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On Adaptiveness

Changing Earth System Governance

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1.1 Introduction

The year 2020 was advocated to be the 'super year for sustainability', in which the United Nations (UN) sought to launch a 'decade of action' for implementing the Sustainable Development Goals (SDGs) within the Agenda 2030 (UN, 2020). Supplementing the SDGs, the Paris Agreement on Climate Change, Sendai Framework for Disaster Risk Reduction, and the New Urban Agenda were all adopted in 2015 and 2016. In order to achieve these goals and thus more sustainable development, global efforts need to be strengthened, to accelerate, and to gain more transformative dynamics (UN, 2020). However, reports have regularly documented that global environmental changes and their impacts have been enormous, while the speed and scale of necessary progress for managing the global challenges have remained insufficient (IPBES, 2019; IPCC, 2018, 2019a, 2019b).

By 2020, the level of global warming was at 1.1°C above pre-industrial levels (IPCC, 2018), and began to seriously impact the world's natural and human systems (IPCC, 2018, 2019a, 2019b). Humankind has thus far failed to achieve the Paris Agreement goal of limiting warming to 2°C (UNEP, 2019). Rapid and transformative actions are increasingly called for to reduce greenhouse gases emissions by 2030 and achieve net-zero emissions by 2050. Such actions not only include processes such as decarbonisation, implementation of bioenergy and carbon capture and storage (BECCS), but also behavioural changes (IPCC, 2018). Nature and its vital resources and services used by humans, including biodiversity and ecosystem functions and services, are deteriorating worldwide (IPBES, 2019). These reports document that we are not on course to achieve the SDGs by 2030 and that governance responses have neither been adequate nor adaptive vis-à-vis the dynamics of the challenges at hand.

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As this book was finalised, COVID-19 was pronounced a global pandemic by the World Health Organisation (WHO, 2020) in March 2020. The virus and its consequences wrought havoc on global health, disrupted education systems, and brought tourism and aviation industries to a halt (UN, 2020). The COVID-19 virus spread globally virtually overnight with the number of people affected and dying increasing exponentially on a daily basis. Governments immediately ordered people to work from, study, and stay at home; wash their hands more regularly; and practise social distancing. From January to April 2020, global aviation was largely grounded, countries' borders closed, jobs lost overnight, and companies declared bankrupt. National economies suffered as the virus spurred economic recession. In response, economic stimulus packages were rolled out in countries around the world. Within a few months, government and institutional responses, as well as public behaviour, were forced to adapt and change practices at extraordinary speeds. Such quick and widespread responses were unprecedented, especially when compared to the pace and scale of the responses to reduce carbon emissions and manage climate change. Driven by the problem at hand and informed by science, governance and institutional responses to the COVID-19 pandemic demonstrate what adaptive governance responses can look like.

Similarly, rapid and transformational actions become ever more urgent to achieve a just, resilient, and ecologically sustainable global society. In particular, governance approaches are called upon that respond to address the respective problem dynamics and are effective to align social, economic, and ecological developments towards the sustainability goals. These governance approaches for rapid and transformational actions have to address changing and uncertain conditions and need to be responsive, flexible, and, in that sense, adaptive.

The Earth System Governance (ESG) Project as a global alliance of social science researchers in the area of governance and global environmental change evaluates current governance practices and explores novel proposals in the search for more effective governance mechanisms to address major changes and transitions in the biogeochemical systems of the planet (Biermann, 2019). In doing so, the ESG Project conceptualised earth system governance 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' (Biermann et al., 2009: 4). In its Science Plan of 2009, the project developed a core research focus around five analytical themes (5As) – namely, architecture, agency, adaptiveness, accountability, and allocation and access (Figure 1.1) (Biermann et al., 2009). To continue the process, the ESG Project prepared a new

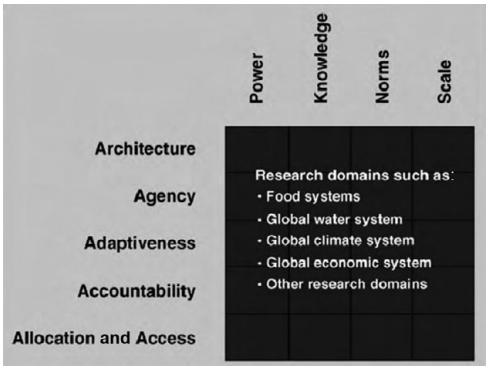

Figure 1.1 Adaptiveness in the 5As within the ESG Project Science Plan 2009.
Source: Biermann et al. (2009: 28)

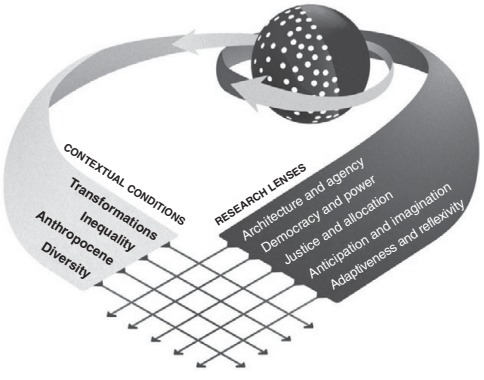

Figure 1.2 Adaptiveness and reflexivity as research lenses in the new ESG Project Science Plan 2018.
Source: ESG (2018: 19)

Science and Implementation Plan in 2018, which combined adaptiveness with reflexivity as a core theme for future research in the field organised around five research lenses and four contextual conditions (Figure 1.2) (ESG, 2018).

The Harvesting Initiative within the ESG Project aims to review the results of a decade of research on these themes and compiles key research findings in books or journal contributions (ESG, 2020). This initiative has resulted in a number of publications, special issues, and edited volumes on agency (Betsill et al., 2019); agency and empowerment (van der Heijden et al., 2019); and architecture (Biermann & Kim, 2020). This book is an outcome of this Harvesting Initiative, focusing on the analytical theme of adaptiveness.

Throughout the book, we follow the initial understanding of adaptiveness as 'an umbrella term for a set of related concepts – vulnerability, resilience, adaptation, robustness, adaptive capacity, social learning and so on – to describe changes

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made by social groups in response to, or in anticipation of, challenges created through environmental change' (Biermann et al., 2009: 45). Understanding adaptiveness as an umbrella for these key concepts, harvesting related research thus could draw on the related outcomes from the related fields of study. However, in this book we seek to draw connections between the respective fields among themselves and towards adaptiveness and adaptive governance in earth system governance. Thus, it is our goal to not only repeat what has been discussed in the respective fields, but also to synthesise and relate the findings to each other and to the challenges of adaptive governance. In doing so, we avoid positing one concept against another in the interest of carving out overarching insights and lessons. However, the challenge arises where to draw the boundaries of the umbrella and to scrutinise the multiple connections and relationships within or under the umbrella, including those that are implicit or not explicitly referring to adaptiveness per se. This book thus followed a pragmatic approach combining a bird's-eye perspective to see the whole picture largely with the means of a systematic literature review with a bottom-up perspective from selective discussions and empirical case studies.

Since the 2009 Science Plan postulated this notion of adaptiveness in the attempt to bring together different research strands, our interest in this book was to analyse how far it has been taken up and brought to fruition in the scholarly community and beyond. Thus, the overarching research question addressed in this book is: *How has adaptiveness, as an umbrella concept, been developed and applied in the context of earth system governance in the first decade after its inception, and what insights and practical solutions has it yielded?* Following the ESG 2009 Science Plan, this broad question will be approached by addressing four specific questions:

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

Thus, this book brings together the threads of a debate that has been gaining societal relevance and academic traction throughout the last decade. This work is a collaboration written by eminent authors in the related fields and documents experiences from different world regions as well as different levels of decision-making. The 10 chapters discuss recent trends in the literature on adaptiveness and the utilisation of adaptiveness concepts and draw on case studies examining challenges and solutions requiring aspects of adaptiveness.

The structure for this chapter is as follows. Based on the introduction to the motivation and rationale for the whole book in Section 1.1, Section 1.2 examines

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the concept of adaptiveness by summarising the latest debates, the links to related concepts and its interlinkages with other analytical issues. The following Section 1.3 reflects on research methods to explore themes of adaptiveness. Section 1.4 presents the book structure as well as key findings from the individual book chapters. Finally, Section 1.5 discusses synthesis findings from this volume, how they relate to the 2009 Science Plan questions on adaptiveness, and the role of adaptiveness in the future of earth system governance. In this section, we put forward the findings from the chapters on the four ESG 2009 Science Plan questions listed in Section 1.1.

1.2 Adaptiveness: Related Concepts and Interlinkages

Within the context of earth system governance, adaptiveness is a catch-all term to describe changes generally made by actor groups or institutions in anticipation of or responding to risks, disruptions, or challenges resulting from environmental change. It thus relates to concepts of adaptive management, adaptive governance, vulnerability, resilience, robustness, adaptive capacity, and social learning. These concepts represent larger research traditions that overlap in parts and all address dynamics in socio-ecological systems. However, they are not identical and have partly complementary and partly divergent research foci. Acknowledging these differences, the overarching notion of adaptiveness seeks to bring together the commonalities and connections between the concepts as outlined in the following.

1.2.1 Adaptive Management and Adaptive Governance

Adaptive management is one of the most utilised concepts in the research related to adaptiveness in the sense of the 2009 ESG Science Plan. It is considered a management approach for responding to ecosystem change (Folke, 2006). It aims at maintaining and managing dynamic and at the same time resilient systems that can withstand stresses of climate change, habitat fragmentation, and other anthropogenic effects without losing its capabilities to provide essential ecosystem services (Chazdon, 2008). Active adaptive management and governance of resilience (Lebel et al., 2006) are essentially tasked with sustaining desired ecosystem states and transforming degraded ecosystems into fundamentally new and more desirable configurations (Folke, 2006). Through feedback learning and structured scenarios, actors can tackle uncertainty and unpredictability intrinsic to all socio-ecological systems (Berkes et al., 2000; Folke et al., 2002). Adaptive management, adaptive co-management, and anticipatory governance share numerous similarities with adaptive governance

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(Huitema et al., 2009; Hurlbert & Gupta, 2018) that brings them together metaphorically and practically underneath the umbrella of adaptiveness.

Adaptive governance has emerged as a framework to proactively and flexibly deal with increasingly uncertain, systemic, complex problems (Dietz et al., 2003). Such governance approaches connect individuals, organisations, agencies, and institutions at multiple levels (Folke et al., 2005), and are often facilitated by key leaders and shadow networks (Olsson et al., 2006). Adaptive governance encompasses a range of interactions between actors, networks, organisations, and institutions emerging in pursuit of a desired state for social-ecological systems (SES) (Chaffin et al., 2014). They seek to align the ecosystem dynamics with governance responses, trying to match scales, complexity, and intensity between governance and SES-related problems (Termeer et al., 2010).

1.2.2 Resilience

The concept of resilience has evolved considerably since Holling's (1973) seminal paper. Resilience is proposed as 'the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedback' (Walker et al., 2004: 5). Like adaptiveness, the concept builds on the insight into non-linear dynamics, thresholds, uncertainty, and surprise. It analyses how periods of gradual change interact with periods of rapid change, and the interaction of dynamics across temporal and spatial scales (Folke, 2006). Resilience, adaptability, and transformability are three related attributes of SES that largely determine their future trajectories (Walker et al., 2004). Adaptability refers to the capacity of actors in the system to influence resilience, while transformability is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable (Walker et al., 2004). With its origin in ecology, the field of study has evolved to address core social science topics of governance, power, and learning (Olsson et al., 2014). Resilience has multiple levels of meaning: as a metaphor related to sustainability, as a property of dynamic models, and as a measurable quantity that can be assessed in field studies of SES (Carpenter et al., 2001). There is a vast breadth of literature proposing various resilience frameworks and attempts to operationalise the concept into specific applications, such as the food system (e.g. Hodbod & Eakin, 2015), urban planning (Davoudi et al., 2012; Lloyd et al., 2013), and disaster management (Chang & Shinozuka, 2004; Cutter et al., 2008; Djalante et al., 2013).

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1.2.3 Vulnerability

Vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as 'the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt' (IPCC, 2014: 1775). Its key components include exposure, sensitivity, and adaptive capacity (IPCC, 2014). Miller et al. (2010) discuss whether resilience and vulnerability are complementary or conflicting concepts. They argue that resilience and vulnerability represent two related yet different approaches to understanding how systems and actors respond to change, to shocks and surprises, as well as to slow creeping changes. Vulnerability research poses many challenges including how to develop robust and credible measurements, how to incorporate diverse methods that include perceptions of risk and vulnerability, and how to incorporate governance research on the mechanisms that mediate vulnerability and promote adaptive action and resilience (Adger, 2006). General conditions of vulnerability are characterised by multiple contexts, multiple dimensions, temporal variability, multiple scales, and scale interdependency (Hufschmidt, 2011). In discussing social vulnerability, Cutter et al. (2012) proposed three main tenets for vulnerability research: (1) the identification of conditions that make people or places vulnerable to extreme natural events (i.e. an exposure model), (2) the assumption that vulnerability is a social condition (i.e. a measure of societal resistance or resilience in regard to hazards), and (3) the integration of potential exposures and societal resilience with a specific focus on particular places or regions. There is a vast number of frameworks available to assess the vulnerability of coupled human–environment systems (Turner et al., 2003) to climate change (Füssel, 2007), to natural hazards (Birkmann, 2006), or to livelihoods (Yaro, 2004).

1.2.4 Adaptive Capacity

As a component of vulnerability (Kelly & Adger, 2000; Smit et al., 2000), the IPCC defines adaptive capacity as 'the characteristics of communities, countries and regions that influence their propensity or ability to adapt' (IPCC, 2001: 882). The adaptive capacity of SES is related to the existence of social, economic, or political mechanisms for coping with (climatic) change. Even though the debate is ongoing about how to conceptualise adaptive capacity, there is broad understanding of its multidimensional character, determined by complex inter-relationships of numerous factors at different scales, and based on institutional collective responses as well as the availability of and access to resources (Cinner et al., 2018; Vincent, 2007).

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Central elements of adaptive capacity are common at different scales, although the structure of each index is scale-specific (Gupta et al., 2010; Vincent, 2007). Collective action and social capital have been identified as pertinent elements of adaptive capacity in relation to the performance of institutions that cope with the risks of changes in climate (Adger, 2003). What seems to be a strongly related message for adaptiveness research is that adaptive capacity requires a diversity of responses to cope with complex systems, high dynamics, and substantial uncertainty in human-dominated environments (Elmqvist et al., 2003).

1.2.5 Robustness

Studies on robustness are commonly discussed in terms of 'network robustness' (e.g. Klau & Weiskircher, 2005) or 'modelling robustness' (e.g. Hinrichsen & Pritchard, 2011; Kuorikoski et al., 2010). Robustness can be seen as an antonym to (static) vulnerability. It is related to general resilience, which includes coping with the unknown (Scholz et al., 2012). Robustness and resilience are necessary for maintaining the adaptive capacity and work through preserving a balance among heterogeneity, modularity, and redundancy, and tightening feedback loops to provide incentives for sound stewardship (Levin & Lubchenco, 2008).

1.2.6 Social Learning

Literature on social learning has emerged rapidly in recent years, mainly originating from the field of psychology (e.g. Bandura, 1977; Mischel, 1973). Social learning is a broad concept encompassing multifaceted, more specific types and levels of learning and knowledge in relation to SES (Reed et al., 2010). These include collective or group learning and social memory, mental models and knowledge-system integration, visioning and scenario building, leadership, agents and actor groups, social networks, institutional and organisational inertia and change, adaptive capacity, transformability, and systems of adaptive governance that allow for the management of essential ecosystem services (Folke, 2006). Of particular relevance is the question of how far knowledge and learning relate to practical behaviour of actors and societies. The process of social learning involves change at and beyond the individual level to change within broader social units by way of social integrations within social networks (Reed et al., 2010). Thus, 'communities of practice' (Wenger, 2010) became a popular research focus. Through successive rounds of learning and problem-solving, these learning networks can incorporate new knowledge and related new or altered practices to deal with problems at increasingly larger scales, ideally arriving at adaptive co-management arrangements (Berkes, 2009). Through problem-sharing perspectives

and working with different kinds of knowledge and competencies, multiple actors or stakeholder parties co-construct a social learning process in an emerging community of practice (Bouwen & Taillieu, 2004).

A core question in social learning studies is which organisational or societal level is concerned. Within organisations such as municipalities or corporations, organisational learning can take different forms drawing on organisational sociology (Siebenhüner & Arnold, 2007). On a national level, social learning processes have been found to relate largely to political cultures among other factors (Social Learning Group, 2001). In global environmental governance, organisations are observed to engage in one of three forms of learning: reflexive learning, adaptive learning, and no learning depending on specific learning mechanisms, change agents in leadership functions, and external triggers such as pressures from governments or non-governmental actors (Siebenhüner, 2008). Reflexive social learning informed by policy and programme evaluation constitutes an increasingly important basis for 'interactive governance' (Sanderson, 2002).

Social learning processes are crucial for building adaptiveness, since they help to cope with informational uncertainty, reduce normative uncertainty, build consensus on criteria for monitoring and evaluation, empower stakeholders to take adaptive actions, reduce conflicts and identify synergies between adaptations, and improve fairness of decisions and actions (Lebel et al., 2010). Informal networks are considered to play a crucial role in such learning processes (Pahl-Wostl, 2009). Transformative change building on fundamental social learning processes towards adaptive management have even been described as 'learning to manage by managing to learn' (Pahl-Wostl, 2007: 49).

1.3 Reflection on Research Methods

Both ESG Project Science Plans of 2009 and 2018 discuss the use and development of adequate methods for addressing the challenges and issues of earth system governance research. While Biermann et al. (2009) discuss various social science methods and stress, in particular the role and benefit of interdisciplinary research methods at the interface of the social and natural sciences, the 2018 Science Plan goes one step further. Beyond the suggestion of a set of new, innovative methods for analysing matters of earth system governance, it outlines the ontological and epistemological foundations of the research agenda and argues for a wide diversity of the ways of knowing and representing the world (ESG, 2018). Additionally, it extends the methodological portfolio and explicitly includes transdisciplinary research methods 'noting the need for engagement with broader societal actors outside of academia who also hold key knowledge and perspectives on what is both feasible and desirable as solutions to societal problems' (ESG, 2018: 84).

Among the ESG analytical problems, the theme of adaptiveness poses some particular methodological challenges. Most of the phenomena subsumed under adaptiveness are intangible and not directly measurable. Vulnerability, resilience, and robustness, for example, are inherent to a (socio-ecological) system and become only apparent when their limits are tested in times of pressure, stress, or crisis. Hence, studies around these phenomena are often placed within such settings of increased stress, describing systems responses to perturbations (see e.g. McGreavy et al., 2016). As another strategy, governance researchers try to approach resilience, for example, through the institutional and governance principles that attempt to shape the resilience of SES. In this vein, analysts take advantage of the inter-relatedness of those different concepts by relating, for instance, the adaptive capacities or arrangements for adaptive governance to the resilience of the underlying SES (e.g. Gunderson & Light, 2006). However, such a research strategy may also appear problematic because it rests on often implicit normative assumptions about those governance models, remains under-specified as to how governance modes and system properties are linked, and hence, may paint an overall simplistic picture (Biesbroek et al., 2017). In this light, the ESG Project's explicit inclusion of interdisciplinary approaches linking social and natural systems, as well as of the critical realist approaches 'to study and seek to understand generative causal mechanisms that produce events, processes and phenomena' (ESG, 2018: 78) appears particularly relevant for the study of adaptiveness.

Beyond these more general methodological issues, the study of adaptation faces some more practical methodological challenges, which could be tackled by a diversity of methodological approaches. Here, we provide a few examples.

Case studies are among the most popular research methods for studying questions of earth system governance, as the contributions of this volume highlight. In the social sciences, case studies are employed for a variety of purposes, including the detailed assessment of a phenomenon under study, the development of explanations for social outcomes and the broader generalisation of those, or the application of more general concepts in specific cases (George & Bennett, 2005).

While case studies are hardly an innovative or overlooked method, they offer great potential for the in-depth study of multifaceted issues, such as adaptiveness, as they allow for the consideration of context and place the research object within its wider social, environmental, and cultural context to trace processes in their historical evolution and to re-draw causal chains linking to specific outcomes. One great advantage here is their versatility to be combined with a magnitude of different methods and analysis techniques. Counterfactual analysis, for example, may provide one fruitful avenue to tackle the intangibility of various phenomena of adaptiveness. A counterfactual is a 'subjunctive conditional in which the

antecedent is known or supposed for purposes of argument to be false' (Tetlock & Belkin, 1996: 4). In case-study research, counterfactual analysis is used to help with assessing the effect of an actual event by asking what would have happened if the event did not take place or occurred differently (Mahoney & Barrenechea, 2019). For example, in his analysis of the effectiveness of international fishing regimes, Stokke (2012) uses counterfactual analysis to assess what would have been if there was no fishing regime. This way of thinking may also prove beneficial in the study of adaptiveness as it may be used to, for instance, examine *ex post* the robustness of a specific governance solution if specific decisions were taken differently. However, *ex ante* case studies will require different complementary methods such as integrative modelling, scenario techniques, or backcasting approaches.

Counterfactual analysis can be enriched through the adept use of longitudinal within-case analysis or by comparison to others (Goertz, 2017). In longitudinal within-case analysis, a researcher takes a case where a specific phenomenon is given and goes back in time until it was not. This strategy enables the assessment of the circumstances under which a phenomenon occurred or did not occur and the significance of changes to those circumstances. For example, to analyse the effects of specific adaptive capacities on the effectiveness of a governance regime, one could trace back when specific governance measures were developed and how they affected regime effectiveness (e.g. reducing vulnerability vis-à-vis climatic changes). However, cases where these changes occur over time and can be traced back to single governance measures may be hard to find in reality. Hence, counterfactual thinking of that kind may provide a useful tool for case selection and for cross-case analysis.

The widespread use of *single- or small-N* case studies, however, may lead to a scattered research field characterised by many dispersed only loosely connected insights – a common problem in many fields of political research (Ryan, 2017). Hence, meta-reviews and analyses may be warranted, also in the study of adaptiveness, to synthesise the knowledge that is already there, and to generate new insights that go beyond the findings of the single (case) studies (Cook, 2014). One way to accumulate existing knowledge lies in reviewing and harvesting the insights produced in the various studies in the field, which is the aim of this book and especially the subject of the systematic review in Chapter 2. Another synthesis approach lies in the transformation of qualitative case studies into quantitative data through structured coding procedures, as envisioned by the case-survey meta-analysis method (Lucas, 1974). Under this method, qualitative case narratives are translated into quantitative data through coding – based on an analytical coding scheme and typically done by multiple raters – allowing for statistical analysis. For example, in their study tracing the processes and environmental impacts of

social learning in participatory governance, Newig et al. (2019) draw conclusions from more than 300 cases of participatory environmental governance. Thus, the method provides for much wider generalisation over diverse settings and contexts (Jensen & Rodgers, 2001).

In general, the specific focus on governance responses and measures in relation to highly dynamic socio-ecological system developments calls for methods addressing these dynamics and temporal developments. As in anticipatory governance (ESG, 2018), forward-looking methods and approaches can help governance actors to better understand current dynamics in their future consequences and thus to act in an adaptive mode. For instance, *backcasting approaches* start out from a desired state of the respective socio-ecological system at some point in the future, and deduce specific steps and trajectories that would be required to take place before this point in time to make the desired state happen (Robinson, 2003; Quist & Vergragt, 2006). Alternatively, *foresight studies* (Meissner, 2012) or *futures studies* (Sardar, 2010) enable actors to acquire understanding of multiple future developments in complex systems. In a similar vein, *scenario techniques* have been used to involve stakeholders or various experts in the analysis of possible future developments linking it to actual and current decision-making (e.g. Bishop et al., 2007). Probably the most used method for analysing future developments, however, are *modelling approaches* of various kinds including system dynamic modelling (e.g. Kwakkel & Pruyt, 2013; Sterman, 2001), agent-based modelling (e.g. Patt & Siebenhüner, 2005), or integrative assessment (e.g. Scheuer et al., 2017). With growing interactive computing powers and social media experiences of users, serious gaming approaches gain prominence in forward-looking studies that explore problem situations and help to analyse decision-making under conditions of complexity and uncertainty (e.g. Mangnus et al., 2019; Vervoort et al., 2010). Even though these methods have not been in much use in earth system governance-related adaptiveness research yet, these methods can prove helpful in addressing the research challenges in the field in the future.

1.4 Book Structure

Subsequent to this introduction and discussion of the umbrella concept of adaptiveness the book structure starts out with the broad picture and the general concepts and progresses to more concrete case studies and practical applications. It thus runs from the general aspects to the more specific. Chapter 2 (Siebenhüner & Djalante) thus comprises a comprehensive analysis of the term ‘adaptiveness’ in most frequently cited research papers and shows how the theme has emerged and developed in the related literature from 1998 to 2018 (a decade before and after the

first Science Plan). The particular focus of this chapter is to answer the four central research questions on adaptiveness posed in the 2009 ESG Science Plan. The next chapters add to the conceptual discussion and undertake the complex task of assessing adaptiveness. Chapter 3 (Montpetit et al.) proposes an operational framework to assess adaptive capacity, and thus suggests a method for identifying governance processes and attributes that foster adaptiveness. Chapter 4 (Fidelman) examines collaborative governance and its relationship to adaptive capacity drawing on examples from coastal resource management in the Western Pacific. Moving to the concrete applications of adaptiveness research, the following chapters focus on the governance of climate change-related challenges. Chapter 5 (Stoett & Vince) presents the cross-cutting nature of global challenges and presents an issue at the nexus between climate change, health, and biodiversity as a problem requiring collective action and adaptation. A cross-scale analysis follows in Chapter 6 (Zia), which applies the SES analytical approach to mitigation and adaptation policy instruments and sheds light on their synergies but also trade-offs. Chapter 7 (Siebenhüner et al.) applies the concept of 'lock-in' to explain how institutional, behavioural, and infrastructural factors can hinder adaptiveness in preparing for or responding to risks caused by climate change.

Subsequent chapters connect global challenges to the governance and management of landscapes and resources at different scales from international, to regional and national levels. Chapter 8 (Peach Brown) calls for more adaptiveness among the responsible international organisations after assessing mixed results of forest management instruments and development interventions in the Democratic Republic of Congo and the Central African Republic. Chapter 9 (Wurtzebach & Schultz) looks at forestry management in the United States in an analysis of the importance of multifaceted policy capacity in designing policy instruments that strike the balance between the stability and flexibility necessary for adaptive governance. Finally, Chapter 10 (Siebenhüner et al.) discusses the relevance of the book's findings for the 2018 Science Plan, the so-called Utrecht Questions formulated in 2018, and their relevance for global sustainability agendas. In some greater detail, the chapters discuss the following aspects.

Chapter 2, 'Synthesising and Identifying Emerging Issues in Adaptiveness Research within the Earth System Governance Framework (1998–2018)', by Siebenhüner and Djalante, synthesises related publications and identifies emerging issues in adaptiveness research within the earth system governance framework (1998–2018). They find that adaptiveness has not been taken up as a term in the earth system governance literature as such, but rather as linked to or implied in related concepts as mentioned earlier in this chapter. Addressing the research questions of the 2009 ESG Science Plan, the scholarly literature reports about specific attributes of governance systems at various levels and whether they propel

adaptiveness. The political nature and the conflicts of adaptiveness constitute one current of this debate with remaining gaps (e.g. with regard to distributive impacts of adaptation policies). Other findings relate to the essential role of knowledge and learning in governance approaches towards adaptiveness.

Chapter 3, 'Climate Change Adaptive Capacity Assessments: Conceptual Approaches and Operational Process', by Montpetit et al., contributes to the research on adaptive capacity in three ways: first, by presenting an operational design of adaptive capacity in a diversity of contexts; second, by providing guidance on how to build an operational definition of the term coherent with the research questions and objectives at stake; and, third, by demonstrating how an operational framework of climate change adaptive capacity that integrates multiple epistemic, spatial, and temporal dimensions can be developed. The authors find that the diverse conceptualisations of adaptive capacity serve different purposes and shape the assessment criteria accordingly. They suggest that this plurality can be seen positively rather than as a challenge.

Chapter 4, 'Assessing Adaptive Capacity of Collaborative Governance Institutions', by Fidelman, explores the influence of governance institutions on adaptive capacity. Based on evidence drawn from examples of collaborative governance of coastal resources in Vietnam and Cambodia, as well as the international governance of seascape ecosystems in the Coral Triangle in the South-West Pacific, the author illustrates that institutions can both enable and disable adaptive capacity and consist of interconnected dimensions. Fidelman also supports the arguments that contextual factors matter, and power relations can be a constraining factor. Given these findings, complexity emerges as a defining property of institutional adaptive capacity. Hence, efforts aiming to assess institutional adaptive capacity should consider the relationships between types of rules and attributes of adaptive capacity, while also appraising the power relations and the surrounding social, cultural, and political context.

Chapter 5, 'The Marine Debris Nexus: Plastic, Climate Change, Biodiversity, and Human Health', by Stoett and Vince, describes the threats posed by the abundance of marine plastic pollution and links it to broader issues such as climate change, biodiversity conservation, and their impacts on human health. Current international agreements are non-binding and rely on nations to adopt their own laws and regulations and the slow or absent implementation of market-based instruments indicate that they will not suffice to reduce macro- and microplastics. Stoett and Vince suggest that most institutions seem better equipped to address single-issue problems. Currently, global political will and the technical sophistication to apply legal frameworks to multiple-issue problems are missing links. Large knowledge gaps and other unanswered questions are further obstacles to overcome, but a cross-cutting, nexus approach could push progress and enhance

the adaptive capacity necessary for this wicked issue. The policy suggestions are seen as adaptive measures, which would constitute collective adaptation to mitigate plastic waste and climate change and protect marine ecosystems and with them global health necessary for moving toward the SDGs.

Chapter 6, 'Synergies and Trade-Offs Between Climate Change Adaptation and Mitigation Across Multiple Scales of Governance', by Zia, uses adaptive governance of SES as a framework to evaluate the mitigation and adaptation synergies and trade-offs through the United Nations Framework Convention on Climate Change (UNFCCC) policy mechanisms – namely, REDD+, the Clean Development Mechanisms (CDM), and the Adaptation Fund. The author argues that integrated adaptive governance of SES may provide a coherent framework to systematically assess the synergies and trade-offs of different policy mechanisms ensuing from the Paris Agreement and other global to local climate policy and governance actions.

Chapter 7, 'Lock-Ins in Climate Adaptation Governance: Conceptual and Empirical Approaches', by Siebenhüner et al., builds on the growing body of literature on barriers to adaptation to climate change, this chapter focuses on 'lock-ins' as a particular conceptual approach to understanding path dependencies. The chapter discusses, first, how lock-ins can be conceptualised, what indicators might identify them, and how they can be detected and described. Second, it postulates the emergence of lock-ins in climate adaptation policies by reference to central mechanisms originating from: (1) knowledge, discourses, and expertise; (2) physical infrastructures; (3) institutions and past policy tools; and (4) actors and their respective mental frames. In summary, the chapter illuminates lock-ins as phenomena that embody the opposite of adaptiveness and finds that institutional, infrastructural, and behavioural attributes of systems may individually or collectively prevent that system from changing.

Chapter 8, 'Governance and Climate Change Mitigation and Adaptation in Conflict-Affected Countries of Central Africa', by Peach Brown, identifies types of conflicts based on four initiatives in reducing emissions from deforestation and land degradation (REDD+) in the Democratic Republic of Congo and Central African Republic. This chapter connects adaptiveness to good governance, which is associated with a lower probability of conflict-related violence at the subnational level. The chapter discusses how by working with national governments to reform the forest management, address issues of tenure security, engage diverse stakeholders, and require accountability and transparency in the REDD+ process, these initiatives are generally promoting essential elements of good governance.

Chapter 9, 'Policy Tools and Capacities for Adaptiveness in US Public Land Management', by Wurtzebach and Schultz, analyses examples from federal

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forestry and land management in the United States and applies the concepts of adaptive governance and adaptive management. While adaptive governance theorists have outlined candidate legal tools for improved adaptiveness, the authors point out that less attention has been given to the resources and capacities needed to design and operationalise policy across multiple levels of governance. Wurtzebach and Schultz find that innovative policy changes allow for novel and more adaptive approaches to governing issues of larger scale, but recognise a need for better understanding of how new institutions interact with old ones and where and which new capacities could further progress.

Finally, Chapter 10, 'Adaptiveness in Earth System Governance: Synthesis, Policy Relevance, and the Way Forward', by Siebenhüner et al., revisits adaptiveness as an umbrella concept and its relations to the new 2018 Science Plan. Following our quest to address the four questions on adaptiveness in Chapter 1, we note that these answers may never be conclusively answered and the answers themselves may evolve. The chapter synthesises findings from the chapters of this book, particularly in regard to five key questions that all authors were invited to answer in their respective chapters. The concluding chapter thus brings together responses to these so-called Utrecht Questions. These questions were identified during the 2018 ESG Conference in Utrecht, the Netherlands, where the editors organised a meeting to discuss the progress of each chapter and discussed how the concept of adaptiveness has developed over time, remaining research gaps, and future research agendas.

1.5 Addressing the Four Adaptiveness Questions from the 2009 ESG Science Plan: Looking Back to Move Forward

The discussions and findings collected for this book are only a small portion of the research and discourse surrounding the theme of adaptiveness. Metaphorically, we attempt to weave threads gathered to form strands of common themes that will join many others to continue strengthening the network of ideas and lessons through the ESG Project and for more sustainable progress and problem-solving of global challenges.

In this section, we aim to summarise the insights collected within the Harvesting Initiative on the theme of adaptiveness to address questions from Biermann et al. (2009: 28) and ESG (2018: 19). Although these answers may never be conclusively answered and the answers themselves may evolve, at the end of this volume we will move on to subsequent questions (called the 'Utrecht Questions' because of their origin at an ESG conference) on adaptiveness to be addressed in the concluding chapter.

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1.5.1 What Are the Politics of Adaptiveness?

The politics of adaptiveness refer to the political nature and the conflicts of adaptiveness, recognising that responses to massive changes in the ecological systems substantially impact political relations and power structures on different governance levels. At the same time, political factors and power relations themselves constitute factors that affect the adaptiveness of socio-ecological systems. Decisions about the necessity of intervention, choices on the direction of change in adaptation processes, and *what or who* should adapt are all inherently political matters. As such, the determination of the questions as to if, what, and how systems adapt may be contentious. Also, the time frames can be considered a political matter with large discrepancies between the pace of environmental change and long-term planning for adaptation and comparatively short electoral cycles.

Findings from Chapter 2 suggest that much of the literature is dominated by assessment tools and indicators for vulnerability, resilience, and adaptive capacity while conflictive and distributive effects tend to be neglected. In the interest of strengthening socio-ecological system capacities against climate or other environmental impacts, the political nature of adaptation measures and supportive policies is not in the core focus of the literature. Thus, consequences (e.g. for poor or other marginalised groups) remain out of sight and deserve more research attention in the future.

While Montpetit et al. in Chapter 3 focus on the indicator and the analytical rather than the power-related dimension of adaptiveness, they explain the political nature of the diverse adaptive capacity concepts and definitions. In doing so, they link the perspective on indicators and assessment tools with the political and power-focused view on whose interests are being served by which assessment tool. Likewise, Fidelman in Chapter 4 finds in the analysis of three case studies that power relations can impede adaptation efforts. The same seems to hold true for conflicts particularly in conflict-ridden areas and countries such as the Democratic Republic of Congo, as Peach Brown in Chapter 8 carves out.

What is more, the political conflicts and power relations from other policy fields, particularly climate mitigation, seem to impact on adaptation governance as well. Zia highlights this special relationship in Chapter 6, and in Chapter 5 Stoett and Vince describe relationships between different policy domains and the overlaps between them.

1.5.2 Which Governance Processes Foster Adaptiveness?

In the 2009 ESG Science Plan, Biermann et al. (2009: 48) emphasise the need to better understand the 'extent to which governance systems are adaptive and evolve

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in response to earth system challenges'. Thus, success of policies and governance processes cannot only be measured in actual environmental or social improvements in the short term, but need to be understood in relation to a dynamically changing socio-ecological system environment. This aspect of almost constant change implies that a governance response that was once effective might no longer be useful in the resulting, changed system environment. Thus, in Chapter 2, we find that monitoring these system changes is almost as essential as the capacity of governance systems to learn and reverse the course based on knowledge and new insights. Similarly, social learning at different scales has proven to be a pivotal governance process to address this dynamic nature of socio-ecological systems. If successful, it will lead into larger-scale transformative change towards adaptiveness at different levels of governance including national jurisdictions and international governance processes. In this volume, these processes are only touched upon implicitly, particularly in Chapter 8, which calls for international organisations that intervene in environmental matters in developing countries to be more reflective and learn from their mistakes, while dealing with complex issues in regions with weak governance structures and in some cases violent conflicts.

Scrutinising specific governance processes towards adaptiveness, Chapter 4 highlights collaborative governance institutions as one approach to bring together different actors as well as governance processes to tackle climate impacts. Another essential capacity of adaptive governance systems is identified by Wurtzebach and Schultz in Chapter 9. They find that modern adaptive forestry governance approaches and policies need to be compatible with older pieces of legislation and need to comply with rules and norms at other governance levels, such as the national level.

By contrast, Chapter 7 develops a conceptualisation of non-successful adaptiveness by highlighting lock-in effects. Siebenhüner et al. stress the need to better understand these rigidities and self-reinforcing mechanisms of governance decisions, instruments, and practices that inhibit flexibility and reduce the likelihood of change and adaptation to altered environmental conditions.

1.5.3 What Attributes of Governance Systems Enhance Capacities to Adapt?

The 2009 ESG Science Plan also seeks to better understand specific attributes of governance systems at various levels, but mainly whether and how they propel adaptiveness. The review of the most cited papers in Chapter 2 revealed that key attributes include participation, multilayered institutions, and knowledge-based deliberative governance approaches. However, several studies indicate that it is not essential to involve everybody, but to be thematically selective and to design the participatory processes well. In particular, real participation in decision-making has

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been valued most by participants and leads to effective outcomes. Also, learning and knowledge sharing requires a structured and well-moderated process to advance adaptive capacities and practical change.

Discussions relating to this question also recur throughout the other chapters in this volume. Here, the array of attributes relating to adaptiveness are often sorted into various categories from adaptive capacity to analytical, operational, and political capacities and how they manifest at the individual, organisational, and systemic levels. Together the attributes enable governing institutions to strike the right balance of stability and flexibility for adaptiveness supported by well-designed and implemented policies and tools. Among these attributes are leadership, communication, networking, and analytical skills; public trust-building and learning capacity; accountability mechanisms, inter-organisational social capital, and effective resource management. Adaptive management and adaptive governance may look or function differently in different contexts, but generally speaking, attributes that help governance systems reconcile multiple interests, deal with uncertainty and complexity, make informed decisions, and solve problems are also the traits that enhance their ability to adapt.

1.5.4 How, When, and Why Does Adaptiveness Influence Earth System Governance?

Findings from Chapter 2 suggest that positive answers to this question refer to the diversity of sectors relevant and involved in adaptiveness in general and into climate adaptation in particular. For instance, the water sector is involved as well as coastal protection, agriculture, urban planning, the health sector, and others. These connections are described in Chapter 5 addressing links between plastic, climate change, and biodiversity that are often overlooked, but are there and require common approaches considering the nexus between the problem and issue areas. Through this cross-sectoral nature of the topic of adaptation, connections to other issue areas and policy fields lie in the concept itself. However, the chances of concepts and insights on adaptiveness to reach out to other fields hinges on the absence of barriers that have been intensively discussed in the related literature. Some criticism and a conceptual way forward can be found in Chapter 7, which focuses on climate adaptation lock-ins.

Recapitulating these insights and reflecting on the chapters ahead has demonstrated that researchers continually advance their understanding of adaptiveness, the processes and characteristics which promote it, and its necessity for sustainable developments and problem-solving. At the same time, observing the current developments in response to a global pandemic has shown that decision makers and many citizens around the world themselves can adapt to sudden and

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extreme threats. However, it is imperative to recognise that the pandemic is not analogue to other environmental, wicked problems and that the adaptive actions to prevent its further spread are neither sustainable nor come from democratic decisions. This example shows the difficulty in balancing effectiveness and timeliness with accountability and acceptance (Weible et al., 2020). Nevertheless, it offers lessons on the vulnerability of global societies and particular groups, may help to build resilience among neighbours and communities, and acts as a window of opportunity to reflect on and learn from our practices and choices. Against this backdrop, adaptiveness emerges as highly relevant and omnipresent.

In summary, this chapter has discussed the rationale and motivation for the book, which correspond to the ESG Project Harvesting Initiatives, but also academic interest in conceptualising and comprehending adaptiveness as a theme. We have introduced the conceptual development of adaptiveness, its related concepts, and their junctures, which will be discussed in further depth in the next chapter.

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