences and economics, there is often less funding for social sciences and humanities in areas of earth system governance. The skewed nature of science has led some to call for 'public interest science' (SHIVA AND BANDYOPADHYAY 1986) or 'post-normal science'. Although the driving force behind the former is the need for science to focus on people and in particular the marginalized and vulnerable people, the driving force behind the latter is the need to realize that 'normal science' is unlikely to address earth system governance problems, which are likely to be characterized by urgency, a large number of stakeholders and no clear answers. At the global level, this often translates into the structural imbalance in knowledge or knowledge asymmetries (J. GUPTA 1997). At the national and sub-national level, tendencies to discount local knowledge in traditional systems of science have recently been much discredited.

Social learning and knowledge are addressed in more detail in IHDP's new Knowledge, Learning and Societal Change initiative. This crosscutting initiative has evolved over a series of IHDP expert workshops in 2007 and 2008; it will emphasize aspects of knowledge and social learning that are most relevant for the sustainability sciences and the core IHDP projects. There are numerous connections between this new initiative and the Earth System Governance Project that vouch for fruitful collaboration. Among others, knowledge is a crosscutting theme also for the Earth System Governance Project, and knowledge and social learning are core parts of the analytical problem of adaptiveness (SEE CHAPTER 5).

NORMS

Third, in exploring each analytical problem of earth system governance, researchers will have to deal with the role of overarching norms, values, and broader ideational structures, which have become the focus of much attention in research (SEE FOR EXAMPLE MARCH AND OLSEN 1989, 1996 AND 1998, FINNEMORE 1996, BARNETT AND FINNEMORE 1999). Also in earth system governance, it will be important to increase understanding not only of singular institutions, but of 'collections of norms and the mix of rules and practices that structure (…) institutions' (FINNEMORE AND SIKKINK 1998, 891). As argued, for example, by Reus-Smit (2005, 196), ideational structures 'exert a powerful influence on social and political action', in addition to material structures. Or, as Conca (2006, 26) writes, 'regimes are built within the context of an overarching structure of values'.

Norms are relevant at all levels of decision-making in earth system governance. Norms, values and principles pervade political processes at the national and local level, and hence all research in earth system governance must be placed in the context of local circumstances and local belief-systems. Likewise, overarching norms and principles will be of special relevance at the international level. Here, for example, it will be crucial to study the role and relevance of overarching norms of governance, many of which are framed in legal terminology as general principles of international environmental law (BEYERLIN 2007, TOOPE 2007, MERRILS 2007). Such principles are contained, even though still often contested, in multilateral environmental agreements, conference statements, ministerial declarations, UN General Assembly resolutions, national legislations, domestic and international judicial decisions, and scholarly writings. Legal principles important for earth system governance include, for instance, Principle 21 of the 1972 Stockholm Declaration on the Human Environment. Other principles are the polluter-pays principle, as reaffirmed in Principle 16 of the 1992 Declaration on Environment and Development of Rio de Janeiro; the precautionary principle (or approach); or the principle of common but differentiated responsibility and respective capabilities as enshrined in Principle 7 of the 1992 Declaration on Environment and Development (BEYERLIN 2007).

Norms are central to the study of all five analytical problems of the Earth System Governance Project.

First, norms are part of any governance architecture, and influence at the same time the creation and shaping of governance architectures. Some research questions on architecture directly relate to the crosscutting theme of norms, for example in the focus on the analysis of overarching norms that inform specific institutions and governance mechanisms. In addition, since norms are an integral part of the overall architecture of earth system governance, this takes us back to the agency-structure dynamic. How does agency

relate to structure and how does an actor exercise agency? Norms are also important, as they may be barriers to adaptiveness. Transformative change is in part about changing norms. Competing norms in a society might inhibit adaptation. There is thus a need to study norm systems under the perspective of adaptiveness. In addition, accountability and legitimacy are based on overarching norms of earth system governance that define what is legitimate, and who is accountable. Thus, the problem of accountability and legitimacy cannot be analyzed without considering the underlying norms in the area. Finally, allocation and access in earth system governance is closely linked to norms. Equity norms have been part of resource governance for centuries (GUPTA 2004, SHELTON 2007), and different systems of norms, based on different socio-cultural traits, have influenced allocation and access. Especially in many parts of the developing world, the differing influences over the centuries have led to the co-existence of different sets of norms at different sites of governance and to legal pluralism.

SCALE

Fourth, regarding all five analytical problems, it will be important to identify whether certain findings or hypotheses apply on all scales, or are valid merely for one scale, for example only for the international or only for the local level. Likewise, researchers will have to analyze to what extent scale influences their finding. 'Scale' is defined as the spatial, temporal, quantitative, or analytical dimensions used to measure or rank any phenomenon. 'Level' is the unit of analysis located at different positions on a scale (GIBSON ET AL. 2000). Scale is not an easy concept as disciplines deal with it differently. However, the concept also has a strong unifying effect, since a focus on scale and ways of scaling produces cross-disciplinary fertilization and richer analysis (CUMMING ET AL. 2006).

Many issues related to earth system transformation are perceived as multilevel (CASH ET AL. 2006, YOUNG 1994B, DUNOFF 2007). Actors contest scales and levels by shifting issues to those at which they are most influential or powerful (LEBEL 2006B, LEBEL AND IMAMURA 2005, MEADOWCROFT 2002). Contests can be relatively direct, as in debate or argument, or through use of technologies, controlling resource access and other ways of shaping the arenas of interaction (CASH ET AL. 2006, COX 1998, LEBEL AND IMAMURA 2005). A scalar perspective is not necessarily accepted by all actors, especially where higher or larger is assumed to also endow authority (BRENNER 2001; FERGUSON AND A. GUPTA 2002). Nor is the response to multilevel drivers and impacts of environmental change necessarily best described through multilevel governance. In some situations, networks or multi-centred structures (nodal or polycentric governance) may better describe the social relations around

mobilization or coalitions and contests (BETSILL AND BULKELEY 2004, HAJER AND WAGENAAR 2003, SHEARING AND WOOD 2002). In sum, the analysis of scale, as a crosscutting theme, is an important element in the study of earth system governance.

Scale is a central factor in studying all five analytical problems.

For one, scale and architecture are closely related. Scale and level determine the frame within which architectures are designed, contested and evaluated. Scaling processes change the operation of policy measures and instruments and may render them less effective (GUPTA AND HUITEMA FORTHCOMING). A core question thus is how problems are framed in terms of scale and level and what implications this has for the scale and level at which architectures are developed. Likewise, it is important to understand whether there can be consistent architectural frameworks if policies cannot be easily scaled up and down administrative levels. The principle of subsidiarity, evoked in many different policy contexts and political systems, is a key element in the debate on the relationship between scale and architecture.

Scale is also important in the study of agency (CASH ET AL. 2006, BULKELEY 2005). The institutional scale helps demonstrate how agency plays out differently at different levels of governance. The politics of moving issue domains up and down the institutional scale is driven by considerations of agency, power and architecture. A question in this context is how agency is reconfigured when scaling up or down, and how actors may gain or lose agency when an issue is scaled up from local to national level, for example. The temporal scale helps to focus on how agency may change over time. How does an actor become an agent? What is the role of focusing events in creating agency, and how does a focusing event create or increase an actor's agency? If agency changes over time, what are the drivers of those changes? For example, does it make a difference to the emergence of agency whether a policy issue is short or long-lived? Do different actors require different amounts of time to develop their agency, if in fact agency is strongly determined by context? The spatial scale may also be important in determining agency. What is the impact on agency whether an environmental problem is local, regional or global in scale or whether a problem is cumulative or systemic?

Scales and levels of analysis are also important to the study of adaptiveness. Adaptive change at one level may be destabilizing at another, with cross-level interactions providing both constraints and sources of innovation (GUNDERSON 2000, GUNDERSON AND HOLLING 2002). Cross-scale interactions among institutions including multiple levels of governance (YOUNG 2002, OBERTHÜR AND GEHRING 2006) and through other mechanisms (MANIATES 2003, CONCA 2006) are likely to be important sources and constraints on adaptive capacities at different levels (ADGER ET AL. 2005). Politics of scale operate in how different groups argue causes, consequences and policy responses (LEBEL 2006B, LEBEL, GARDEN AND IMAMURA 2005, MEADOW-

CROFT 2002, SWYNGEDOUW 1997, YOUNG 1994B). Part of the politics of scale is also challenging conventional views of administrative hierarchy and group membership as implied, for example, in the notions of encompassment and verticality (FERGURSON AND A. GUPTA 2002).

Scale is relevant for the study of accountability and legitimacy, too. In traditional governmental systems, clear notions of accountability often defined legitimacy. As we move to multiple sites of earth system governance, accountability and legitimacy have to be re-defined to take into account these different circumstances. At the same time, problem boundaries often define the issues that need to be taken into account to determine what factors determine legitimacy. For example, if legitimacy is determined, among other things, by participatory processes, then defining problems at specific levels or scales determines who may be considered a stakeholder in the problem. Scale clearly also has a strong North-South dimension as issues are defined at levels to escape accountability or gain access to resources elsewhere (J. GUPTA 2008). Similarly, if the sites of governance shift, the questions of accountability shift—for instance, if non-governmental organizations make policy such as in the Forest Stewardship Council, to whom are they then accountable?

Finally, scale relates to the analytical problem of allocation and access. By defining problems in terms of specific scales and levels, actors shape allocation and access. For example, when green-house gas emissions are framed as a global problem and their impacts as a local problem, this implies separating emissions from impacts (J. GUPTA 1997) and limits for example debates on compensation. Similarly, scaling up of solutions may affect allocation and access. Scaling down in light of the concept of subsidiarity may give local communities better control over policies affected them. However, this may not be always easy as studies of the European Union show (BENSON AND JORDAN 2008). For example, market-based, large-scale solutions in water supply can limit access of poorer people to water because of lack of purchasing power.

10

METHODS OF ANALYSIS IN EARTH SYSTEM GOVERNANCE

A long-term research programme on earth system governance also requires a focus on methodological innovation to address its unique challenges. Researchers must confront dynamic social and ecological processes occurring at multiple spatial, political and temporal scales. The causal arrows and interactions between variables are often quite complex. Researchers must confront nonlinearities and the possibility of thresholds and abrupt change.

The institutional research programme of IDGEC was firmly grounded in methods and theories of social science and largely employed qualitative social science methodology, in addition to developing databases and recent efforts at deepening methodological knowledge (YOUNG ET AL. 2006). Also many participants in the Earth System Governance Project will need to use existent theoretical frameworks, research designs and methodologies from the social sciences to tackle the research questions laid out in the previous chapters. Case studies will continue to provide an important foundation. However, researchers may also need to extend case selection and consider comparative designs—including quantitative analysis—to ensure that such studies yield fruitful and generalizable lessons that can inform the study and practice of earth system governance.

In addition, the Earth System Governance Project is designed to expand the more traditional social science approaches in two directions. First, intrinsic developments within the social sciences and the increasing integration of social sciences in the Earth System Science Partnership require a renewed focus on the possibilities and problems of integrating social and natural science research into computer-based modelling or scenario-building projects. Research on earth system governance will need to be an interdisciplinary effort that links all relevant social sciences, but draws on findings from natural science as well. Several programmes in this direction are underway, including in the fields of qualitative modelling, agent-based modelling, game theory or scenario development. It seems crucial to further explore the analytical value of these approaches and to potentially integrate these initiatives into a larger research programme on earth system governance. Particular challenges include the need for better data collection and integration and improved operational measures of key variables. In addition, the study of earth system governance would benefit from improved tools for analyzing complex causalities, capturing the dynamics of complex systems, and accounting for thresholds and abrupt change.

Yet it seems also important for social scientists within the Earth System Science Partnership to reemphasize the 'social' aspects of global change research, that is, the social construction of knowledge, the cultural and temporal embedding of the researcher, and the reflexivity of social knowledge. This is especially important regarding the normative uncertainty prevailing

in earth system governance. We do not know what governance systems and governance outcomes future generations want. Important advances have been achieved in the field of the participatory appraisal of research and policies (HISSCHEMÖLLER ET AL. 2001, SIEBENHÜNER 2004, VAN DE KERKHOF 2006), which have not yet, however, been systematically integrated into global change research.

In each of the discussions below, this Science Plan offers examples of how different methodological techniques might be used in the study of earth system governance, and highlights areas where new tools and approaches might be developed. These examples are meant to be illustrative and should not be interpreted as prescribing which tools and approaches should be used for investigating a particular analytical problem or research question. Ideally, researchers will employ what Young et al. (2006) refer to as a 'portfolio approach,' where methodological choices are determined by the question at hand and the research objective. It is important that researchers consider the unique advantages of different techniques in the context of a particular project or set of questions. In some cases, it may be appropriate to combine several methods and approaches in a single research project. Other scholars may attempt to replicate findings in one study using a different set of methodological tools. In sum, we encourage scholars of earth system governance to embrace methodological heterogeneity and to make informed choices about the use of particular techniques.

SOCIAL SCIENCE METHODS

Case studies

Case studies involving detailed examinations of specific governance arrangements, resource systems or events are likely to play a central role in the study of earth system governance. Throughout the social sciences, case studies are used for a variety of purposes—providing detailed descriptions of an individual phenomenon; developing explanations for social outcomes that can be generalized beyond the initial case; and testing the applicability of general explanations in a specific case (GEORGE AND BENNETT 2005, YIN 2003). Case studies can be particularly useful for situating the object of study in its social, cultural, historical or ecological context and illuminating the causal processes that generate specific outcomes. Researchers can draw on a number of different techniques, such as natural experiments, tests of rival hypotheses, process tracing and counterfactual analysis to strengthen insights derived from single case studies (FEARON 1991, GEORGE AND MCKEOWN 1985).

There already exists a substantial body of case studies on individual institutions and agents in the area of environmental governance. Much of this work was done within the IDGEC project and has enhanced our knowledge about who participates in earth system governance and the effectiveness of international environmental regimes. Scholars of earth system governance could begin by revisiting some of the existing cases and focusing on new aspects, such as how the performance of institutions is affected by their embeddedness in larger architectures (SEE CHAPTER 3 ABOVE), the relationship between agency and accountability (SEE CHAPTER 4), and whether deliberative processes enhance adaptiveness (CHAPTER 5). It is important, however, to extend the case selection in several respects. Scholars need to move beyond the 'success stories' and investigate instances of governance failures and nongovernance (DIMITROV ET AL. 2007, MITCHELL AND BERNAUER 1998; SEE ALSO CHAPTER 3 ON ARCHITECTURE ABOVE). In addition, we need a better understanding of the consequences of non-environmental institutions for socio-ecological systems (in terms of both environmental consequences and implications for equity and social justice). Finally, case studies should be developed with a more conscious awareness of their spatial and temporal scale.

Comparative case studies

There is substantial scope for addressing the research questions advanced in this Science Plan through comparative studies of earth system governance arrangements and processes. For example, these comparisons could focus on similar environmental-resource problems, like basin-level transboundary integrated water resources management, or a particular institutional feature such as collaborative decision-making, across a wider range of resource contexts. Comparative studies should address different levels of governance such as local communities, regional networks, domestic policy-making, supranational organizations and international agreements. Such studies can be useful for identifying patterns and are essential to our ability to draw lessons (YOUNG ET AL. 2006). Structured, focused studies which adopt case-control designs that compare various features associated with success and failure allow researchers to address questions of effectiveness, be it related to a particular governance architecture, type of agent, or the achievement of adaptiveness, equity and accountability in earth system governance (GEORGE AND BENNETT 2005, MAHONEY AND GOERTZ 2004).

Comparative case research designs can also be used to study changes over time and evaluate the effect of different interventions or events. Historical and scenario-based analysis of concurrent environmental and governance-related changes could be explored to better understand causality and other relationships in specific cases as well as forming a basis for more forward-looking analyses (BENNETT ET AL. 2003, GALLOPIN ET AL. 1997, LEBEL ET AL. 2005).

For example, where the hypothesis is that adaptiveness involves change in governance, retrospective research could focus on major shifts in governance and then explore alternative explanations for why it came about and its implications for specific measures of adaptiveness. Researchers could also conduct meta-analyses of existing case studies to identify patterns and relationships between variables (YOUNG ET AL. 2006).

Statistical techniques

Comparative case studies designed to examine general trends and causal patterns can be complemented by the use of statistical techniques, which allow researchers to separate and isolate causes and effects as well as test hypotheses generated through other forms of investigation (MITCHELL 2002A, YOUNG ET AL. 2006). One of the most significant obstacles to employing such techniques is the availability of data. Therefore, to facilitate the accumulation of knowledge on earth system governance, it will be useful to develop databases and typologies focusing on types of agents and/or governance arrangements, forms of agency, measures of accountability, etc. A first step could be to identify and build on existing databases, such as those documenting public-private partnerships (ANDONOVA AND LEVY 2003, BIERMANN ET AL. 2007A AND B), non-central-state forms of climate governance (BETSILL AND BULKELEY 2008, BULKELEY AND KERN 2006, BUMPUS AND LIVERMAN 2008, OKEREKE 2007A AND B), multilateral regimes (BREITMEIER ET AL. 2006, MITCHELL 2002A, 2008), and new environmental policy instruments (JORDAN ET AL. 2003).

Discourse and content analysis

Many analytical problems of earth system governance are closely linked to the core principles underlying social institutions. Discourse analysis helps to understand the changing nature of discourses in societies and in global society, factors influencing such change, and the broader implications for earth system governance. Philosophers and jurisprudence scholars could study for example the ethical foundations of principles of allocation and access and how different schools of thought are compatible with different notions of equity. The identification of the overarching and crosscutting norms of earth system governance will require a close analysis of legal documents, both hard and soft law as well as an analysis of case law emerging from international tribunals, arbitrations and the International Court of Justice. Such analysis helps to provide a state-of-the-art assessment of principles in international law (BANURI ET AL. 1996, ANAND 2004, RAJAMANI 2002).

Legal Analysis

Legal analysis will also be of special relevance for the study of earth system governance. The analytical problem of architecture has the most direct link to law studies, for instance when it comes to the legal analysis of norm collisions, of institutional fragmentation, and of overarching norms of earth system governance. The role of non-state agency in earth system governance relates to new approaches in legal science that seek to understand the role of non-state actors in public law-making and adjudication (e.g., locus standi of non-governmental organizations), including the role of soft law. Adaptiveness is related to the study of dynamic legal systems in international and national law. Accountability, as well as allocation and access, also touch core questions of the legal sciences, and require in-depth analysis from a legal point of view.

Participatory action research

Participatory action research, in which the researcher engages in a current governance challenge, could provide useful insights on a number of questions, especially those focused on the relationship between governance mechanisms and achievement of adaptiveness, equity and accountability. Medium-term studies where research groups have been engaged in an issue for a decade or more are likely to be particularly valuable as there can be some direct observations of co-evolutionary and coincidental dynamics. Engagement in social learning, assessment and deliberative processes, for example, could be a basis for more analytical reflections (DORE 2007, LEBEL AND GARDEN 2007, LUKS AND SIEBENHÜNER 2007, SIEBENHÜNER 2004). The value of such research is partly cautionary: for example an informed 'reality check' on the limits of adaptiveness as strategy and discourse in earth system governance (MÜHLHÄUSLER AND PEACE 2006).

Social network analysis

Social network analysis is a methodological tool designed to study the relations between actors (WELLMAN 1983, EMIRBAYER AND GOODWIN 1994, SCOTT 1991, WASSERMAN AND FAUST 1997).[20] Social networks are defined by a set of actors and the ties between them. One can study the characteristics of a full network in terms of its size, inclusiveness, and centrality, or of a single node (actor) within the network. Social network analysis can be used to identify how particular agents in earth system governance obtain the consent

20 For an example relevant to the study of earth system governance, see the Comparing Climate Change Policy Networks (COMPON) project http://www.soc.umn.edu/research/COMPON/COMPON.htm.

of other actors and thus become authoritative (SEE CHAPTER 4 ON AGENCY ABOVE). It could also be useful in exploring whether particular social configurations tend to give rise to specific forms of earth system governance as well as how different governance mechanisms interact. Moreover, if we conceptualize the coupled human-natural system as a network, social network analysis can help to explore the connections between human and natural 'nodes' (JANSSEN ET AL. 2006). In other words, it may be a powerful methodological tool for linking insights from the social and physical sciences. Both social network analysis and agent-based modelling (SEE BELOW) can be combined with GIS technologies to examine the spatial dimension of human-environment interactions.

INTERDISCIPLINARY METHODS AT THE INTERFACE OF SOCIAL AND NATURAL SCIENCES

Earth system governance research needs to be interdisciplinary and to consider human as well as ecological systems. Research within individual disciplines remains important and we do not downplay the importance of disciplinary research. However, more attention must be paid to interdisciplinary research especially in the field of earth system governance, and particularly regarding collaboration between social and natural sciences. This section gives some examples of areas where social and natural sciences can cooperate and work together.

As for the analytical problem of architecture, one example for useful collaboration between natural and social sciences is the assessment of interdependencies in ecological systems and biogeochemical cycles. At present, most governance agreements build on more or less artificially decomposing system complexities for the sake of 'manageability'. Agreements are negotiated by specialized ministries, or functional organizations, in forums that are detached from the negotiation of other agreements. This often obscures the interconnectedness of the goals shared by issue-specific regimes. In many ways, the current architecture of earth system governance is thus not designed as conducive to the development of coordinated and synergistic approaches to collective problem-solving as it may be required by global interdependencies of the earth system (UNU 1999, YOUNG 2002, ESTY AND IVANOVA 2002, KANIE AND HAAS 2004, PERRSON 2004, VALKERING ET AL. 2006). More effective architectures of earth system governance may come about by better linking the study of nature with the study of governance.

Also, interdisciplinary collaboration between natural and social scientists is needed to reassess claims of feasibility of proposed solutions. From the perspective of natural scientists and engineers, it might appear at times that technologies can solve problems of earth system governance. In the eyes of

an engineer, the reduction of greenhouse gas emissions may not be difficult when solar panels are used throughout the world. Social scientists, for their part, rather point to the complexity of societies and embedded interests, while not always being familiar with technological options. Thus, improved collaboration of these two different perspectives is likely to advance (research on) earth system governance. For example, there are over forty proposals on the future institutional architecture on climate change, and many of them employ different perspectives due to the disciplines they rely on (ALDY ET AL. 2003, BODANSKY ET AL. 2004, KAMEYAMA 2004, TORVANGER ET AL. 2004, NIES AND IGES 2005, PHILIBERT 2005, HÖHNE 2006, KUIK ET AL. 2008). Some propose an architecture that is based on worldwide emissions trading in terms of economic feasibility, while others propose, from a business and technology perspective, an international technology development framework. Still others propose institutional frameworks in terms of political feasibility. All these strands of research appear to be fragmented in terms of methods and disciplines. Qualitative Comparative Analysis (QCA) provides one possible way of bringing together qualitative and quantitative approaches to analyzing causal patterns and evaluating these different proposals (RAGIN 1987). This method is particularly useful for exploring the co-production of effects.

A further tool to study the interactions between human and natural systems is agent-based modelling (AXELROD 1997, HOFFMAN ET AL. 2002, MOSSBERGER AND STOKER 2001, PARKER ET AL. 2003, PATT AND SIEBENHÜNER 2006). In agent-based models, agents interact with one another as well as with the natural environment, and their decision-making can be structured by social institutions and the biophysical world. Agents and their social context must be defined by the modellers, typically by drawing on detailed empirical work so that the context bears some resemblance to the 'real world'. This method is particularly well-suited for dealing with the uncertainties that characterize earth system governance and for exploring different models of collective decision making in the face of environmental change (JANSSEN AND OSTROM 2006). Agent-based models could be used, for example, to investigate the politics of adaptiveness in earth system governance, the attributes of earth system governance that allow for an equitable distribution of resources, or how agents exercise agency. This research area is still very young, and therefore has considerable space left for further development. Both empirical data and computer-based simulations are underdeveloped (ABSSS 2008). On the qualitative side, theories on bottom-up synergistic (cooperative) reflexive behaviour, as opposed to administratively planned top-down change, are developed in many disciplines, including sociology, political science, mathematical biology and economics (AXELROD 1997, HOFFMAN ET AL. 2002, PARKER ET AL. 2003). On the quantitative side, (evolutionary) game theory is

used in different disciplines and has potential to advance our understanding of earth system governance through cooperative research (TERANO ET AL. 2003, TERANO ET AL. 2005, DEGUCHI 2004).

For many problems of earth system governance—with their characteristics of scientific uncertainty and high risks to human society—also scenarios are used to provide policy options and perspectives for the future (BENNETT ET AL. 2003, GALLOPIN ET AL. 1997, LEBEL, THONGBAI ET AL. 2005). Models and scenarios are frequently used communication tools between policy-makers and scientists, and scenarios are also an important part of research on earth system governance. Scenarios, however, are not value free, and often value-biases are not understood outside the narrower circles of experts. Scenarios and models are traditionally developed and used by natural scientists and engineers, and to some extent by economists. However, most scenarios also deal with assumptions about societies, institutions and governance. For example, some scenarios have contradicting assumptions in their international and domestic scenarios, assuming for example more frequent global trade while at the same time also assuming closed regionalism. To avoid such contradictions and construct better scenarios, more collaboration between natural and social sciences is needed. Participatory integrated assessment and participatory technology assessment are here also major areas for increased interdisciplinary collaboration (ROTMANS AND ASSELT 2002, BEHRINGER ET AL. 2000, EEA 2001).

A systems approach is another way to facilitate coordination between natural and social sciences. Systems analyses can be used to study feedback mechanisms and emergent properties in complex human-environment systems (EASTERLING AND POLSKY 2004, YOUNG ET AL. 2006). Studies that are rigorous from a natural science perspective often lack political feasibility, while research projects that build on ethical considerations frequently fall short in the natural science aspects. Systems analyses allow for the examination of social and natural processes that occur at different scales, the interactions of these processes, and their implications for earth system governance. Geographic Information Systems technology, for example, can be particularly useful for highlighting spatial variation in social indicators and relating that variation to ecological systems and processes.

As a final example, the allocation of emissions rights in climate governance cannot be fully appraised without integrated interdisciplinary approaches. In the case of greenhouse gas emissions, we first need to evaluate the relation between an emission stabilization level, such as 450 or 500 parts per million, and temperature increase, such as 2 degrees temperature increase from pre-industrial levels. Assessing the temperature increase requires the evaluation of the impact of climate change on human societies and dangerous levels of climate change. Such information-generation is one issue that benefits from collaboration between natural and social scientists. The way in which informa-

tion is provided, and subsequently a decision on a target level is made, is also an inherent part of the problem of accountability (SEE CHAPTER 7 ABOVE).[21] A further step in allocating emissions of greenhouse gases is the calculation of a long-term global emission path to reach certain stabilization levels, for instance by a dynamic optimization model (FOR EXAMPLE EICKHOUT ET AL. 2003, HOHNE ET AL. 2004 AND HIJIOKA ET AL. 2006). Only then can global differentiation schemes be calculated. Such schemes involve the consideration of a long-term and short-term institutional framework on climate change, as well as social and political feasibility, data availability, and ethical aspects (KANIE ET AL. 2008). The most important and difficult challenge is how to translate equity considerations into numerical calculations.

21 There have been many cases of stakeholder participation in integrated assessment of climate policy. See Van de Kerkhof (2006), Gupta and van Asselt (2006), Ott et al. (2004).

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FLAGSHIP ACTIVITIES

To implement this Science Plan of the Earth System Governance Project, it seems useful to focus empirical research on a number of case study areas in which the investigation of the five A's—the analytical problems of architecture, agency, adaptiveness, accountability, and allocation and access—will stand at the centre. This will mirror the successful programme on 'flagship activities' within IDGEC and other IHDP projects, and it will at the same time be linked with joint ESSP projects to ensure the crosscutting nature of the Earth System Governance Project.

As one example, the Earth System Governance Project will collaborate with the ESSP Global Water System Project in studying the problems of architecture, agency, adaptiveness, accountability, and allocation and access with the example of local, national or global water regimes. A second flagship activity will be climate and energy policy, in cooperation with the ESSP Global Carbon Project. A third flagship activity will be the study of governance of food production and distribution, in collaboration with the Global Environmental Change and Food Systems Project, another joint project of the Earth System Science Partnership. Additional flagships activities will be explored, for example with the research programmes Land-Ocean Interactions in the Coastal Zone Project and the Global Land Project.

Crosscutting research and the engagement of other projects as flagship activities is no one-way street. On the contrary: research findings on one of the five analytical problems of the Earth System Governance Project, derived in one of the other global change projects, will be interesting also for all other global change projects dealing with similar problems. For example, research on allocation and access conducted in the areas of water governance, food governance, or global economic governance, will be specific to their particular cases, yet will also yield new general insights useful for progress in the social sciences as a whole. The Earth System Governance Project is designed as the central nodal point within the global change research programmes to guide, organize, and evaluate these various activities on governance in separate projects.

This chapter elaborates in more detail on how this Science Plan could be implemented in a number of 'flagship activities' (SEE FIGURE 1).

EARTH SYSTEM GOVERNANCE AND THE WATER SYSTEM

Introduction

First, the study of earth system governance in relation to the global water system could be developed by close collaboration with the Global Water System Project (GWSP), a joint project of the Earth System Science Partnership. The Global Water System Project (GWSP SCIENCE PLAN 2005) aims to understand how humans are changing the global water cycle, the associated biogeochemical cycles, and the biological components of the global water system, and what the social feedbacks are that arise from these changes. The Project has three sub-questions, namely about the magnitudes of anthropogenic and environmental changes in the global water system and the key mechanisms by which they are induced; about the main linkages and feedbacks in the earth system that arise from changes in the global water system; and how resilient and adaptable the global water system is to change and what sustainable water management strategies are. This third question focuses on the institutional and governance dimension. Within the institutional framework the GWSP takes a global perspective, justified by four arguments: first, the hydrological system is a global system; second, human behaviour and global environmental change is driven by forces that are often beyond the jurisdiction of local, national or regional agencies; third, many local phenomena may occur globally and have cumulative impacts at the global level; and fourth, the impacts of reduced quantities and qualities of water are likely to be global (PAHL WOSTL ET AL. 2008, CONCA 2006). An implication of the GWSP approach is the need to take a global perspective when developing policies at local or national levels. The five analytical problems of the Earth System Governance Project suggest the following sets of core questions:

Research questions: Architecture

The architecture of water governance tends to be highly fragmented across many sectors and cultures (CONCA 2006, J. GUPTA 2004, PAHL WOSTL ET AL. 2008). This is a function of historical trends and power politics that determine which issues are dealt with, where and how. Different sites of governance have different regulatory systems, resulting in legal pluralism (PALACIOS 2006, GUEVARA-GIL 2006, J. GUPTA AND LEENDERSTE 2005). Another challenge is the relationship between water governance and other fields of governance—namely in relation to issues of investment, trade and climate change that often lead to contradictory results and to North-South conflicts (CHIMNI 2003, CRASSWELL ET AL. 2007, GLEICK ET AL. 2002). This situation has led to international meetings on the architecture of water governance. Since these are not

formally under UN auspices and have no formal intergovernmental negotiating committee, they often appear to be vague and ineffective (GLEICK AND LANE 2005, VARADY AND ILES SHIH 2009). To make water manageable, different scholars tend to promote different boundaries of the architecture of water governance. Legal scholars tend to focus on the need for integrated national policies; hydrologists on the river basin approach; ecologists on ecosystem based limits; and watershed specialists on the need to focus on watersheds and on communities. Low levels of public finance in this area have led to calls for public-private partnerships, but such partnerships are not necessarily easing the problems of water management (SCHOUTEN AND SCHWARTZ 2006, DELLAPENNA AND DRAPER 2004, HALL AND LOBINA 2006). Scientists have identified a number of new principles to be applied to water governance (ILA BERLIN RULES 2004, MCCAFFREY 2001, DELLAPENNA AND J. GUPTA 2008), and integrated water management is increasingly promoted (GWP 2000). However, the adoption of these principles and their implementation are fraught with challenges. Furthermore, the need for multi-level governance approaches that effectively deal with local challenges including gender issues is of critical importance (LEBEL ET AL. 2007). This suggests the following questions relating to the architecture of water governance:

First, what are the criteria for determining the appropriate boundaries of architectures of water governance? Second, under what circumstances can water governance principles and instruments be scaled up and down? Third, how do power relations from local to global level affect water governance? How does the notion of public-private partnership redesign power relations and how does this affect different segments of society? Fourth, based on an understanding of what works in water governance in specific contexts, what overall principles of institutional design can be derived? How do pluralist systems of governance jointly address water problems, and what coordinating mechanisms exist? Fifth, what are the most appropriate principles of water management—for example, how does the principle of state sovereignty interact with other principles of water management—for example integrated river basin management? Sixth, how can water governance systems be reconciled with the principles of sovereignty?

Research questions: Agency

Key to addressing water problems is to understand who owns water and who has authority to manage it. While ownership patterns are path-dependent and historically determined, they are becoming much more diffuse, and internationally subject to dispute (BRUNNÉE AND TOOPE 2002, CAPONERA 1996A). While ownership and authority patterns at the national level have evolved without much conflict in most developed countries (AUBIN AND VARONE 2004, SANGARE AND LAROUE 2004), such evolutionary patterns are question-

able in the developing world in particular in relation to the rights of indigenous people and women (LEBEL ET AL. 2007, MARTIN AND LEMON 2001). Increasingly scientific communities shape water governance. For example, the International Law Association has had a considerable influence on water law (BOURNE 1996). However, engineering communities have also had a major influence in water regimes. This suggests the following research questions: First, what factors determine whose knowledge is used in water research? Second, how do actors use scale to promote their own interests? Third, how are the sites of governance changing in water governance? Who is gaining authority and who is losing it? What are the implications of this for water governance? Fourth, what design principles could deal with the issue of agency? And fifth, how do epistemic communities shape water governance?

Research questions: Adaptiveness

Water management has historically been a process of adaptive governance. Over time, different motivating factors have influenced and changed policy-making in different parts of the world. However, as institutions and habits get old and entrenched, the ability of institutions to learn and adapt flexibly diminishes. Recent explorations of social learning need follow-up research (PAHL-WOSTL ET AL. 2007). Rejuvenating water institutions is critical for dealing with the challenges of the 21st century. This suggests a number of specific research questions: What factors influence the ability of institutions to learn in water governance? Second, what scalar factors impact on social learning? Third, how does power influence the politics of adaptation in water governance? Fourth, how do the rule of law and its inherent tendency to be stable and predictable interact with the need to continuously and rapidly transform and change?

Research questions: Accountability and legitimacy

Who is accountable for water management, and how can the legitimacy of water governance be guaranteed? To understand this we need to understand the problem boundaries. For example, increasing democratic legitimacy calls for enhancing public involvement in decision-making (E.G. AARHUS CONVENTION 1998, EUROPEAN UNION 2000, OAS 2000). However, translating this into practice is more complex, and it is critical to ensure that decision-making does not make a mockery of participation (GUPTA 2003). Given that there are different ways to draw problem boundaries, accountability and legitimacy also depend on system boundaries. At national level, the accountability of private and public service providers to citizens is a critical issue that needs further analysis. In the area of water governance, important questions regarding accountability and legitimacy include, for example, what factors influence the

legitimacy of scientific knowledge and assessments in water governance, and to what extent are scientists accountable for the results they generate? Second, are notions of accountability and legitimacy different along different rungs of the water governance scale? Third, how can power politics in water governance be balanced by principles of accountability and legitimacy? Fourth, what are the limits of the classic model of policy-making and how does it compare and contrast with modern adaptive models at different sites of governance? Fifth, how can participation increase legitimacy of decision-making, and how can this be operationalized in different contexts of water governance?

Research questions: Allocation and access

More than a billion people do not have access to potable water, and more than two billion do not have access to sanitation services. The dominant response of lawyers to this problem of access is to talk in terms of rights (MCCAFFREY 2005, SCANLON ET AL. 2004, WHO 2003), of economists to talk in terms of pricing of scarce resources, and of engineers to find technical solutions (GUPTA 2004). Regarding legal approaches, the discussion on water rights moved from the adoption of the 'right to water' in 2002 in the General Comment No. 15 of the UN Economic and Social Council (GENERAL COMMENT 2002) to the appointment of an expert in 2008 by the Human Rights Council to work on this issue for the coming three years. The human rights issue has a North South dimension as access is primarily a Southern challenge and hence possibly not seen as quite so important in the North. It also has a national and local dimension. In the national context it is often disputed, with some countries recognizing such rights and others not; and some recognizing these for indigenous but not for poor people (for example the Philippines). Regarding economic approaches, lending institutions have focused heavily on price rationalization and public-private participation in water management. Technical responses focused on dams as means to enhance access to water, on interbasin transfer schemes (TARLOCK 2005, J. GUPTA AND VAN DER ZAAG 2008), on water storage sites (VAN DER ZAAG AND J. GUPTA FORTHCOMING), as well as on international trade (WEISS 2005). Internationally, recognition of the urgency of dealing with access has led to the adoption of the Millennium Development Goals in 2000, and many aid agencies and national governments are trying to prioritize the question of access.

While access focuses simply on the notion that all should have access to bare minimum needs, allocation looks at how water resources are shared within and between societies. At national level, different systems of ownership, licensing and appropriation often determine allocation. Internationally, allocation often depends on the balance between sovereignty and equity. Although the problem of allocation has led to the articulation of principles of equity in the UN Convention on the Law of the Non-Navigational Uses of

International Watercourses 1997, there has been little progress in ratifying this agreement, and much of the conflict revolves around equity (MCCAFFREY 2001, TANZI AND ARCARI 2001, SALMAN AND UPRETY 2002). At national level, different types of challenges emerge, including the need to mobilize leadership, and how one can scale up community level solutions to other levels of management (SIJBESMA AND VAN DIJK 2006, VAN BERS ET AL. 2007). Transboundary pollution and environmental flow issues are also critical elements that influence allocation.

This raises the following research questions: First, how does agenda-setting on water research affect the debate on allocation? Second, what are the different ways in which the choice of scale and level of governance affect distribution? Third, how does the adoption and implementation of different principles of water governance empower or disempower social actors? Fourth, what are ideal design principles for water governance? What context-relevant factors need to be taken into account? Fifth, given the conflict between equity and the 'no harm' principle in water law, how can the equity issues of the future be taken into account?

EARTH SYSTEM GOVERNANCE AND THE CLIMATE SYSTEM

Introduction

A second flagship activity of the Earth System Governance Project will be global climate governance. This activity will thus be linked to the research programme of the Global Carbon Project, a joint project under the Earth System Science Partnership (GLOBAL CARBON PROJECT 2003). Even though the study of earth system governance goes beyond the core questions of the Global Carbon Project, there are complementarities between the two initiatives: studies of earth system governance in the context of coupled human and natural systems can be expected to yield insights related to the role of humans and societal institutions as drivers of change as well as the ways that humans are likely to organize themselves in the face of change. In particular, complementarities with the Global Carbon Project lie with Task 3.2.3 of its Science Plan that envisions research for designing carbon management institutions and multilevel governance for urban carbon management. Regarding the five analytical problems of the Earth System Governance Project—architecture, agency, adaptiveness, accountability, allocation and access —the following more detailed questions in relation to climate governance appear important.

Research questions: Architecture

Regarding the analytical problem of architecture, it is important to note that the climate problem is not just a cumulative and systemic problem at the global level (TURNER II ET AL. 1990), but can also be unbundled as having different features and impacts at different levels of governance. The implications of this are two-fold: On the one hand, there is a need for a global process to reduce emissions to minimize dangerous impacts of climate change. On the other hand, since the policy space and windows of opportunity are contextual and influenced by networks and information flows, there are possibly more opportunities, including the use of courts, for creatively addressing climate change at regional to local levels (BULKELEY AND BETSILL 2003, REZESSY ET AL. 2006, DEANGELO AND HARVEY 1998, ANGEL ET AL. 1998, GUPTA 2007A AND B).

At the global level, the architecture of climate governance essentially evolves around the 1992 United Nations Framework Convention on Climate Change and the follow-up decisions of the conference of the parties and the 1997 Kyoto Protocol (ALDY ET AL. 2003, BODANSKY ET AL. 2004, KAMEYAMA 2004, TORVANGER ET AL. 2004, HÖHNE 2006, KUIK ET AL. 2008). At the same time, hundreds of organizations work on climate-relevant issues, from intergovernmental and non-governmental organizations to multinational corporations. Their goals and activities may not always be synergetistic with the climate regime. Yet policy development is occurring beyond the global level. At the regional level, the European Union, for example, has established a framework of directives and policy documents for implementation within the European Union (PEETERS 2005). At the national level, all industrialized and most developing countries have set up national coordinating bodies and adopted policies to mitigate greenhouse gas emissions or to adapt to climate impacts. There is also much activity at the city and provincial levels, which is not always linked to top-down implementation but to the influence of transnational networks, especially in the case of cities, and policy entrepreneurs (BULKELEY AND BETSILL 2003, DHAKAL AND BETSILL 2007). In addition, a growing number of initiatives are developed in the private sphere, many transnational in scope.

This suggests the following research questions: First, to what extent does the increasing fragmentation, or diversity, of the overall architecture of global climate governance affect its performance? How can actors in fragmented architectures jointly address climate change, and what coordinating mechanisms exist? Second, under what circumstances can principles and instruments of climate governance be scaled up and down? Third, how do power relations from the local to global level affect climate governance, and how

does the introduction of market mechanisms re-design power relations? Fourth, on the basis of an understanding of what works in climate governance, what principles of institutional design can be derived?

Research questions: Agency

A critical element of climate governance is assessing who has the authority to decide how responsibilities are shared at different levels of governance (BOTHE 2003). While many societies are locked into complex infrastructural and technological trajectories, changing these becomes complex and the vested interests in each society have differing levels of power. States have been key actors in determining the nature of policy responses to climate change. However, their authority is often challenged by non-state actors that try to shape governmental decision-making or to create governance arrangements that bypass the state. Furthermore, the struggle to gain power in climate governance is critical. For example, the Global Environment Facility has been at the centre of much North-South controversy (J. GUPTA 2006). These agents of earth system governance sometimes coordinate their efforts and create synergies across levels of governance. Other times, different agents come into conflict as they promote different visions of the nature of the problem and the appropriate responses. Furthermore, radically different starting points and disciplinary assumptions often lead to different conclusions about the policy options to address climate change. Also, designing compliance regimes is challenging (BRUNNÉE 2003). This suggests the following questions: First, what factors determine whose knowledge is used in climate assessments? Second, how do actors use the politics of scale to promote their own interests? Third, how are the sites of governance changing in climate governance? Who is gaining authority and who is losing it? What are the implications of this for climate governance? Fourth, what design principles need to be developed to deal with agency?

Research questions: Adaptiveness

For many years, 'adaptation' was contested in political debates surrounding climate change for fear that it would divert attention from the need to address the underlying causes of rising atmospheric greenhouse gas concentrations. However, the damage inflicted by extreme events such as Hurricane Katrina highlighted increasing vulnerabilities. It is essential to reduce vulnerabilities to the impacts of climate change and to enhance the ability of human populations to adapt to earth system transformation. As a first step, scholars of earth system governance will need to evaluate the existing architecture of climate governance and the configuration of agents in terms of their effects on adaptive capacity. Next, it will be necessary to consider whether and how existing

elements of that architecture can be adapted to facilitate societal adaptation. This suggests several research questions: What factors influence the ability of institutions to learn in climate governance? What scalar factors impact on social learning? How does power influence the politics of adaptation? And finally, how does the rule of law and its inherent tendency to be stable and predictable interact with the need to continuously and rapidly transform and change?

Research questions: Accountability and legitimacy

A key area in climate governance is understanding how accountability and legitimacy is organized. Accountability becomes particularly important when economic stakes are high and incentives strong to calculate emissions or reduction credits in one's favour. The problem of legitimacy of decision-making is illustrated by the increasing role of non-state actors in influencing policy-making. At the same time, formal rules of procedure in negotiations are at times suspended in the interests of expediency and efficiency, which may lead to questions about the legitimacy of decision-making. This suggests the following set of questions: First, how can interdisciplinary methods of accountability be generated that can be universally applied? Second, how can one assess the accountability of actors within the climate regime? Third, what factors influence the legitimacy of scientific knowledge used in climate assessments? Fourth, do notions of accountability and legitimacy differ at different levels of climate governance? Fifth, how are power politics in climate governance related to principles of accountability and legitimacy?

Research questions: Allocation and access

More than a billion people lack access to energy services. To meet the Millennium Development Goals will thus eventually require a more equal distribution of greenhouse gas emissions per capita. In terms of allocation, the key principle of the climate convention is the principle of 'common but differentiated responsibilities'. However, the degree at which industrialized countries reduce their own emissions and assist developing countries has been lower than anticipated and than what is necessary. The long-term objective of the climate convention is thus also a question of allocation and access regarding who decides the level at which climate change becomes dangerous and how it is decided (PACHAURI 2006, YAMIN ET AL. 2006, J. GUPTA AND VAN ASSELT 2006). Likewise, the debate on principles of liability and compensation are in essence questions of allocation (MANK 2005, PENALVER 1998, GROSSMAN 2003, ALLEN 2003, GILLESPIE 2004, WEISSLITZ 2002, HANCOCK 2005, JACOBS 2005, RAJAMANI 2005, J. GUPTA 2007A). Furthermore, emissions are attributed to countries based on where they are generated, irrespective of where the

product is consumed. Some argue that this favours consumers at the cost of producers. In relation to emissions trading, one can question the implicit use of the 'grandfathering' principle as opposed to other principles. In relation to financing for emission mitigation and climate change adaptation, the question is how responsibilities are allocated among countries. In relation to counting the emissions of greenhouse gases, one could explore alternative systems for carbon counting and attribution, for example in terms of net aggregate per capita contributions from consumption. On the issue of bioenergy, a critical challenge is how the need to create bioenergy will compete with access to food, water, and other resources.

This suggests a number of questions: First, how can one take into account within climate governance the rights of access to basic services, such as food, water, energy and transport? Second, what are the different ways in which the choice of scale and level of governance affect allocation? Third, how does the adoption and implementation of different principles and instruments of climate governance empower or dis-empower actors? Fourth, how does the introduction of market mechanisms affect allocation in the climate regime? Fifth, what are optimal design principles for climate governance, and what context-relevant factors need to be taken into account? Sixth, where should emissions be allocated along the product chain—to the producer or the consumer? Finally, given the conflict between equity and efficiency in climate governance, how can equity issues of the future be taken into account?

EARTH SYSTEM GOVERNANCE AND FOOD SYSTEMS

Introduction

A third flagship of the Earth System Governance Project will be food systems. This interaction between earth system governance and food systems will be analyzed through collaboration with the Global Environmental Change and Food Systems (GECAFS) project, one of the joint projects of the Earth System Science Partnership. The goal of GECAFS is to determine strategies to cope with the impacts of global environmental change on food systems and to assess the environmental and socioeconomic consequences of adaptive responses aimed at improving food security (GECAFS 2005). The GECAFS research agenda is specifically targeted towards delivering the new science necessary to underpin policy formulation for improving food security in the face of global environmental change. So far GECAFS has set out to (a) investigate how global environmental change affects food security at regional scale; (b) determine options to adapt regional food systems to cope with both global environmental change and changing demands for food; (c) assess how potential adaptation

options will affect the environment, societies and economies; and (d) engage the international global environmental change and development communities in policy discussions to improve food security. One of the main objectives of GECAFS is to demonstrate that the relationship between environmental change and food systems is about much more than crop yields and must address more complex issues of food availability, access and utilization both now and in region-specific future scenarios (ERICKSEN 2007). GECAFS also has a strong focus on food-system vulnerabilities and on options for reducing exposure to risk and/or increasing coping capacity and on the development of decision support tools for policy makers to examine adaptation options.

The issue of food security and governance is of high salience given that 17 per cent of the world's population are undernourished and that food production occupies 37 per cent of the world's land of which about 70 per cent is pasture.[22] Food is the major force driving fisheries collapse, and agricultural production, processing and food transport are significant sources of greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) suggests that climate change may have serious implications for food supply, with more than 100 million more people at risk from hunger in a warmer world by 2080. It is also important to recognize that while many are hungry, there is also a crisis of obesity and over-consumption of food in many countries, which brings its own set of health and environmental problems.

There are strong institutional and governance questions underpinning GECAFS analysis of food systems. These include (a) the extent to which concerns about food systems are incorporated into global and regional environmental governance, for example into the adaptation or mitigation strand of the climate convention process or in environmental components of regional trade agreements; (b) the ways in which the governance of the food system affects the earth system, for instance how the shifts to long global supply chains controlled by large private firms affect climate and land use; and (c) the inadvertent impacts of earth system governance on food systems, for instance the interaction between biofuels, energy efficiency or carbon sequestration projects and food security. GECAFS has also engaged closely with key actors in international food governance, including the UN Food and Agriculture Organization (FAO), the Consultative Group on International Agricultural Research (CGIAR) and regional economic governance institutions in Southern Africa and the Caribbean. In many ways, earth system governance is integral to the GECAFS agenda, and the Earth System Governance Project provides an excellent opportunity to expand and strengthen understanding of food systems and security in the face of environmental change.

22 FAO www.fao.org/ES/ess/os/envi_indi/part_221.asp.

Research questions: Architecture

The architecture of food and agricultural governance is extremely complex and ranges from global systems of governing trade to local level systems of agricultural extension and food security support. The international systems of food governance have been designed with objectives that include the prevention of famine and malnutrition, the control of agricultural diseases and pests, the support of agricultural research and productivity, food safety, and the management of trade in food commodities at regional and international levels. The Earth System Governance Project prompts several challenging questions about the architecture of food governance. These include: How do the international structures for governing food interact with those for governing the earth system including regimes for governing climate, biodiversity and marine environments? How do threats to food security (and associated norms of rights to food or the Codex Alimentarius) influence negotiations on the architectures of earth system governance, for example in debates about the targeting of funds for adaptation, role of biofuels, the potential of biotechnology in climate adaptation, the interaction of food security and land cover, or the impact of carbon pricing on food security? At what scales is the food system governed and how do these interact with each other and with other governance systems?

Research questions: Agency

Non-state actors are critical to the security and governance of food and are increasingly responsible for governing major sectors of the food system. Among the most powerful are the large transnational companies that may control several stages in the food value chain from inputs to production contracts and distribution and increasingly important major retailers who govern food consumption for many consumers, especially in the developed world. These actors have always interacted with the formal architecture of food governance (for example the World Trade Organization) and food aid, but they are now beginning to play a role in earth system governance through systems of voluntary environmental and sustainable certification and labelling, participation in emission reduction programmes, and funding of environmental research and biodiversity conservation. Consumer and political pressures are also encouraging food system actors to address earth system concerns across a range of scales including energy use in operations and greening of supply chains. Other influential non-state actors include nongovernmental organizations, especially charities whose traditional concerns with disaster relief and poverty alleviation have expanded to include climate change vulnerability and mitigation and who are publishing and lobbying on earth system issues.

Many questions could be researched about agency in food governance. From the GECAFS perspective priorities would include: What role are non-state actors such as corporations and non-governmental organizations likely to play in food system adaptation to global environmental change and in efforts to mitigate changes in climate, biodiversity, or land cover? What role should the state play in promoting or regulating the actions of non-state actors, for example in the development of certification schemes, adaptation options, or carbon markets for the food sector? Who are the most powerful actors in food system governance and how are they addressing earth system concerns?

Research questions: Adaptiveness

There is a long history of humans adapting to changes in the earth system through governance of food and environmental systems, and numerous studies have documented how societies have used technology and social organization to cope with environmental extremes and variations, for example through irrigation systems, local markets and common property regimes. Cultural ecology and agricultural economics are among the disciplines that have studied how such institutions cope with changes in both environment and political economy and the limits to the adaptiveness of technologies, social arrangements and state policies in the face of environmental and economic crises. Some institutions are especially focused on adapting food systems to change, including agricultural extension services and international development institutions such as the World Bank and CGIAR, but their policies may have unintended consequences and reduce rather than increase flexibility (illustrated by the debates over whether the Green Revolution reduced plant genetic diversity and if it benefited the poor). GECAFS has a particular focus on how local and international food systems can become more adaptive and resilient in the face of global environmental change.

Possible research questions for the Earth System Governance Project include: How can food governance be designed so as to maximize adaptation and flexibility to global environmental change? What can be learned from local knowledge and institutions that facilitates adaptation at other scales? How have major changes in food governance, such as those from public to private sector, or from simple to complex technologies and supply chains, altered the adaptiveness of the food system? What can be learned from the experience of the Green Revolution and other major efforts to transform food systems that is relevant to earth system adaptation? To what extent will food system adaptation become a focus of earth system governance, including finance flows and technology transfers?

Research questions: Accountability and legitimacy

The accountability and legitimacy of food system governance is a significant focus of nongovernmental organizations, the media and consumers in contemporary societies, with governments held to account for increases in food prices and the practices of food multinationals criticized for their lack of accountability or concern for the poor or the environment. Many governments, especially in lower income countries, are aware that they are often held accountable for food system failures at the ballot box and in the street, and private sector firms are addressing environmental and equity concerns in their corporate accountability practices and advertising. Food safety has many years of experience in governance for accountability, including state and private management of testing and standards and frequent calls on both accountability and legitimacy from media food scares. One of the most interesting trends is the emergence of voluntary certification systems that address social and environmental concerns including fair trade, organic, sustainable harvests and carbon footprints.

Example research questions for the Earth System Governance Project might include: How have systems of food governance become accountable for the environmental and social impacts? What strategies are the state and private sector using to legitimize policies and decisions about food systems, especially those that take account of environmental concerns and how are consumers, nongovernmental organizations and the media having an influence? What sort of science is needed to monitor and legitimize food governance and how is this changing because of environmental concerns?

Research questions: Allocation and access

Access to food and its allocation is a dominant governance question at scales ranging from the international to the local. In many cases, it focuses on ethical questions and norms about the human right to food and the humanitarian concerns about famine. And yet more than a billion people do not have access to enough food. For centuries, societies have established systems to provide food to the poor and victims of food crises including grain reserves, food subsidies, food for work and food aid. These have been formalized into contemporary forms of governance at international and national scales by both public and private sectors. Theoretically, scholars such as Sen (1981, 2000) and Chambers (1997, CHAMBERS ET AL. 1981, CHAMBERS AND CONWAY 1992) have long ago set out relationships between food access, poverty and famines and the significance of seasonality, power, knowledge, gender and local institutions in governing access to buying and producing food through land ownership, agricultural practices, employment, and institutions. Subsistence producers are especially sensitive to patterns of resource ownership and

tenure including the quality of land and access to common property including land and fisheries. As producers lose access to land or cannot obtain adequate incomes from food production they may be forced to expand into forests or degrade their land with implications for the local and global environment. The concept of vulnerability to environmental change is especially relevant to food allocation and access in that changes in vulnerability are often manifest through loss of access to buy or produce food. Access to food is also a major campaign issue for a range of nongovernmental organizations, a primary focus of reports from international organizations such as UNDP, FAO and the World Bank, and key to several of the Millennium Development Goals. Allocating food is increasingly left to the market, whether international trade in food commodities or regional exchange. One of the most significant allocation issues is the balance between market demand for land and labour for producing food as opposed to other commodities such as fibre or biofuels. Agency interacts with allocation in the shifting consumer food preferences across food types, especially from more vegetarian and unprocessed foods to diets that include more meat and processed food (that in turn has larger energy and emission impacts on the earth system).

Linking earth and food system governance raises the following questions about allocation and access: What legal, moral and other norms are entrenched in food systems governance and how might these change because of environmental issues? How have changes in markets and state policies changed food allocation and access? How might vulnerability to climate and other environmental changes translate into food system vulnerabilities? How does the governance of land use, land cover and biodiversity (for example through the establishment of protected areas) or the use of land for non-food activities (such as biofuels or cities) change patterns of access to food resources?

EARTH SYSTEM GOVERNANCE AND THE GLOBAL ECONOMIC SYSTEM

Introduction

The performance and future of the global economic system lies at the heart of most analyses and debates about the prospects of a sustainable earth (REDCLIFT 2000, HAMILTON 2003, MANIATES 2003, JASANOFF AND MARTELLO 2004, CONCA 2006, SPETH AND HAAS 2006). Decades, or centuries, of impressive economic growth and institutional development have left their marks on the earth's oceans, landscapes, rivers and atmosphere (TYSON ET AL. 2002, STEFFEN ET AL. 2004, SCHELLNHUBER ET AL. 2006). The notion of 'the economy' is among the most powerful social constructs ever conceived; and

there is no doubting its influence once articulated (T. MITCHELL 2002). Yet questions are rarely addressed directly about those economic institutions and their politics that made those great transformations happen, and other transitions towards sustainability, daunting challenges. Four aspects of the global economic system are especially pertinent to earth system governance.

First, the globalization of trade increasingly links distant peoples and places through energy and material flows, and through the impacts of associated production and consumption activities. Shrimp farmed in Thailand eat fish meal from off the coast of Peru or Norway and are exported to be eaten in the United States or the European Union (DEUTSCH ET AL. 2007). Bilateral, regional and international trade agreements govern the exchange of goods. In the case of farmed shrimp, politics is intense over dumping allegations, food safety standards, and increasingly, campaigns by consumers around issues of fairness to producers and environmental harms associated with poor production practices (WILKINSON 2007). The interactions of trade and the environment and the systems designed to govern each are complex (CARPENTIER 2006, KESSLER AND ABAZA 2006, KUKLA-GRYZ 2006). The impacts of trade liberalization on greenhouse gas emissions, for example, may vary between sectors and forms of trade relationships (GALEOTTI AND KEMFERT 2004, SAUNDERS ET AL. 2006). Certification and labelling, fair trade and various quality assurance schemes singly or jointly are altering the way production-consumption linkages are governed (GOODMAN 2003, RENARD 2003, RAYNOLDS 2004, VANDERGEEST 2007).

Second, the liberalization of investment and capital markets has multiplied foreign direct, and domestic, investment stimulating greater extraction and use of natural resources, on the one hand, and much needed capital flows to developing countries on the other. Sharp contractions of investment after boom times also have implications for livelihood and land use. Access to long-term funds by governments and firms in capital markets are important to adaptiveness. But financial regulations vary in quality over time and among countries. Fraud and corruption in stocks and bonds can have major impacts on development outcomes. Capital markets also create opportunities for investors to select portfolios on environmental and ethical criteria (SHARMA 2006). Superannuation funds are a good example with growing influence on investment patterns that include sustainability and other environmental or ethical criteria.

Third, the trans-nationalization of corporate organization through which an increasingly large share of the trade, material and financial flows is not through strictly open market places but rather through supply networks and value-added chains or among divisions or subsidiaries within a vertically integrated firm that spans multiple national boundaries. One consequence has been the concentration of power. Expanding requirements for standardizations of practices has had other important effects directly relevant to driv-

ers of environmental change (CLAPP 1998). Many household appliances and larger goods like automobiles are assembled from parts sourced across several countries to be sold in another. Private governance through individual firm or sectoral standards is important, but so are national and regional regulations and directives. At the same time, many transnational corporations increasingly regulate and reward subsidiaries and input suppliers for following standards they set which can be beneficial, for example in reducing pollution intensities or improving energy efficiencies during manufacturing (PESONEN 2000, ROCK AND ANGEL 2005).

Fourth, the de-regulation and reformation of the financial sector has resulted in more ways to get loans (BOONE ET AL. 2002, ANDERSEN AND TARP 2003, FREEDMAN AND CLICK 2006). Multilateral banks enter into complex relationships with governments of developing country in which conditions on loans force national policy changes. Such activities raise questions of governance related to agency (or sovereignty) and accountability. Changes in the financial sector, for example, were crucial to the huge growth in domestic investment that helped drive several decades of rapid economic growth of newly industrializing economies of Southeast Asia, at least up until the 1997 financial crisis. Currency controls and policies can affect land-use and industrial activity through how they affect competitiveness of exports, costs of imports and incentives for foreign investment. De-regulation is often followed by swings to reformation of banking and credit systems after larger collapses. A good example is the Chiang Mai Initiative which led to the development of the Asian Bond Market to reduce reliance on short-term foreign borrowing and instead swap foreign reserves (SUSSANGKARN AND VICHYANOND 2007). At the same time stagnant policy in the face of massive changes in the global economic system can undermine adaptive capacity.

These four aspects of the global economic system are particularly important to the Earth System Governance Project, but by no means the only ones that matter. Information and communication technologies, for instance, are another obvious transformation with profound impacts in all areas mentioned above.

In sum, globalization involves strong interactions between economic, social and environmental variables. A flagship research activity within the Earth System Governance Project on the governance of key aspects of the global economic system will benefit from adopting a socio-ecological system framework to exploring these interactions (YOUNG ET AL. 2006). The Earth System Governance Project will concentrate on just a few key issue areas that are not yet adequately addressed in existing international research efforts, with a particular focus on the five analytical problems of architecture, agency, adaptiveness, accountability, and allocation and access.

Research questions: Architecture

The architecture of the global economic system is dynamic. Among many different forces re-shaping it today, the role of emerging large developing countries like China, India and Brazil is particularly important as they have frequently turned to bilateral and regional forms of cooperation on trade and investment rather than just following global regimes (LEVY 2006, HOADLEY AND YANG 2007, GU ET AL. 2008). This regionalization can be important to harmonization of environmental and food safety standards where more local interests take precedence, while at the same time creating tensions with the World Trade Organization. Regional agreements are also important for environmental cooperation within the European Union and between the United States and its neighbours (FOR EXAMPLE CARPENTIER 2006). The changing architecture of these economic institutions is potentially important for climate change, sharing of international waters or conservation of biodiversity as more narrowly framed environmental regimes. This leads to the following questions:

First, what are the consequences, in terms of adverse or positive environmental changes, and altered social vulnerabilities for people living in developing countries of engaging in multilateral versus bilateral, or regional versus global, negotiations and agreements on trade? Second, how important is interplay among international environmental institutions and those concerned primarily with trade? To what extent is it important to consider interactions with, and the effects of, the international regime in the design and implementation of regional trade agreements, alternative fair trade networks, and mainstream certification and labelling schemes? Third, what are the links in practice between regional environmental and economic cooperation? How important has institutionalization been to successful incorporation of adverse environmental changes into decision-making on otherwise primarily economic issues? How has deliberative politics impacted environmental or sustainable development provisions in regional trade and economic cooperation agreements? Fourth, how has the stretching of linkages in production-consumption systems, including within firm supply chains and through trade in open markets, altered environmental governance challenges? Under what conditions have constraints been overcome through private governance mechanisms and led to greening of supply chains?

Research questions: Agency

Conventional notions of the state lay it above society and see it as encompassing local communities as a way to legitimize its authority (FERGURSON AND GUPTA 2002) or, more specifically, those actors good at deploying state institutions for their ends. Globalization of trade, investment, financing and

corporate organization complicates practices and discourses (CONCA 2006). Some corporate actors challenge state authority straight on, whereas others look to benefit from private-public partnerships and work with state institutions. Industry and trade associations in particular may be crucial to implement voluntary policies (BAILEY AND RUPP 2006). From the perspective of managing environmental impacts and natural resources, economic and ecological agency are increasingly argued to be related or in need of linking. Civil society also may sometimes underline their independence from governments while in other circumstances promoting strongly nationalist ideals. Either way, making strategic appeals to sovereign territories in resource management conflicts and crisis, neglects a reality in which effective authority has often long been given up (AGNEW 2005). Multilateral banks can have substantial influence on economic and environmental governance through their insistence on structural adjustment programmes (MCGREGOR 2005) or specific funding for sustainability or environmental objectives (MILES 2005). The most salient and intriguing questions of agency in earth system governance are no longer, about whom, but how.

This suggests the following more detailed research questions: First, under what circumstances, and how, have transnational civil society networks altered the ways decisions are reached with respect to international trade and investment in ways that reduce adverse environmental changes? Second, what has been the role of multilateral banks in transforming how land and water resources are used and managed in developing countries? How have structural adjustment programmes and environmental conditionalities on loans interacted and have they made a difference? Third, what have been the effects of the Global Environment Facility financing mechanisms on earth system governance? Fourth, who uses arguments about global environmental change to address concerns with the governance of the global economic system and to what ends and with what effects? Fifth, how have consumers and employees, through decisions on what to buy and with whom to work, successfully contributed to reducing impacts of their economic activities on the earth system? When, and how, have they been also able to coordinate individual decisions into collective actions?

Research questions: Adaptiveness

Globalization is central to transformation and resilience of social-ecological systems (YOUNG ET AL. 2006). Connectedness as exemplified by international trade, can have both amplifying and dampening effects on adaptiveness. Timeliness is a key theme in governing adaptiveness with different actors benefiting from speed or delay. A common debate, for example, is on how much to invest in adaptation against future environmental changes or risks and on the appropriate balance between present and future costs and benefits.

Waiting to reform only until after a serious crisis has unfolded has been a typical response (ANDREWS 2006), but could be catastrophic way to respond to abrupt changes in the earth system (STEFFEN ET AL. 2004, SCHELLNHUBER ET AL. 2006). Uncertainty is important to decision-making: farmers in Australia, for instance, adjust investments in response to both climatic (for example drought) and larger-scale economic uncertainties (MARANGOS AND WILLIAMS 2005). The global economic system is both dynamic and 'monumental'; thus, it carries forward with it constraints on environmental responses to the impacts and vulnerabilities it creates.

This suggests the following questions for the Earth System Governance Project: First, what are the consequences of differences in speed at which institutional and other policy changes in the global economic system unfold relative to the speed by which environmental governance initiatives are launched and refined? Second, how does the regulation of capital markets influence the underlying drivers of large-scale environmental changes, and what are the prospects of re-directing these towards improving long-term adaptive capacities of vulnerable peoples and places? Third, who has financed adaptiveness? Fourth, does international trade improve adaptiveness, or does it undermine it?

Research questions: Accountability and legitimacy

The ability to monitor and sanction is critical to learning and improvement. In international trade, environmental governance matters both along chains and in particular places. Rees (2006) and Princen et al. (2002) have argued that distancing associated with long-distance trade, on balance, impedes critical feedbacks and learning. But attempts to grow food or produce other products in unsuitable places clearly also has important negative implications for sustainability; an argument for avoiding the 'local trap' (PURCELL AND BROWN 2005, BORN AND PURCELL 2006). Transferring authority and responsibility for management of natural resource and ecosystem services to the private sector has a mixed history. Neo-liberal policies in Latin America have had diverse outcomes for forests, water, agricultural land and fisheries (LIVERMAN AND VILAS 2006). China's transition to a market economy and integration into the global economic system is being supported by a vast array of initiatives to protect the environment, but these policies are often un-folding in a context of limited transparency and accountability (ECONOMY 2006, SHI AND ZHANG 2006, GU ET AL. 2008).

Many formal institutional initiatives as well as activities organized by local communities, civil society and business are exploring, testing and challenging new models of accountability (PALMUJOKI 2006, NEWELL 2008). There is, for example, a vast literature comparing different approaches to managing common pool resources with a recognition that multilevel approaches are increas-

ingly required for earth system challenges (BERKES 2002, YOUNG 2002). Businesses now frequently promote themselves as adherents to corporate social responsibility or socially responsible investment. The literature on corporate social and environmental responsibility, for instance, explores the potential and limitations of transnational firms taking on roles in society beyond profit maximization (DETOMASI 2002, JONES 2005, JONES ET AL. 2005, MORGERA 2006, JONES AND HAIGH 2007). But legitimacy is difficult to achieve without independent monitoring or some other form of public scrutiny (MALONI AND BROWN 2006).

Some of the questions about the global economic system relevant to the Earth System Governance Project include: First, how can corporate social and environmental responsibility promises, initiatives and routines be strengthened to include explicit references and responses to key earth system challenges? Second, to what extent has the introduction of international standards into global production networks improved environmental performance? How have such introductions been achieved and how are decisions now made to monitor and improve them? Third, what are the differences between a firm and its board being held accountable to shareholders and a government and its representatives being accountable to its citizens? And, what are the implications for governing the environmental impacts and vulnerability-inducing consequences of economic activity? Fourth, how (by what mechanisms) do policies and initiatives in the private, public or mixed sphere aimed at improving accountability of economic activities with respect to environmental and social outcomes gain and maintain legitimacy? Fifth, under what circumstances, and how, have quality assurance schemes, including but not restricted to certification and labelling, significantly reduced adverse environmental impacts of production-consumption activities? Sixth, when has privatization and pricing of natural resources and ecosystem services led to better management and when has it resulted in worse outcomes relative to alternatives?

Research questions: Allocation and access

As states and peoples have sought and then engaged with the global economic system, the increasing wealth of the societies they live in, accompanied by expansion of consumption activities, invariably also leads to greater exploitation of natural resources (REES 2006, YORK 2007). As these become scarce, questions of allocation increasingly arise which are often tangled up with process of economic, social and institutional development (ELSTER 1992). Questions about fairness of systems of allocation also arise with the respect to the environmental risks associated with economic activities (REDCLIFT 1997, PARKS AND ROBERTS 2006). Global environmental changes interact with economic aspects of globalization to redistribute benefits and risks as well as creating new vulnerabilities and adaptive capacities (O'BRIEN AND LEICHENKO

2000, O'BRIEN AND LEICHENKO 2003). Anti-globalization movements often target their critiques at the governance of the global economic system, claiming dominance of decision-making by wealthy people and places. The World Trade Organization, the World Economic Forum, the World Bank and the International Monetary Fund are the most common targets. But the relationships between international financial institutions and state agencies receive a lot less public scrutiny than they deserve (THOMAS 2007). Rights-based approaches are often advocated to counter the impacts of emerging markets on poor and disadvantaged groups. At the same time there are others who believe that market-based instruments can create the right sort of incentives for better natural resource management (JENKINS ET AL. 2004), reward efforts and practices and thus help stimulate the innovation and lifestyle changes needed to alleviate poverty.

This suggests the following more detailed research questions: What are the implications of international trade agreements for initiatives taken as part of fair trade movements? Does main-streaming fair trade work? Or does it lead to capture and redirection? Is fair trade better for the environment? Who benefits most and who least from the introduction of environmental standards, certification procedures and labelling schemes? When are environmental improvements an outcome and when are they not? What have been the experiences with efforts to introduce payments for ecosystem services from landscapes (or watersheds) in terms of financial incentives, environmental and social outcomes?

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IMPLEMENTATION OF THE SCIENCE PLAN

INTRODUCTION

A research programme on earth system governance requires a particular research practice. For example, it needs to adopt a holistic analytical perspective that synthesizes a mosaic of local, national, regional and global political processes. While the traditional study of environmental policy has long been devoted to cross-national comparisons, this is even more important for the study of earth system governance. This applies for example to the relations between the academic fields of development studies and African, Asian and Latin American area studies, on the one hand, and traditional environmental policy research that has focused on the rich countries in the North, on the other. Likewise, a research programme on earth system governance requires a global approach to the organization of research. The study of earth system governance encompasses all the world's regions and must be internationally organized to make use of local knowledge, values and insights. Diversity within the research community together with strong networking is a prerequisite for studying earth system governance. The globalization of problems can be countered only by the globalization of research.

Research on earth system governance has also to cope with normative uncertainty. We do not know what governance systems and governance outcomes future generations want. This calls for particular forms of participatory research and assessment that integrate lay-experts in academic research programmes. Stakeholder dialogues or citizens juries are key elements in the larger effort of understanding and strengthening earth system governance. Added to this all comes the general problem that all science is context-bound in the person of the scientist. When it comes to earth system governance, this contextual embeddedness of the researcher relates to both time and (cultural) space. Regarding time, we need to develop and 'test' today, with the knowledge of today, governance systems that will help to achieve a safe human-nature co-evolution over the course of the century. Regarding space, the cultural-normative embeddedness of social scientists requires new forms of diversity-management in global science in the form that is supported today in many global environmental assessment institutions. All this makes earth system governance one of the most challenging, but thus also one of the most exciting research objects in the social sciences.

Consequently, a Science Plan to provide guidance for an international research programme that is expected to last for a decade at least, cannot be only about science. It must also be about the structure of the scientific collaboration, of the exchange of hypotheses, data, methods, and findings, and about the continuous improvement and evolution of the research programme. This chapter thus discusses the practical aspects of this research programme: the governance and institutionalization of the study of governance and institutions. Scientific cooperation in larger international research programmes knows many models, and there are no two international research programmes that are identical in their governance.

The Earth System Governance Project will have a governance structure that combines elements from traditional core projects of the IHDP with new ideas on crosscutting collaboration and on motivating and steering research on a worldwide scale.

THE EARTH SYSTEM GOVERNANCE PROJECT AS AN IHDP CORE ACTIVITY

First, the Earth System Governance Project will have the basic structure and facilities of major scientific research programmes: First of all, this Science Plan lays down the basic research programme in terms of concepts, theories, research questions, methods, and cases. In addition, the Project is supported by an international project office with an executive officer and limited administrative staff. This project office provides a communication focal point, attends and organizes meetings, oversees the website, and reports, synthesizes and communicates findings, among other important functions. At present, the international project office, and its executive officer, is co-located with the international headquarters of IHDP in Bonn, Germany. However, other solutions are conceivable if specific institutions and countries are willing to host (parts of) the support system for the project. Moreover, a scientific steering committee has been appointed by IHDP according to the usual procedures of the programme. The Earth System Governance Project has also elaborated a procedure for the initiation and endorsement of research projects that fall under the science plan. Finally, the Project will soon provide for an extensive communication network including a professional newsletter, a website, an e-mail list, and a series of workshops and outreach activities. More information is available on the Project's website (www.earthsystemgovernance.org).

THE EARTH SYSTEM GOVERNANCE PROJECT AS A CROSSCUTTING ACTIVITY

Second, the Earth System Governance Project attempts in its research activities to cut across the entire Earth System Science Partnership community. Most IHDP projects, as well as the ESSP joint projects, address questions of governance and institutions. Many projects have been consulted in the drafting process of this Science Plan, and the Science Plan itself seeks to strengthen the knowledge base on governance issues in the other global change research programmes. Practically, the Earth System Governance Project has addressed this need to collaborate with, and to cut across, other global change programmes through extensive consultations with these projects, and by inviting leading representatives of other projects to the drafting process of this Science Plan: from the IHDP core project Global Environmental Change and Human Security (Ken Conca), from the ESSP joint project Global Environmental Change and Food Systems (Diana Liverman), from

the ESSP joint Global Water System Project (Joyeeta Gupta), as well as from the programme Global Change System for Analysis, Research and Training (Joyeeta Gupta).

THE EARTH SYSTEM GOVERNANCE PROJECT AS A COMMUNITY OF PRACTICE

Third, the Earth System Governance Project will engage in a number of decentralized, partially virtual activities. For example, a part of the implementation of the Science Plan will be a series of focused mid-size conferences over the next years, with events in different continents. These conferences on earth system governance will have a clearly defined theme—for example one analytical problem, such as 'architecture'—that is formulated in a way that different academic disciplines and discourse communities as well as different geographic regions can be attracted. The conferences will build on open calls and intensive double-blind peer review that guarantees high-quality content, and be rather small in size with around 150 paper presentations to allow for a high level of interaction and exchange. The conference series will thus give the science plan a stronger impetus and assist in creating a larger research community on earth system governance.

In addition, for all its activities the Earth System Governance Project will need to rely on a large network that reflects the interdisciplinary, international, and multi-scale challenge that lies ahead. To the end, the Project will spend substantial resources on building a network and implement a project design that is as open as possible. A number of categories of affiliation and association are available for the implementation phase of the project:

(1) *Associate Faculty Members*, a highly select group of not more than 100 colleagues worldwide who provide regular guidance and fresh insights into the project implementation and will take the lead in developing research on the analytical problems and flagship activities outlined in this Science Plan;

(2) *Senior Fellows and Fellows*, who seek to link their own research projects with the broader themes and questions advanced by the Science Plan of the Earth System Governance Project, participate in the various events and networks of the project and serve as regular authors, co-authors, reviewers and critics of the project outputs; here, some financial support will be solicited for doctoral students or early postdoctoral researchers;

(3) *Research Centres and Affiliated Projects*, which will support the implementation of (parts of) the Earth System Governance Science Plan, for example by committing to sharing responsibility for the analysis of one particular analytical problem or one particular flagship activity; and

(4) *Practitioners' Affiliates*, who will advise the Project on the political, practical aspects of its mission and who will review its research outputs accordingly.

LIST OF ABBREVIATIONS

ABSSS	Agent-Based Social Systems Sciences
CGIAR	Consultative Group on International Agricultural Research
ESSP	Earth System Science Partnership
FAO	United Nations Food and Agriculture Organization
GCP	Global Carbon Project
GECAFS	Global Environmental Change and Food Systems
GIS	Geographic Information Systems
GWSP	Global Water System Project
IDGEC	Institutional Dimensions of Global Environmental Change
IHDP	International Human Dimensions Programme on Global Environmental Change
ILO	United Nations International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
QCA	Qualitative Comparative Analysis

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