colleagues all generously offered their thoughtful and sometimes critical but constructive collegial comments on earlier chapter drafts, thereby helping to improve the completed volume. In order to move into and provoke conversation on what constitutes "adaptation success," this review process involved a fair bit of discussion, deliberation, and patient exchanges to go deeper and farther into the question.

At various times, we also had assistance with graphics and the tedious details of formatting from Ami Nacu-Schmidt and Elizabeth Hall, respectively, at the University of Colorado.

In the final tally, however, it's the ones who supported us and gracefully tolerated the countless hours we spent on this book, rather than with them or on other, equally worthy tasks. Susi particularly wants to thank her colleagues on a related project – Amy Snover, Lara Whitely Binder, Hannah Gosnell, Steve Adams, and Adina Abeles – whose collaborative spirit and careful thinking on adaptation success on the US West Coast have been a sustaining inspiration. Most of all, however, she is grateful to Carol Berzonsky for her unwavering support, love, and encouragement.

And Max wishes to thank colleagues and support at the University of Colorado, Boulder and the Cooperative Institute for Research in Environmental Sciences, Center for Science and Technology Policy Research, and the School of Geography along with friends in the Environment and Environmental Change Institute at the University of Oxford for institutional support throughout this process and production. He also thanks Monica, Elijah, and Calvin Boykoff for their love and care all along the way.

That this book now is successfully concluded is maybe our ultimate "revenge" for all the prodding and nudging that we did to ourselves and each other. It is professional respect and personal friendship that brought us together for this project, and we have it still. And for that we thank each other.

Susanne C. Moser and Maxwell T. Boykoff

Note

1 Gonzalez, L. (2012) *Surviving Survival: The Art and Science of Resilience*. New York: W.W. Norton.

1 Climate change and adaptation success

The scope of the challenge

Susanne C. Moser and Maxwell T. Boykoff

Successful adaptation: an introduction

Adaptation to the impacts of climate change is now fully established in the scientific literature as necessary and complementary to mitigation efforts (NRC 2010a,b,c; Holdren 2008; IPCC 2007). The world of policy and practice at all levels of government, in business, and in civic society is also rapidly waking to that reality. Climatic signals are clearly emerging out of the "noise" of year-to-year variability, and the effects of climate change are increasingly documented by researchers, and becoming apparent to the layperson. Particularly the occurrence of extreme climate and weather events has played a role in bringing adaptation to the fore (IPCC 2012; Leiserowitz *et al.* 2012; Peterson *et al.* 2012).

Meanwhile, international climate negotiations on emissions reductions have yet to yield a breakthrough with substantive policy plans that would set the nations of the world on a clear and feasible path toward significantly slowing the causes of contemporary climate change. Similarly, international adaptation policy progress has been patchy at best (Keskitalo *et al.* 2012; Liverman and Billett 2010). Despite a surge of scientific studies on adaptation, policy-makers, planners, and resource managers are grappling to determine how to meet the challenges ahead.

As emission trends continue upward (IEA 2011), many individuals and communities struggle to grasp the practical implications of significant climate warming. They are asking: what new or familiar but greater threats must we prepare for? What strategies, both new and well established, are available and feasible? How can and when must they be implemented? And how can the effectiveness of these strategies be assessed against the backdrop of a continuously changing environment? While such questions are not entirely unique to adaptation policy and practice, climate change poses particularly difficult challenges to policy-makers and managers given its global, complex, interconnected, and rapid nature.

The central question of this book is front and center on their minds: "What does successful adaptation look like?" In fact, it is that question – posed to us by practitioners – that has motivated the explorations collected in this volume. It is a question that has no easy scientific or political answers. Those who are just beginning to explicitly grapple with the adaptation question may not know where to begin to unravel the complexities involved that the question of success may

entail. And even those already deeply engaged in adaptation often have little experience with how to set themselves up for long-term learning, evaluation, and ongoing adjustments to meet policy goals in an uncertain and rapidly changing environment.

This edited volume responds to these practical matters through careful analyses of different cases and situations, and by questioning some unspoken assumptions that have pervaded climate adaptation decision-making to date. Contributors here aim to unpack the question of successful adaptation and offer both scientifically informed and practice-relevant answers from various sectors and regions of the world. We aim to frame how to think about adaptation success, rather than provide a uniformly applicable answer. Importantly, we approach this challenge from the assumption that there are social, ecological, economic, political, technical, institutional, psychological, and cultural dimensions to consider, and that, therefore, there will not and cannot be just *one* answer. For example, judging merely the achievement of economic goals (such as optimization or cost-effectiveness) may meet some stakeholders' objectives, but not at all those of others. Similarly, many cases from past experience exist where narrow definitions of "success" and inadequate consideration of diverse interests and concerns have led to resistance and policy blocking. Moreover, past lessons have shown that achieving desired outcomes at one level (say, the city or neighborhood) may not lead to or be consistent with desired outcomes at a regional or national level. The spatially interconnected and dynamic nature of climate change and similarly that of adaptation will, in fact, ensure such complications.

Clearly, the question of success is not simply to be decided on scientific, rational, objective, or procedural grounds, but is in important ways normative, historically contingent, and context-specific. Some dimensions of success will be outcome-based, yet, in many instances, success on all outcome dimensions cannot be achieved simultaneously (or ever). The question then arises how to adjudicate among goals, how to assess and negotiate trade-offs, prioritize goals and strategies, and move a process along that may be socially and politically deeply contested.

Given these premises, this volume does not offer a simplistic definition of success, but instead illuminates and critically assesses different dimensions of success and makes the case for which elements of successful adaptation to take seriously, when, where, and why. This is accomplished by drawing on the extant literature, a range of theoretical constructs, expert judgment (i.e. that of our contributing authors), and the practical experience gained in the case studies and examples presented here. We appraise how climatic and non-climatic stressors play a role, how scientific understanding as well as empirical grounding has informed climate adaptation decision-making, and how perceptions of trade-offs among priorities and other concerns can shape adaptation planning and implementation on the ground.

The overarching objective of this edited volume thus is to shed light on key issues that arise in on-the-ground adaptation to climate change – across a range of geographic areas and sectors – and how effective interactions between science and practice can assist in successfully adapting to a changing environment.

We begin by outlining six fundamental reasons why thinking carefully about adaptation success is useful or even necessary. In what follows from there, we define key concepts associated with climate adaptation and relevant work that can be drawn upon to inform questions involving "success." In so doing, we set the stage for the chapters – provided by over three dozen contributors – that follow.

Six principled reasons for thinking about adaptation success

At its core, this book is driven by the concerns of those who are charged with making practical decisions on adaptation, now and in the near future. A variety of trends at the international, national, and local levels are driving this interest. It also reflects a rush in the scientific community to the topic of adaptation success. For example, while the scientific literature of the past decade yields only limited insights on adaptation success (as discussed below), a recent international conference (*Adaptation Futures 2012* in May 2012 in Arizona, USA) saw a significant number of papers on "assessing adaptation effectiveness." International aid and climate-focused programs as well as governments and private foundations are asking whether their expenditures are reducing vulnerabilities, increasing resilience, or succeeding in "climate-proofing" valuable assets. Whether driven by policy pressures, funding, or applied research interests, the motivations to examine adaptation success are now widely apparent. The reasons can be grouped into six general categories, loosely mirroring steps in the adaptation process itself (adapted from Moser and Snover 2012):

(1) *Communication and public engagement*: For years, public engagement on climate change has been challenging in many countries of the world, and continues to be so for a complex set of reasons (e.g. Reser and Swim 2011). Yet, engagement specifically on local impacts, vulnerabilities, and adaptation is arguably still in its infancy. Practitioners and scientists alike have recognized, however, that for many individuals climate change can easily become a threat so big and unwieldy that they find it difficult to hold on to a positive outlook and hope for the future (Vanderheiden 2011). Rather than only conveying an abstract scientific phenomenon, or, alternatively, evoking "gloom and doom" through a focus on big, unavoidable, negative impacts, communicating a positive vision and inviting stakeholders into becoming part of a co-creative process of success is thought to be a more effective approach to public engagement (e.g. Boswell *et al.* 2012; Moser 2012; Moser and Dilling 2007), and, as such, an important element of adaptation planning. And those directly involved in on-the-ground planning and decision-making know that effective communication and truly meaningful, empowered public engagement are necessary to a successful decision-making process (NRC 2009, 2008; Cooke and Kothari 2001).

(2) *Deliberate planning and decision-making*: Thinking carefully about what an adaptation strategy or option is meant to achieve and how it will do so is a

fundamental element of good planning and decision-making practice: setting clear goals, identifying metrics of success, developing decision criteria, establishing timelines, and setting up appropriate decision processes (e.g. Margoluis *et al.* 2009b; Savory 1999). While clear goals and good decision-making may not guarantee that desired outcomes will be achieved, a lack of a clear goal has the potential to fundamentally undermine one's ability to align strategy, means, and ends.

(3) *Improved fit with other policy goals*: Part of a deliberate and reflexive approach to decision-making is to examine a policy's or strategy's interaction with other policy objectives, whether related to climate change or non-climate issues. We single this out from (2) above, because of the emphasis here on the broader policy context, rather than the adaptation planning and decision-making process itself. Where adaptation policy supports other policy objectives (e.g. mitigation goals, broader development objectives, or disaster mitigation targets), the positive synergies can result in cost savings, greater political support, and other important efficiencies and benefits. Similarly, negative interactions need to be carefully considered, weighed, and managed. However, when adaptation is not yet guided by policy or mandate, while other policies already are codified in law or programs, the pursuit or implementation of these other policies can undermine the chances of focusing on or succeeding with adaptation (Moser 2011; Klein *et al.* 2007).

(4) *Justification of adaptation expenditures*: Most advance planning and implementation of adaptation options requires funding, which – when the necessary sums are large and choices need to be made among several policy priorities – demands persuasive arguments. There is evidence even from highly developed countries that a lack of funds for both adaptation planning and implementation is a major obstacle to progress (Carmin *et al.* 2012; Hart *et al.* 2012; Foster *et al.* 2011). Thus, demonstrating prospects of success or achievements of specified objectives and criteria becomes critical for garnering public and funding support (CREXE 2012; Sanahuja 2011).

(5) *Accountability*: The complementary argument arises out of the growing demand for accountability – in both the public and private sector for one-time or repeated expenditures; in fact, sometimes there are legal requirements to do so. Against this backdrop of a growing "culture of accountability" and calls for greater transparency, decision-makers will need to demonstrate that the money, effort, and staff time is well spent (e.g. Anderson 2011; Margoluis *et al.* 2009a; W.K. Kellogg Foundation 2004). Setting expectations for success will also help stakeholders decide whether to engage in an adaptation decision-making process and support monitoring and enforcement, but also place performance pressure on those who are thus committed to deliver (Moser 2009a).

(6) *Support for learning and adaptive management*: Finally, to the extent adaptation is viewed as an ongoing, iterative process of managing climate risks, ongoing monitoring, periodic assessment, and evaluation of progress or effectiveness against the goals and metrics set initially is an essential part of adaptive management and social learning (CCS 2011; NRC 2010a,b,d).

Taken together, these six reasons for thinking about success balance the needs of being forward-looking and being reflective, between proving that something works and improving what is being done (W.K. Kellogg Foundation 2004).

Climate change, emerging impacts, and the urgent need to identify successful approaches to adaptation

Human-driven climate change (Box 1.1) is an established scientific fact. In 2007, the Intergovernmental Panel on Climate Change (IPCC) established – through a series of independent but theoretically consistent and mutually reinforcing observations – that global warming is "unequivocal." At the same time, the assessment established that most of the warming observed over the past half century is largely attributable to human forcing. Through improving detection and attribution work (e.g. Brander *et al.* 2011; Shindell *et al.* 2009; Allen *et al.* 2000; Tett *et al.* 1999), a consensus has emerged in the climate science community that observed climate changes – particularly over the past half century (with underlying changes in land use and emissions dating back much longer) – are largely driven by human activities and not merely the result of natural fluctuations (IPCC 2007).

The US National Research Council (NRC 2010a) confirmed this with new scientific insights in a more recent synthesis of the literature. With impacts already emerging across the globe, climate change is increasingly recognized as a challenge not just for future generations and decision-makers, but one increasingly pressing on decisions and challenges faced right now. That said, scientists expect that future impacts will be considerably more profound and affect numerous and wide-reaching environmental, economic, and social systems, albeit playing out differently in various contexts (Stafford-Smith *et al.* 2011; Parry *et al.* 2008; IPCC 2007). In fact, all sectors of society – water, energy, coasts, forests and conservation areas, agriculture and food security, human health, transportation, urban and rural communities and related infrastructure, marine environments and fisheries, and a broad array of related economic activities – are sensitive to changes in average climate and, particularly, to climatic extremes. However, depending on the specific exposure of ecological systems, valued resources, assets, or groups of people, and the adaptive capacities available and enacted, vulnerabilities to climate change vary dramatically across the globe. Researchers widely recognize that development pathways, the extent of poverty and level of human security, deep-seated structural factors, and other, non-climatic conditions and events are crucial co-determinants of both adaptive capacity and the ultimate impacts that are being and will be experienced from climate variability and change (IPCC 2012; O'Brien *et al.* 2008; Adger *et al.* 2007).

Not surprisingly, the specter of impacts has elevated adaptation to climate change on the agenda of international, national, sub-national, and local policy-makers (e.g. Bierbaum *et al.* 2012; Ford and Berrang-Ford 2011; Measham *et al.* 2011; Tompkins *et al.* 2010; NRC 2010b). The international community has – at least in principle – agreed to a global goal for mitigation codified in Article 2 of the

UN Framework Convention on Climate Change (in order to "prevent dangerous anthropogenic interference with the climate system") and tentatively operationalized through the 2°C target of warming beyond the pre-industrial average global temperature below which climate should be stabilized. However, no such international goal for adaptation exists. Absent deeper cuts in emissions, a growing number of researchers admit that staying below this 2°C target is practically unattainable, thus placing ever-growing demands on national and local-level adaptation to reduce climate change impacts and avert "dangers" to human and natural systems (Anderson and Bows 2011; Stafford-Smith *et al.* 2011; IEA 2011; NRC 2010c; Stern 2007).

This book then comes at a pivotal time. Policy-makers and managers in local communities, in regional and national-level agencies, and in international negotiations are becoming aware of the complexity and magnitude of the adaptation challenges ahead. Many are currently developing their first adaptation strategies, setting in place processes and institutional arrangements that will guide adaptation efforts for years to come. It is in this context that the scientific community has the opportunity to bring the developing scholarship on adaptation (and adaptation success) to bear on the real and growing practical needs for guidance on defining and measuring progress toward successful adaptation.

Box 1.1 A few words on defining key concepts that often have divergent meanings

In preparing this volume, it became clear that virtually all of the key concepts that thread through it can mean different things to different contributors. We believe this to be a reflection of the larger scientific and policy environment on adaptation at this time, and maybe for some time to come. In fact, what became apparent is that there are not just remarkable differences in understandings of success, but that these differences are at least in part rooted in how people interpret adaptation, the unspoken assumptions and goals they have in mind, and whether they focus on climate change or climate variability. We thus asked our contributors to make these unspoken and underlying understandings explicit rather than assume or impose a single set of meanings on them. That said, this volume is held together by a few central concepts whose specific meanings are discussed in each of the chapters that follow. This common ground is made up of the following central ideas and understandings:

Climate, climate variability, and climate change: The contributions to this book refer to the threats stemming from climate in any one region or locale and from the magnified or additional risks created by contemporary, anthropogenic climate change. Climate refers to average atmospheric characteristics (such as average temperatures, annual precipitation, seasons, etc.) but also includes its natural climate variability and extremes. Climate change then refers to changes in any of these conditions. The starting point for this volume is the broad scientific consensus on the major tenets of climate science as established in the IPCC (2007) and many other national academies and professional societies around the world. At the same time, many of our contributors work closely with practitioners "on the ground" and know full well that climate change alone rarely drives adaptation policy and decisions; climate change alone is not the only global or local change that matters to the future; and many decision-makers primarily focus on – and struggle with – adequately addressing current climate variability and extreme events with little attention paid to future changes. We are thus inclusive in our understanding of what summarily falls under the umbrella of the terms "climate" and "climate change" here.

Adaptation: The understanding of adaptation that runs through this volume is – generally – consistent with the understanding of this term held in the climate science and policy communities (i.e. as defined by the IPCC 2001; Adger *et al.* 2005): any "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." Several contributors, however, contest or extend this narrow interpretation of the term by drawing on a much longer history and disciplinary pedigree of the term. While the simple relabeling of "what we've always done" as climate change adaptation (be it in development, water conservation, public health surveillance, or any other arena) is rejected, our contributors recognize that many past activities are, in fact, adaptations to historical climate conditions, and many options in the existing and well-established portfolio of strategies and actions will still be useful for some time. Our emphasis here, however, is on actions that recognize anthropogenic climate change in why they are chosen and how they are designed.

As in any other multidisciplinary effort in this field, confusions or conflations of mitigation of causes (here: greenhouse gas emissions) with mitigation of effects (here: the hazards arising from climate changes) run deep (IPCC 2012), but we have attempted to focus the use of "adaptation" in this volume on the proactive and reactive responses to climate change impacts. Some contributors mean by this the relatively small, incremental adjustments, while others point to the far deeper, transformative changes that may be required to meet the adaptive challenge ahead. While the former often entails co-benefits for greenhouse gas reductions ("mitigation" in IPCC parlance), the latter quite likely will lead – ultimately – to the paradigmatic and systemic changes that will deliberately also reduce emissions. Importantly, when defining their terms, contributors imply certain goals (e.g. reduce vulnerability, enhance resilience, retain livelihoods, or preserve psychological well-being) and also certain temporal or process dynamics (e.g. preparedness, managing risks, engagement, consciousness

shifts), both of which directly affect their delineation of success (see also Doria *et al.* 2009).

Science: red thread that runs through the entire collection of chapters is the question how "science" can contribute to, inform, assist, and support society's adaptation efforts. By science we mean not just atmospheric science, and not even just physical science (e.g. hydrologic modeling or sea-level rise projections), but the full range of physical, natural, engineering, social, economic, medical, and humanistic sciences and fields of systematic academic inquiry. This focus on science's role is not to the exclusion of other forms of knowledge. In fact, the social sciences and practical experience have repeatedly established the critical importance of integrating multiple ways of knowing in local adaptation planning and implementation. But, given the often privileged role of science and the growing demand on science to inform adaptation decisions (Eakin and Patt 2011; Averyt 2010; NRC 2010d, 2009), this book specifically explores science's potential and limitations in adaptation.

Practice: Similarly, we are eclectic in our definition of "practice." It is the broadest collective term for activities ranging from policy-making, to planning, management, advocacy, and the physical implementation of certain adaptive actions, with all its sub-tasks. These activities are being carried out by a wide range of actors, and our contributors specify them and their actions in each case.

Foundations: thinking about adaptation success to date[1]

Overview

A search of the scientific literature on the topic of successful adaptation yields relatively limited direct insights to date (e.g. Adger *et al.* 2005; Doria *et al.* 2009; Eakin *et al.* 2009), though pragmatic attention to the topics of success, effectiveness, and evaluation is rapidly growing (e.g. a US National Research Council workshop on this topic in 2012[2]; CREXE 2012; Brunner and Nordgren 2012; Pringle 2011). Our book is an expression of this rapidly growing interest in academia. The limited availability of focused research on adaptation success is partly due to the long neglect of adaptation science, and partly due to the relative newness of the topic in practice, such that few actual cases exist where one could explore the question of adaptation success empirically.

A diverse and voluminous body of research exists, however, that is relevant to the question of adaptation success, though not specifically focused on climate change adaptation. This literature ranges from broader treatments of global environmental change (e.g. Kasperson and Kasperson 2001; O'Brien *et al.* 2010), to the rapidly expanding field of sustainability science (NRC 1999; Kates *et al.* 2001; Kates 2010), and narrower (but substantial) bodies of literature on disaster risk reduction and disaster resilience (Brunner 2012; Bahadur *et al.* 2010; Brown and Westaway 2011; Collier *et al.* 2009; Paton and Johnston 2006; see also the broader literature on resilience (reviews posted at www.resilientus.org) and on ecosystem services; MEA 2005; Walker and Salt 2006), as well as on economic and human development (Pelling 2011; Mitchell *et al.* 2010; Jerneck and Olsson 2008; Huq and Reid 2004).

In practice, the majority of proactive climate adaptation efforts are still in the relatively early stages of attempting to understand potential risks and vulnerabilities, adaptation planning, and options assessment (Bierbaum *et al.* 2012; Hart *et al.* 2012; Preston *et al.* 2011; Measham *et al.* 2011; NRC 2010b; Tompkins *et al.* 2010; Adger *et al.* 2007). Few examples exist that are in the implementation, monitoring, and evaluation stages where either the involved actors or independent evaluators could examine whether or not an adaptation action yielded the desired outcome(s) and could be considered a success. As a result, evaluative research on adaptation success to date either (a) reviews adaptation frameworks (Preston *et al.* 2011) and processes (Smith *et al.* 1996), or (b) makes common-sense, if normative, suggestions such as what outcomes to achieve (Adger *et al.* 2005; Smit *et al.* 1999), which elements to include in adaptation planning (e.g. downscaled climate information, vulnerability assessments, careful options assessment, stakeholder engagement to foster buy-in and legitimacy, sufficient resources) (e.g. Carlson 2012; CCS 2011; Snover *et al.* 2007), or what principles to use to guide adaptation (e.g. avoid actions that foreclose future adaptation options or negative externalities, work in partnership, focus on the highest-rated risks, make it sustainable, ensure fair outcomes) (Eriksen *et al.* 2011; Smith *et al.* 2009; Adger *et al.* 2006; Adger *et al.* 2005). These guides, expert elicitations, and reviews are meant to assist planners and managers in developing "best practice" processes and strategies but do not usually define adaptation success explicitly or with any specificity (UKCIP 2010; Bizikova *et al.* 2008; Snover *et al.* 2007; USAID 2007; Mehdi *et al.* 2006; Lim *et al.* 2005). Typically, they aim at establishing the need for adaptation, and lay out the "how to" of adaptation planning or implementation (including the need for evaluation of effectiveness and adjustments over time), but do not specify clear goals, endpoints, metrics, or criteria for success (see Bizikova *et al.* 2008 for a rare exception and a brief discussion in Carlson 2012). The growing guidebook literature on adaptation monitoring and evaluation, largely in the international development context (e.g. Spearman and McGray 2011), is similarly focused on processes and metrics for monitoring and evaluating *progress* toward defined adaptation outcomes but pays limited attention to how those outcomes could be defined to encapsulate success. To the extent such criteria are offered, they are necessarily general and recognize the need for context-specific operationalization (Doria *et al.* 2009; Adger *et al.* 2005). Other relevant work has focused on adaptation policies or actions, some on the skills of individuals and of effectively functioning organizations that have to carry out the work of adaptation (Lonsdale *et al.* 2010; Moser 2009b), and some on processes of stakeholder engagement, risk communication, and linking knowledge development to decision-making thought

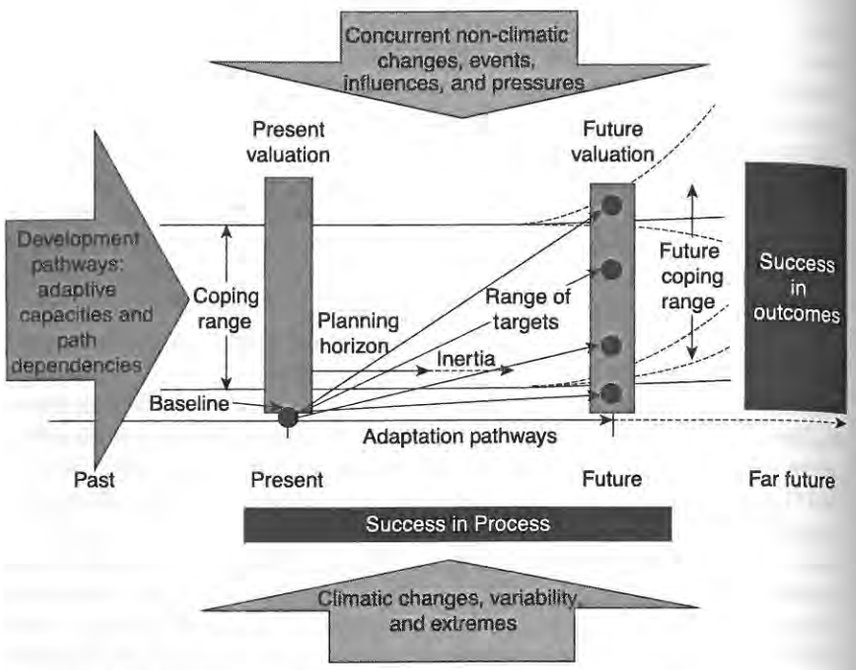

Figure 1.1 Challenges in defining and achieving adaptation success.

Note: A range of factors, influences, and uncertainties make it difficult to both define and achieve success in adaptation processes and outcomes. They include: the development pathways and their influence on adaptive capacities, current and future coping ranges, and path dependencies; potential differences in how today's stakeholders value certain resources, assets, and process features versus how future stakeholders might do so; the ability to capture today's baseline against which the effectiveness of an adaptation can be judged; uncertainties about which targets decision-makers should aim for, and how climate variability, change, and extremes as well as non-climatic influences affect the capacity to meet them; the synergies and trade-offs among adaptation outcomes; characteristics of the adaptation process along the adaptation pathway chosen; and the match or mismatch between planning horizons and the impact of decisions with the speed of climate change.

to increase the success of adaptation planning efforts (e.g. Averyt 2010; Miles *et al.* 2006; Lemos and Morehouse 2005; Gamble *et al.* 2003).

In the sections that follow, we explore key insights from the existing literature, thereby illuminating some of the complexities and challenges involved not only in defining adaptation success, but, more importantly, in achieving it (Figure 1.1).

The meanings of adaptation and their implications for success

A number of authors have observed that different interpretations of "adaptation" exist that vary in fundamental ways in their underlying – often implicit – theoretical and normative assumptions (e.g. Pelling 2011; Doria *et al.* 2009; Eakin *et al.* 2009). These differences set up rather distinct frameworks against which one might judge

success. Eakin *et al.* (2009) distinguish three such interpretations – an "adaptation," "vulnerability," and "resilience" approach – each representing a distinct policy response to managing climate risks, focused on different temporal scales, and involving different policy actors and stakeholders. The typically short- and medium-term focused adaptation approach is most often interested in specific sectors (e.g. water supply, transportation infrastructure, coasts, and agriculture) and seeks to address known and evolving risks and desires to achieve maximum loss reduction with the least effort, i.e. at minimal economic cost and governance change. Implied is a notion of success that is essentially about retaining current uses, structures, institutional arrangements, income levels, economic systems, and social relations as they are. By contrast, the vulnerability approach addresses past and present social and structural conditions in particular places, communities, and specific social groups (e.g. the poor, the elderly, or local communities in developing countries), and aims to protect the most vulnerable in society, reduce social inequities, and enhance response capacity. Implied notions of success entail socioeconomic restructuring, empowerment of the disadvantaged, and institutional or governance changes toward a fairer, more equitable, humane, and just society. Finally, the long-term, future-oriented resilience approach focuses on large-scale coupled social–ecological systems (e.g. a coastal watershed, rangeland, or forest reserve) with the goal of enhancing overall system capacity to persist, recover, and renew after disturbance, and thus minimizing the probability of rapid, undesirable, and irreversible system changes. Often the stronger emphasis here is on the continuation of ecological functioning and the provision of ecosystem services (Turner 2010). These distinctions are echoed in Pelling (2011), who differentiates (in roughly parallel order) between a "resilience," a "transition," and a "transformation" approach. In the conservation/natural resource management arena, the notion of the "4 Rs" (resistance, resilience, response, and realignment) mirrors these approaches to adaptation (Hansen and Hoffman 2011; Millar *et al.* 2007).

While human and cultural ecology have long distinguished "adjustments" (smaller management and structural interventions) from the deeper, more fundamental, and lasting changes called "adaptations" (e.g. Kates 1985; Burton *et al.* 1978), there is little agreement in the modern adaptation literature on the "unit of analysis" that constitutes an adaptation. For example, Eisenack and Stecker (2012) focus on adaptation as individual actions, while others more commonly focus on rather complex (but rarely specified or individually analyzed) sets of activities involved in realizing a particular option (e.g. building a dam or relocating infrastructure). To realize one such adaptation option involves repeated technical assessment, budgeting, planning, staffing, engagement, decision-making, permitting, building, and oversight activities, each with its own challenges, different sets of actors, and time horizons (Moser 2009b). While assessing overall success may focus only on the main strategy in question, the full story of why it worked or not may well be hidden in the underlying complexity.

These challenges only become magnified, the bigger the adaptation required to avert significant negative impacts from climate change. Kates *et al.* (2012) recently brought attention to the need for "transformative adaptation," i.e. actions

that are "adopted at a much larger scale, that are truly new to a particular region or resource system, and that transform places and shift locations" (2012: 7156). Their discussion differentiates the more common notion of adaptation as "incremental" change – akin to the approaches discussed above that essentially maintain the status quo or only make minor adjustments to "business-as-usual" governance and management processes – from the more fundamental shifts that may be required to minimize climate risks. In this context, the commonly heard notion of "mainstreaming" adaptation into existing planning and decision frameworks is revealed as a procedural goal embedded in interpretations of adaptation as relatively small adjustments. Differently put, it is difficult – if not outright oxymoronic – to imagine how transformation could be "mainstreamed" into existing structures of society. How deliberate transformative change might occur, however, is not well understood at present and is an emerging research topic in adaptation science (but see also past and current core projects of the International Human Dimensions Programme at http://www.ihdp.unu.edu/). Transformation is one of the core research themes of the recently launched framework for the international research initiative Future Earth (http://www.icsu.org/future-earth), and a key theme in the Fifth Assessment of the IPCC.

Coping range and societal acceptance of a future with risks

One of the most fundamental contributions to an understanding of adaptation success comes from Hewitt and Burton (1971) who first developed the idea of a community's or sector's "coping range" – an envelope of conditions within which society is able to deal with hazards such as may arise in the current or future climate. This envelope evolves out of historical experience and resulting societal choices, and reflects socially acceptable limits (Jones and Boer 2005). The related concepts of an exposed unit exceeding its risk tolerance, or crossing thresholds beyond which climate change is considered "dangerous" to a system of concern (IPCC 2001), are all relevant, but have yet to be operationalized at the local or even national level. The envelope of the coping range or of risk tolerance reflects the implicit and explicit adaptations already made, i.e. the systems in place and the learned and innate capacities to deal with extreme events or other sources of variability and change (such as insurance, structural protections, emergency response systems, etc.). On the assumption that no future state will be free of risk, but will entail a changed level of risks, successful climate change adaptation then might be said to be achieved if the coping range changes in lock-step with the changing risks, so as to not increase (and maybe even decrease) the overall risk as climate changes.

The problem of "institutional lag time," i.e. the idea that society and institutions rarely respond instantaneously to growing risks but require time to pick up changing risk signals, develop and agree upon appropriate responses, and the realities of the often significant lead times required to implement institutional and infrastructural changes, suggest that it may be unreasonable to expect the coping range to change simultaneously with the changing risks. This implies that a conceptualization of success would need to integrate this dynamic dimension, and that evaluations of the effectiveness of such "in lock-step" adjustments to the changing risk portfolio would need to encompass a relatively wide window of time.

Smith (2001) also brought attention to the fact that societies (or specific communities) – in the course of development or other non-climatic changes – may go through transitions by which not just the frequency or magnitude but also the type of risks they face may change (e.g. development from lesser to greater wealth reduces the risk of hunger and other poverty-related health threats, but increases the risks of economic losses). This suggests that any exploration of adaptation success should be cognizant of a community's or system's risk profile and net risk levels, and not just be focused on one risk. In this context, an extensive body of work on "human security" offers complementary insights as to the conditions, capacities, rights, and freedoms that ought to be created or retained if the goal is to ensure that individuals and communities are fundamentally secure in the face of global environmental change (Adger 2010; Brauch *et al.* 2009; Dalby 2009; O'Brien *et al.* 2008).

Shaping expectations: the failure-to-success continuum

A number of studies have also examined the presumed opposite of "success." In a comparative analysis of regions around the world in various stages of environmental degradation, Kasperson *et al.* developed the notion of "environmental criticality," a situation in which "the extent and/or rate of environmental degradation preclude the continuation of current human-use systems or levels of human well-being, given feasible adaptations and societal capabilities to respond" (1995: 25). In their discussion of human responses to environmental threats, they then distinguish human management responses along a failure-to-success continuum (Table 1.1), which usefully breaks up the simplistic "success or not" dichotomy by offering various benchmarks against which one may judge adaptive responses. The work also brings attention to the fact that all natural environments are already impacted to varying degrees by human use and modification, and that many human systems are shaped by deep-seated social challenges (e.g. injustice, corruption, institutional divisions, worldviews), thus setting implicit parameters around what could be achieved through climate change adaptation: maintenance of the status quo, degradation in the face of changing conditions, restoration, or maybe even more fundamental change and improvement.

A complementary research track focuses on barriers and limits to adaptation (often very process- and actor-focused; see reviews in Biesbroek *et al.* 2011; Burch 2011; Ekstrom *et al.* 2011; Adger *et al.* 2009b), where sometimes "success" is implied simply by the normative assumption that all barriers to adaptation are "bad" and that – therefore – overcoming them is "good" (see Moser and Ekstrom 2010 who explicitly take exception to that judgment).

Important complementary recent work has focused on the question of maladaptation (typically, more outcome-focused, e.g. Barnett and O'Neill 2010).

Table 1.1 The failure-to-success continuum

- **Maladaptation**
  Responses that worsen the situation or transfer the challenge from one area, sector, or social group to another (see also Barnett and O'Neill 2010)
- **Inadequate response**
  Responses that only partially address the causes or symptoms of degradation, so that the situation continues to worsen, maybe more gradually
- **Stabilization of a degrading situation**
  Responses that halt negative trends (including the prevention of novel and additional insults or maladaptive practices) or that compensate for increasing stresses
- **Repair and recovery**
  Responses that ameliorate the situation despite multiple stresses
- **Building something different or better**
  Responses that create a new and better situation altogether

Source: Adapted and extended from Kasperson *et al.* (1995).

Work on maladaptation helps to get a clearer handle on what constitutes undesirable or failed attempts at managing the risks of climate change. Barnett and O'Neill (2010) offer five normative criteria by which to judge whether an action is maladaptive, including whether it leads to increases in emissions of greenhouse gases; disproportionately burdens the most vulnerable; has high opportunity costs; or reduces incentives to adapt further or differently; and whether the adaptation sets in place path dependency that limits future adaptation options.

Adaptation pathways: failure, success, and social learning

In addition to making explicit our interpretations of adaptation (i.e. key subjective dimensions) the dynamic nature of climate change and, therefore, of adaptation adds objective challenges to the definition of "success." The magnitude and uncertainty of climate change and related impacts are projected to increase with time, affecting both adaptation needs and success over time. Despite the traditional emphasis in the climate science and adaptation communities on adapting to the *trends* associated with climate change, both scientists and practitioners increasingly realized that, in the near term and maybe for decades, climate risks may derive as much from (changing) *variations* in climate and from extremes (IPCC 2012; Hawkins and Sutton 2012; Sarachik 2010), a finding perhaps foreshadowed by Sarewitz and Pielke's (2000) call for adaptation via reducing known risks of climate variability. While adaptation is frequently dubbed "climate risk management" (e.g. NRC 2010a,b), an automatic extension (and success) of managing short-term variability and extremes toward managing long-term climate risks cannot be presumed (IPCC 2012).

What is clear, however, against the backdrop of a continually changing climate and environment (as well as contextual, unrelated societal changes), there is no "one" adaptation option to implement, and thus no one action to judge successful

or otherwise, for all time. In fact, adaptation is broadly recognized as a long-term, iterative evolving process of change (Stafford-Smith *et al.* 2011; Hess *et al.* 2011; World Bank 2010; Dobes 2008; Eales 2006), much like adaptive management in the natural resource management and conservation communities (e.g. Brunner and Nordgren 2012; Tompkins and Adger 2004; Walters 1986). Thus, there is a need for delineating adaptation pathways whereby approaching or crossing of certain thresholds in drivers and/or outcomes suggests changes in the adaptation strategy being pursued (e.g. Füssel 2007; Wilbanks *et al.* 2007; IPCC 2007). In a series of adaptive actions, initiated once these thresholds are crossed, one action no longer working "effectively" does *not necessarily* mean that it failed (e.g. beach nourishment may be cost-effective and preferable for some time, but, beyond a certain amount or rate of sea-level rise, retreat may become the more cost-effective approach). This, again, has important implications for the notion of adaptation success: for effectiveness to be assessed, clear targets, as well as spatial and temporal bounds, are required (Adger *et al.* 2005). Moreover, periodic review and clear thresholds need to be identified beyond which previous actions are reviewed and revisited. If, moreover, one assumes that different adaptation actions have different lead times (including time to develop, decide upon, and implement a particular strategy or action), the challenge is to build this needed time into adaptation planning processes, so that actors know when to repeat, upgrade, augment, or completely change previously taken adaptation actions to remain on a generally "successful" adaptation pathway (or within a socially accepted coping range).

Not surprisingly, an extensive literature has acknowledged that the never completed process of adaptation requires – if success is to unfold on a changing playing field – iteration, monitoring and evaluation, and a variety of arrangements that encourage and assist in social learning (e.g. Yuen *et al.* 2012; Lebel *et al.* 2011; Martin *et al.* 2010; Collins and Ison 2009; Pahl-Wostl *et al.* 2008; Pelling *et al.* 2007). As Glantz (1996) warned, however, merely listing lessons "to be learned" should not be mistaken with actually learning and acting on them.

Proactive adaptation – required in many instances to minimize losses, costs, and undesirable impacts – will often have to be undertaken in the face of considerable uncertainty. This uncertainty stems in part from the changing climate (and the limited ability of science to forecast it), in part from uncertain or unknown interactions between the changing climate and other systems, and in part from the irreducible uncertainty about how future societies will judge actions taken in years and decades prior. This points to the importance of adequate information required to make adaptation decisions (Keller *et al.* 2008), the ability to cope with – and update – uncertain information in the decision process (NRC 2010d; CCS 2011), the flexibility required to change those decisions if indications emerge that a given adaptation strategy is no longer able to produce desirable outcomes (Fankhauser *et al.* 1999; Smith *et al.* 2009), and the desirability of so-called "robust" adaptation choices that achieve intended, desirable outcomes over a range of future climate scenarios (Lempert *et al.* 2003).

Multi-scalar complexity and interactions among climate risks and adaptation actions

Even if the future were well known and adaptation actions implemented in a timely fashion, with added safety buffers to ensure robustness in the face of surprises, the paradox of multiple independent actors and complex connections and interdependencies among them adds yet other challenges – both analytical and practical. For instance, determining success of adaptation is made more difficult by the fact that adaptation is typically not just to one climate risk, but to multiple interacting ones (unfolding across geographic scales, spatial and sectoral boundaries, ecological systems, and social strata) against a backdrop of non-climatic stresses and conditions. It is conceivable that adaptation objectives are set for each identified risk, but, given the real-world interactions among them, and the still limited understanding of these interactions, it is possible to imagine a situation in which each adaptation is implemented perfectly and yet overarching goals are not met.

Moreover, adaptation decisions frequently will be in the context of policy goals that transcend climate change considerations (Adger *et al.* 2007; Adger *et al.* 2005). For example, economic development may be a higher goal than risk reduction in an urban floodplain. It is already well established that adaptation is rarely motivated only – or even primarily – by climate policy goals (e.g. NRC 2010b; Adger *et al.* 2007). Thus, when adaptation and climate change thinking get "mainstreamed" into existing governance and decision-making processes, the question arises whether the incremental difference of that inclusion should be assessed against the adaptation-free counterfactual or whether the impact of the modified institutional arrangement as a whole should be assessed vis-à-vis larger institutional or societal goals. The former may be technically more feasible; the latter is likely to be the challenge if adaptation gets mainstreamed into existing policy and management mechanisms, and, more importantly, what matters politically.

This has important implications for the criteria against which one may hold up adaptation actions. Adger *et al.* (2005), for example, show that defining adaptation success simply by whether or not an action has met its predetermined objectives is not enough because of the potential externalities it may impose on spatially or temporally distant communities and systems, as well as on other social groups besides the one that was meant to benefit from the action. They thus suggest four normative criteria – effectiveness (vis-à-vis specified objectives), economic efficiency, outcome equity, and process legitimacy – fully recognizing their complex and contested nature and the difficulty (but not impossibility) of measuring them. Doria *et al.* (2009) – using a Delphi process with experts – arrive at a definition of successful adaptation that reflects these same normative dimensions. Eriksen *et al.* (2011) propose four pragmatic principles that may help avoid some of the negative externalities of adaptation on larger societal objectives: recognize the context for vulnerability, including multiple stressors; acknowledge that differing values and interests affect adaptation outcome; integrate local knowledge into adaptation responses; and consider potential feedbacks between local and global processes.

Given the multi-scale, multi-sector nature of climate change impacts and adaptation and the equally complex nature of existing governance structures through which they will be addressed, adaptation will involve multiple interacting (or independently, maybe even counterproductively working) actors, policies, and institutions. Climate change impacts and adaptation research to date has raised the issue of distributional and interactive (i.e. synergistic, cascading, cumulative, and teleconnected) effects among impacts and among the adaptive responses to them, only some of which a local actor may have control over (Moser and Ekstrom 2012; Eriksen *et al.* 2011; Adger *et al.* 2009a; Adger *et al.* 2005). The implications for assessing success, however – such as which of the actors, levels of governance, or adaptive actions to focus on, or how to judge effectiveness if actions at one level were implemented as planned but actions at another were not, yet the ultimate outcome depends on both – have not yet been explored in an integrated fashion.

Evaluation challenges: problems old and new

Part of the iterative risk management (or adaptive) process is that achievements are periodically evaluated so that course corrections can be taken, if needed, and – through a deeper analysis of what worked and what did not – involved or observing actors can learn from the experience to date. Formal and systematic program and project evaluations face several fundamental challenges, including the need to clearly specify goals, the establishment of agreed-upon baselines against which progress is being measured, as well as clear criteria by which it is assessed. Maybe most challenging is the discernment of plausible causal links between actions, outputs, and outcomes, though detailed understanding of the process, multiple lines of evidence, and appropriate counterfactuals can help make a convincing case. Such evaluations, however, fundamentally require ongoing or at least periodic tracking of key indicators (e.g. Shaw *et al.* 2006).

In reality, evaluation so often is not undertaken or lacks rigor because one or more of these challenges are not adequately addressed. Goals are often not stated explicitly or only vaguely; criteria are rarely specified; baselines are not captured at the time of policy initiation or when a particular action is taken; attribution claims are made without persuasive evidence and counterfactuals; or quasi-experimental comparisons are seldom used, and sometimes impossible (Margoluis *et al.* 2009b; Moser 2009a). Maybe the biggest hurdle is that significant institutional and financial barriers prevent ongoing or long-term tracking of outcomes, and, even when monitoring and tracking occur, the frequency, intensity, and timing vis-à-vis the actions or initiatives that are being evaluated have significant implications for the quality of the evaluation. Rarely are there sufficient resources to undertake evaluations from multiple stakeholders' perspectives as is frequently recommended (Parks *et al.* 2005; Beierle 1998). Not surprisingly then, much performance evaluation focuses on near-term, tangible, easily countable

outputs or the completion of process steps, rather than long-term outcomes (W.K. Kellogg Foundation 2004).

Climate change and the long-term temporal dimension of adaptation add several difficulties to these commonplace ones (Walker *et al.* 2010). For example, aiming for a particular goal or target set some time into the future is fraught with the scientific or predictive uncertainties arising from both climate change and concurrent non-climatic changes. These uncertainties grow larger with time. The interaction among multiple climate risks (or between climate risks and concurrent other stressors, as discussed above) may reduce (or maybe sometimes increase) the effectiveness of an adaptation action taken. In addition to scientific uncertainties about the changing systems, there is also considerable value uncertainty. Future valuation of impacts and outcomes of adaptation may be affected by changing social values, expectations, and norms (a form of predictive uncertainty about society), but is also complicated by the fact that individuals' values can be ambiguous and the sum of or competition among individual values do not add up to collective values (Walker *et al.* 2010). It is also not clear how often or how soon an adaptation should be evaluated. This is an issue that has to be decided in the context of a range of climatic, geographic, and contextual factors for different types of adaptation actions. For all practical purposes, participatory scenarios planning and frequent evaluations of processes and short-term outputs and outcomes need to be combined with *post hoc* analyses and comparisons across cases and scales to arrive at an informed assessment of whether natural systems, society, or any of its components are staying within a dynamically changing, yet still acceptable coping range (Arvai and Froschauer 2010; Garmendia *et al.* 2010; Ernoul 2010; Tevis 2010; Keen *et al.* 2005; Herrick and Sarewitz 2000).

As is the case with many hazard mitigation, public health, and environmental policy interventions, publicly perceived success is achieved when an anticipated problem or impact does *not* occur: it is the deaths prevented, the damages avoided, the species surviving and thriving that constitute desired states of the world, yet proving that this is the result of a policy or management intervention is often difficult. Reasonable alternatives and credible explanations need to be sketched out. Moreover, from a pragmatic and political point of view, it is often those interventions that "no one notices" that are most socially acceptable, but by the same token these are often the most difficult to trace (Brunner and Nordgren 2012).

Among the tasks for science as decision support for evaluating adaptation effectiveness then is to specifically support this aspect of the iterative climate risk management process (e.g. Lemieux and Scott 2011; Haug *et al.* 2010; Palm *et al.* 2010). This involves both theoretical advances and empirical tasks. Importantly, such evaluative research must help stakeholders and decision-makers clarify their vision, objectives, and criteria for adaptation; science must also help actors calibrate their expectations of the future (e.g. through the identification of realistic targets, uncertainty bounds, and trade-off analyses) and identify and select compelling, integrative indicators of a desirable future, as well as sufficiently sensitive gauges that offer early warning alerts to decision-makers; tracking

relevant metrics to represent these indicators may be a joint task among scientists, government agencies, businesses, or civil society organizations with adequate funding sources. Uncovering plausible causal links between adaptation actions and outcomes may be aided by theoretical advances in understanding as well as by "thick" empirical analyses of particular cases (Adger *et al.* 2003).

Success as ideal, success as tyranny: the need for a pragmatic way forward

In the end, the ambiguities, uncertainties, complex interactions across time and space, the multiple and competing objectives, and fundamental challenges in evaluating success may seem to make the project of defining adaptation success overwhelming or outright impossible. In addition, stakeholders may place unfair expectations on adaptation as a way to fix past ills, solve pressing current problems, and ultimately create a better future, even if climate change makes this more difficult than ever (see discussion above). Clearly, policy-makers, planners, and managers need a pragmatic way forward (Brunner and Nordgren 2012).

Slightly more removed from the heat of political pressures and debates, scientists themselves may contend that the quest for clear guidance on successful adaptation is overwrought. Contrary to all "ideal-type" approaches to policy- and decision-making, analysts developed a more realistic view of "how things get done in the real world" decades ago. Rather than proceeding in a rational and deliberate fashion, much of on-the-ground policy- and decision-making is more disorderly and opportunistic – as echoed in the notion of the "garbage can" model of making choices (Cohen *et al.* 1972). More often than not, we "muddle through" (Lindblom 1959), or – taking note of the active and strategic choices policy actors make – we always navigate around the barriers that exist and, in that messy and circuitous way, eventually make progress (Moser and Ekstrom 2012). Good arguments thus can be made for this meandering path being just how society will work through the additional challenges posed by climate change adaptation.

While such realism and pragmatism is a helpful corrective to the academic untangling of seemingly simple ideas, an equally good argument can be made for improvements in decision processes to better account for the challenges of reaching policy objectives that arise as a result of climate change.

For example, adaptation planning opens up an opportunity to develop institutional mechanisms for long-term planning to transcend the long-bemoaned limits of short-term planning and election cycles. It also gives reason to identify more robust and socially and ecologically more sensitive policy and management priorities. Thinking about adaptation success further opens up an occasion to think beyond common but narrow policy objectives, such as economic growth, single-species protection, or preservation of the interests of the few. Moreover, given that the cost of anticipatory adaptation is often borne now, while the greatest benefits may be reaped only in decades to come, adaptation takes on the character of a public good. These are best provided by institutions with a responsibility toward the collective, rather than by individual or private actors (Walker *et al.*

2010). At the same time, adaptation will be both proactive and reactive, involving private and public actors, thus begging greater attention to the question of coordination among different actors. The fact that the ultimate effectiveness (i.e. the outcome success) of many implemented adaptation choices will not be known until tested by the unfolding impacts of climate change brings greater attention to the transparency, inclusiveness, and quality of the decision-making processes that shape the path to the future. At the same time, calls for greater efficiency in governance, the quite possibly growing urgency of climate-related decisions, the complexity of the issues, and thus the privileged role of experts and technocrats in informing adaptation choices raise serious questions about the future of democratic processes.

Quite pragmatically then, tracking and evaluating the adaptation *process* – with all its individual components (e.g. assessment, planning, stakeholder engagement, decision-making, implementation, institutionalization, monitoring, and social learning) – become at least as important as the question of success in *outcomes*. One could argue, for example, that maladaptation – to date predominantly judged on outcome criteria (Barnett and O'Neill 2010) – calls for consideration of process criteria. Clearly, a failed process (due to, say, inadequate leadership, corruption, lack of professional facilitation, a breakdown in fiduciary duties, insufficient funds, legal obstacles, or unresolved social conflict) can have significant implications for the chances of achieving desired outcomes. As not all outcomes may be able to be achieved simultaneously, and perceptions of "success" are subjective, the processes in place to adjudicate among different interests become crucial (Moser 2009a,b).

At the same time, the causal link between procedural adequacy and outcome success may not be straightforward. It is possible to imagine decision-makers following "best practices" in terms of assessment in any number of processes involved and yet not achieving intended outcomes; or – by contrast – enacting rather substandard processes and yet faring surprisingly well. Thus, policy-makers and scientists may require integrative indicators of success that include both process and outcomes observed at any one time and together paint a nuanced, if temporary picture of an "outcome gestalt."

Mapping the contributions in this volume

Each of the eighteen chapters that follow contributes to more than one theme touched upon in the above overview. Nevertheless, we place them into thematic groupings that touch on key threads delineated here.

The first group of chapters focuses on setting adaptation goals and the need to change them in light of climate change. This group of chapters also addresses synergies and trade-offs among different objectives. In each case, the authors discuss implications for the adaptation process, for adaptation strategies, and for institutional arrangements that could support successful adaptation. Building on their earlier work, Barnett and colleagues systematically assess proposed adaptation strategies for dealing with sea-level rise on small Pacific Islands and with water shortages in Melbourne, Australia to discern the degree to which they

manage to avoid certain criteria of maladaptation. They conclude that strategies that build adaptive capacity are preferable to those that reduce exposure when limits to adaptation are not yet reached. Stein and Shaw, as well as Hale and colleagues, take on the challenge prevalent in the conservation arena (but surely not restricted to that sector) that historically pursued goals of preserving existing patterns of biodiversity and ecosystem services are becoming increasingly unattainable. While Stein and Shaw focus on the pragmatic implications for conservation strategies, Hale *et al.* make a philosophical case for why humans have an obligation to assist species in adapting to the changing climate conditions, even when restoration to historical baselines is no longer attainable. They argue that success lies not in the achievement of a particular outcome, but in sufficiently justifying a particular course of action through extensive deliberation among concerned stakeholders. Finally, Schroeder and Okereke take on the question of trade-offs and synergies between mitigation and adaptation policy goals negotiated at the international level, making a clear case for the deliberate consideration of multiple policy objectives. They also raise critical questions as to the scale at which one might locate the measurement of adaptation success, when multiple scales of governance and financing are involved.

The second set of chapters focuses explicitly on institutional arrangements, on barriers to adaptation, and on the interplay and alignment of institutions to support adaptation. Ekstrom and Moser begin with a comparative case study of local governments in San Francisco Bay (California, USA), in which they explore barriers to adaptation and strategies to overcome them through the theoretical lens of institutional effectiveness. Regardless of the particular approach taken to measure institutional effectiveness, they find early indications of success, and argue that nested, multipurpose, and adaptable structures that enable ongoing dialog among stakeholders are crucial foundations for a successful adaptation process. Kasperson and Ram take on the prospects of rapid transformation of the US energy sector, focusing on the interactions and necessary alignment of multiple actors and policies and market mechanisms across scale, institutions, and interests. Anchored in the rich detail of contemporary energy politics and policies in the US, as well as in a theory of industrial transformation, they lay out a vision for systemic change of an entire sector that must radically reduce its contributions to the problem of climate change in the first place, while meeting energy security and adaptation goals. Finally, Khan and Roberts focus on an equally unwieldy topic, i.e. international finance of adaptation – an acknowledged need still lacking in serious commitment and carry-through. They argue that failure to adequately finance adaptation will have negative consequences not just for those locally who suffer the unmitigated consequences of climate change, but also for the global community. On the basis of recognizing one's self-interest in helping others succeed with adaptation, they work through relevant legal mechanisms that could help successfully codify the obligation to financially assist those who are least responsible for causing the problem.

The third group of chapters centers on effective science–practice interactions. Preston and colleagues begin with a careful exploration of the value of science in

three different cases: water management in utilities in the UK, and local coastal management and wine industry responses to climate change in Australia. Their concern is mostly with science successfully providing useful input into the decision-making process, not only illustrating how varied science's influence is for different stakeholders and at different points in the adaptation process, but also raising serious questions about the position adaptation science may hold in the future. Dilling and Romsdahl explore results from two independent surveys of the status of adaptation planning in natural resource management in different regions of the US and the role that improved decision support could play in supporting adaptation there. Based on the empirical findings, they propose concrete steps for improving the ways in which science could help resource managers meet their objectives, most notably greater investment in people as opposed to merely in hardware, static databases, tools, and scientific information. Patt then examines the potential of climate risk management – typically focused on shorter timeframes and more immediate hazards than climate change – to provide somewhat of a blueprint for adaptation. Using examples from many parts of the world, particularly Africa, he concludes that climate risk management could usefully serve as a learning laboratory for successfully connecting science to policy and practice, and as a way to build adaptive capacity among actors. Boyd and Cornforth similarly focus on short-term mechanisms – early warning and the near real-time monitoring of climate variability – to inform decision-making at the local level. Theirs are two interesting case studies from Africa where scientific and grassroots knowledge are linked via both technology and boundary organizations. They show how these cross-scale systems have come into being, how they are maintained, what makes them succeed, and where they fall short, pointing particularly to the role of effective communication, local leadership, sufficient time, and the multiple benefits they serve (besides enabling greater preparedness and resilience in the face of variability and extremes). Finally, Carmin and Dodman take the reader to the other end of the science–practice spectrum, and report on how city leaders across the world are using science and deal with the uncertainties in scientific projections. Just as successful decision support from scientists is often contingent on changing mindsets and learning about the needs of practitioners, those in decision-making positions are learning not just about the changes in climate, but also about the changing nature of science. Carmin and Dodman show what urban leaders do to successfully cope with moving guideposts.

The group of chapters that follows focuses on effective communication and engagement in support of adaptation. Boykoff and colleagues provide one of the first surveys in the literature on how adaptation is being treated in elite newspapers, both globally, and in their focus area, India. There they show how elite newspapers and new/social media appear to treat adaptation in a very limited way to date, and as such provide little of a discursive forum in which to explore visions of success. But they illustrate that separate, parallel discourses on adaptation exist, each using a rather different framing of adaptation, and thus shaping divergent, possibly even competing imaginaries of desirable futures. Lebel and colleagues explore cases of successful risk communication in the deltas and

coastal regions of Vietnam, Thailand, and Cambodia. They argue for multi-directional communication that links science with experience-based knowledge, builds trust and adaptive capacity, and as such serves as a necessary, if not sufficient, condition for successful adaptation. Burch *et al.* make similar arguments based on two cases in British Columbia, Canada, albeit with a focus on the use of visualization in the communication and engagement process. They find the combination of scenarios with GIS-based visuals anchored in the local context to significantly improve lay audiences' understanding of climate risks, their ability to deliberate about preferences for the future and trade-offs, and their willingness to take action.

The final grouping of chapters carries forward the theme of engagement but has a deeper psychological focus. Here the unifying theme is tapping into what matters to people at the most profound levels, fostering reflexivity, dialog with others, and thus the prospects of personal change as part of dealing with climate change: adaptation "from the inside-out." Moser highlights the emotional and political challenges that arise in the face of inevitable change and loss that climate change and adaptation will entail. Reporting on focus group findings held in coastal California, she highlights deeply held visions of success that are embedded in people's place identities and emotional attachment to place and community. She finds success to be about coming to terms with loss, while finding common ground with others, being engaged in shaping the future, and retaining some sense of control and hope. O'Brien concludes the volume with a piece that invites readers and those involved in adaptation to engage in self-reflection, contemplation, introspection, and personal vulnerability to open up the possibility for more fundamental shifts in society. She claims such inner work may be necessary to successfully work with others and ultimately to create a future in which both humans and non-human beings thrive.

In closing

Upon revving up our critical and analytical faculties to interrogate this notion of "successful adaptation" to climate change, the contributions collected here address many of the dimensions that shape common notions of success:

- *Economic dimensions* – how to minimize or avoid losses, damages, and adaptation costs, while maintaining, creating, or banking on possible benefits and opportunities;
- *Institutional and policy dimensions* – how to formally account for obligations to each other and to non-human beings when establishing and promoting particular actions and behaviors;
- *Ecological and environmental dimensions* – how to value and foster resilience, cultivate diversity and health in the biosphere, and continue to provide vital ecosystem services;
- *Social dimensions* – how to reduce inequities, vulnerabilities, and, in turn, how to strengthen communities, livelihoods, and justice;

- *Political and procedural dimensions* – how to support transparency, inclusiveness, and collective learning via democratic and legally defensible responses to climate change; and
- *Cultural and psychological dimensions* – how to create and retain the highest quality of life, meaning, and happiness, sense of community, and connection to place.

Each of these dimensions, and the interactions among them, must be the focus of further research in years to come, especially in developing sample metrics and learning in in-depth and comparative ways from cases where adaptation strategies have been developed and implemented. These results need to be widely shared and communicated to practitioners and stakeholders. Of particular interest will be the question of how the communities and individuals involved have addressed these various dimensions, found synergies, managed trade-offs, and engaged affected publics in making difficult decisions.

Of course, each of these dimensions is deeply value-laden and perpetually contested on the never-level playing field of social relations in any one on-the-ground adaptation process. Our goal with this volume is not to resolve the tensions among these dimensions, but to name them, and to compile encouraging evidence that resolutions can be found. In so doing, we show clearly that science and scientists have a critically important role to play in educating, informing, supporting, *and* challenging those charged with planning for the future. It is equally true that scientists have much to learn from practitioners so as to realign their research foci with increasingly pressing societal needs. And practitioners are learning to open up calcified procedures, institutions, and mindsets to better accommodate the fact that "the future ain't what it used to be."[3] Whether as scientists or practitioners, we hold privileged positions in understanding and affecting the future. In line with O'Brien's powerful take-home message, we believe we owe it to ourselves, our fellow citizens, and those who come after us to consider how we enact these roles, examine our beliefs, behaviors, and the structures we have built to protect them, and expose them to the possibility of change. This involves honest, critical, and sustained self-reflection and outward-facing examination. We would consider it a remarkable indicator of success if we started here.

Notes

1 This review draws and expands on Moser and Snover (2012).
2 The workshop was entitled "Developing Improved Decision Support for Adaptation & Mitigation" and was hosted by the Committee to Advise the US Global Change Research Program, National Academies of Sciences, Washington, DC, 4–5 April 2012.
3 The phrase is the title of the 2005 King County, Washington (US) climate change conference, hosted by an early leader in climate change adaptation, King County Executive Ron Sims. See: http://www.kingcounty.gov/exec/globalwarming/environmental/2005-climate-change-conference.aspx.

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