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The Concept of Adaptation

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Keywords

adaptation, resilience, transformation, pathways, maladaptation, Loss and Damage

Abstract

Adaptation (i.e., actions that reduce the harms caused by climate change) is widely recognized as one of two pillars of climate action, along with mitigation (i.e., actions that reduce the concentrations of greenhouse gases which cause climate change). Action to date in both pillars is widely recognized as insufficient. This article argues that a major source of this deficiency of adaptation is ambiguity in the concept of adaptation, which hinders planning and implementation of action. The review traces the origins and consequences of this ambiguity and examines three major conceptual obstacles: the unclear relationship between adaptation and mitigation, the tendency to define adaptation by listing distinct types that are not directly comparable and hence difficult to measure, and a persistent separation of short-term and long-term perspectives that limits the ability to build from current action to transformation. The article identifies recent efforts that have addressed these obstacles, although new areas of concern have emerged, particularly maladaptation and Loss and Damage.

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1. INTRODUCTION

Is a review of the concept of adaptation necessary? Adaptation is well established in climate change settings. Its nature seems self-evident and unproblematic. Yet this taken-for-granted quality should not itself be taken for granted: The concept arrived on the global stage in a particular period in a particular way and has had a distinctive history which shapes current debates. Its ability to meet certain conceptual and organizational needs was quickly recognized. Though the concept has been extensively reviewed, much of the discussion focused on specific details rather than on a fuller consideration of the concept's nature, history, and trajectory. This taken-for-granted quality has allowed some assumptions about the concept to remain unexplored and some ambiguities within the concept to remain unresolved, whether consciously through acts of omission or unconsciously through inattention. This article seeks to examine the concept by considering these assumptions and ambiguities, showing both the progress that has taken place from the concept's entry into climate discussions and the obstacles that hinder further progress.

Another well-established aspect of adaptation in climate change settings makes such a review timely. It is widely agreed that the world has not done enough to adapt to climate change, much as it has not done enough to reduce greenhouse gas emissions in order to limit the rise in global temperatures. Although climate change adaptation activities have grown in recent decades, the need for further adaptation is growing more evident as well. A review of the concept of adaptation

can contribute to understanding this deficiency and could thus support a much-needed expansion of adaptation.

The sources of this deficiency might seem to be political, a lack of will to take action to promote adaptation, in a world with other priorities which require attention and resources as well. However, as is argued in greater detail below, such action has also been limited by conceptual obstacles, particularly the imprecision of definitions of adaptation and the lack of clarity on the relations between adaptation and other central concepts, especially mitigation. As discussed below, at many points, the concepts and politics are inseparable, as the concepts which guide thinking and decisions also guide the political debates over priorities and courses of action. And the progress that has taken place to date—the expansion of adaptation action and funding, even if insufficient in scale—also shows the interaction of conceptual and political elements. In summary, this article about the concept of adaptation is also about the politics of adaptation.

These conceptual obstacles can be traced to the origins of the contemporary concept of adaptation. In the late 1970s and 1980s, the growing threat of climate change led a set of researchers, public officials, and civil society organizations to hold several international meetings and conferences on this topic (1). In these discussions, these groups voiced a need: a need to take action to address the risks or impacts of climate change that would occur in the future or that were already beginning to take place in the present. The term “adaptation” came to occupy that space. It was not a new term—it had been used since the nineteenth century to describe a variety of biological, psychological, and social processes. But at this point, adaptation started to take on this new meaning within the realm of climate change planning and response, where it has remained ever since.

Of enormous consequence for the concept of adaptation were two international organizations that emerged from these meetings: the Intergovernmental Panel on Climate Change (IPCC), which assesses knowledge about the climate system, including its changes and impacts, as well as societal responses to it, and the United Nations Framework Convention on Climate Change (UNFCCC), which formulates policies to address climate change. These organizations, discussed below, have operated as the key center in which climate concepts are debated and from which new formulations of the concepts are disseminated. The global membership of these organizations includes representatives from national governments (in the case of the UNFCCC) and from the natural and social sciences (in the case of the IPCC), conferring legitimacy on their deliberations. This article sketches their key activities and demonstrates their importance as the context for debates over the concept of adaptation.

1.1. Key Aspects of the Adaptation Concept

From its emergence in these two organizations, the concept of adaptation has been marked by several long-lasting features that have both sustained its importance in climate thought and action and placed constraints on it. First, adaptation has been yoked unevenly with mitigation. Early discussions in the 1980s and 1990s prioritized mitigation, at a time when scientific experts argued that climate impacts were concentrated in the future rather than the present, were characterized by uncertainties, and could best be addressed by limiting greenhouse gas emissions. Adaptation entered climate discussions in a secondary and somewhat problematic role, with some researchers arguing that it should not be considered at all, in order to double down on mitigation. The relationship between the two concepts, though it has shifted over time, remains uneven and retains areas of ambiguity and tension, even as the need for adaptation has grown more evident. This lack of clarity is noted here not because it prevents full parity (it is difficult to imagine what a 50–50 split between the two might mean) but for other reasons: It leaves adaptation neglected on an absolute scale (rather than in relation to mitigation), it often suggests that mitigation should

IPCC:

Intergovernmental
Panel on Climate
Change

UNFCCC: United

Nations Framework
Convention on
Climate Change

serve as a model for adaptation (despite their differences), and it can block coordination between the two that could draw on their complementarity.

Second, the concept of adaptation has lacked a clear, precise definition. It is often described taxonomically, through a listing of types of adaptation, rather than by stating its central characteristics. These definitions name the different forms which adaptation takes, often observing pairs of forms. One early definition listed three pairs: anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (2). Though it may seem natural to observe that a number of forms of adaptation exist, such listings of types (which show no sign of abating) leave the definition of adaptation partially unresolved. Which types are most important, and what are the relations among them? An important consequence of this lack of a precise definition is the difficulty in measuring adaptation; it is hard to tell which adaptation actions are larger or more significant if they lack a central feature or element along which they can be consistently compared. For this reason, the difficulty in measuring adaptation contributes to a difficulty in prioritizing adaptation actions. It also shapes discussions around financing adaptation: It is easier to say how much an activity could cost than how much adaptation it would deliver.

Third, the temporal scale of adaptation remains divided and uncertain. Adaptation can be regarded as operating in the short term, often through specific projects; this approach is sometimes called incremental. Research on this timescale often takes place through the analysis of case studies. Adaptation also operates in the long term, often through what are termed pathways; this approach is sometimes called transformational. Research on this timescale often takes place through modeling and scenarios. Though it may seem reasonable to take action in the present while also looking to a more distant future, in the case of adaptation these two time frames are usually treated separately rather than jointly, and the crucial intermediate scale, in which these time frames connect, remains neglected—a gap that this article calls the missing middle ground. As a result, it is difficult to see how action in the present and immediate future will—or will not—contribute to longer-term goals of a positive, more sustainable future.

The difficulties created by these questions about adaptation—its relation to mitigation, its definition and measurement, and the relations of its dynamics on different timescales—compound one another, because the relations between adaptation and mitigation cannot easily be established if adaptation is not clearly defined and systematically measured and if the timescales on which the relations between the two unfold remain weakly connected. Importantly, these questions about adaptation leave some basic issues incompletely addressed. In which regions and sectors has adaptation progressed most effectively? What resources and support are needed to promote adaptation? Only in recent years have these questions advanced, and the answers remain incomplete.

To examine these constraints on the concept of adaptation, this article traces the concept of adaptation through three periods. The discussion examines the interrelated developments in the concept and politics of adaptation for each of these periods. The first runs from its beginnings through 2007, when adaptation achieved recognition as a full complement to mitigation. The second extends from 2007 to 2014 and 2015, when the IPCC's Fifth Assessment Report (AR5) and the UNFCCC's Paris Agreement provided solid footing for adaptation within climate assessment and policy. The third runs to the present, a time marked by an increased sense of urgency for action and by the emergence of new narratives, termed here orderly narratives and critical narratives, the former more centered on the enablers of adaptation (particularly governance, finance, and knowledge) and the latter more focused on the limits to adaptation (including loss and damage, and maladaptation). This section closes with a review of advances in the concept, and politics, of adaptation in recent UNFCCC events and IPCC reports along with a consideration of upcoming events. In this way, it shows that the core conceptual obstacles—the unclear relations of adaptation and mitigation, the imprecise definitions of adaptation, and the missing

middle ground—continue to result from politics and to influence it; this section also shows some efforts to address the obstacles, through specific elements within the Paris Agreement and through the concept of climate-resilient development.

2. THE ARRIVAL OF ADAPTATION ON THE GLOBAL STAGE (1990–2007)

2.1. The Slow Arrival of Adaptation

Soon after climate change appeared as a major global issue, adaptation emerged as the second pillar of climate change action, joining mitigation, which had been the primary focus. It has consolidated that position. This pairing now is broadly accepted both within the two key international institutions, the UNFCCC and the IPCC, and elsewhere. Adaptation has become widespread and yet remains unfocused: It is still difficult to measure adaptation and even to establish unambiguously what it is.

One can speak of a history of adaptation before climate change—a topic that others have covered in depth (3) and is sketched briefly here. The word has a long history in English, dating back to alchemical and theological texts from the sixteenth and seventeenth centuries that use it to refer to transformations of inorganic and organic substances. Darwin (4) employed the word more than 20 times in *On the Origin of Species* (1859) to refer to modifications of organisms or species which allowed them to survive in their environments. It acquired related meanings in the psychology of perception (the adjustment of the eye to the intensity or color of light) and of human development (the capacity of an individual to adjust to circumstances). The pragmatist philosopher John Dewey (5) developed a parallel sense in his discussion of the processes by which individuals and societies came to know the worlds around them and to change features in them, so that their goals could be met more effectively.

Drawing on these usages by Darwin and others, social scientists in the middle of the twentieth century also spoke of adaptation. Anthropologists primarily looked at normal or stable conditions; important figures include Julian Steward and Marvin Harris, who discussed cultures as adaptations that throughout history have permitted humans to establish and maintain livelihoods and social life in a wide variety of environments (6). Some geographers such as Karl Butzer (7) and William Denevan (8) used the term in this sense, though others focused on extreme events. Gilbert White, Robert Kates, Ian Burton, and others underscored the role of hazards in eliciting human responses and shaping institutional forms (9).

One can also speak of a history of climate change before adaptation. There are two key elements to emphasize that emerged from this history: the linkage of climate change to sustainable development and the strong dominance of international organizations and donors and of national governments within climate change policy. Climate change as an issue emerged in the era of sustainable development, which itself is a subperiod within the broader age of development that began after World War II. Both the new United Nations, founded months after the end of the war, and other international organizations sought to accommodate the disparate groups of nations among their members; these groups included countries that were becoming independent (a trend that started in the late 1940s and accelerated in the 1950s and 1960s) and their former colonial rulers, and the opposed sides of the Cold War, which unfolded more or less simultaneously. Development provided a common language and a promise that all could adopt. When faced with the rise of environmental movements in the 1960s and 1970s, which threatened to question the commitment of development to endless economic growth, development barely faltered. The issue was addressed at the United Nations Conference on the Human Environment in 1972 in Stockholm. The declaration that emerged from the conference established an environmental goal “to defend

UNEP: United Nations Environment Programme

WMO: World Meteorological Organization

and improve the human environment for present and future generations” as a third goal (10, p. 2), equal to and in harmony with the United Nations’ two other goals of peace and of economic and social development; the United Nations Environment Programme (UNEP) was founded at the same time. The slow progress toward that goal led the UN General Assembly to establish a commission which generated a 1987 report, “Our Common Future” (11), that widely diffused the phrase “sustainable development,” which had been introduced earlier that decade (12). The use of this phrase, in turn, influenced the subsequent decadal global environmental summits, particularly the 1992 Rio Summit, the Stockholm+20 Earth Summit, and the Stockholm+50 Conference.

Climate change emerged as a global issue—with an initial approach focused much more strongly on mitigation than on adaptation—in the contexts of these global environment organizations and meetings. The UNFCCC was established at the 1992 Rio Summit, along with the Convention on Biological Diversity and the Convention to Combat Desertification. Though other environmental agreements and organizations of other scales and types are influential, these UN-based conventions assure the centrality of international arenas and of national governments in establishing the frameworks for governance of environmental issues, including climate change. It is within these frameworks that adaptation arrived as a concept.

Although these three conventions were announced at the same meeting, each built on separate efforts in different environmental realms, as has been discussed elsewhere for the cases of biodiversity (13) and desertification (14). In the case of climate change, the convention developed from a set of international climate conferences, organized by groups led by natural scientists, particularly the World Meteorological Organization (WMO) and the International Council for Science, along with the UNEP and other UN bodies (1). A conference in 1979 led to another in 1985, which recommended “ensur[ing that] periodic assessments are undertaken of the state of scientific understanding and its practical implications” (15); the UN General Assembly resolution that created the IPCC, under the WMO and the UNEP, was a direct consequence. A third conference in 1990 reviewed the first IPCC report; among its conclusions and recommendations was the statement that “[n]ations should launch negotiations on a convention on climate change and related legal instruments without delay and with the aim of signing such a convention in 1992 [at the Rio Summit]” (16, p. 66). It singled out natural science as a critical underpinning of the convention, noting:

The development of policy regarding climate change requires on the part of policy makers an understanding of the underlying science and a weighing of the scientific uncertainties associated with the prediction of climate change and its likely impacts. An important aspect of future work is therefore a continued dialogue between scientists and policy makers. (16, p. 66)

This proposal led directly to the UNFCCC, which was established at the Rio Summit in 1992 and entered into force in 1994, when a sufficient number of countries (called “parties” in diplomatic parlance) had signed it.

In other words, these two organizations, the IPCC and the UNFCCC, appeared on the global stage within a relatively short period. Both are intergovernmental institutions, with national governments as their component units, and both are strongly rooted in natural science. They were designed with their complementarity in mind, with the IPCC providing scientific assessments that would guide the formation of policies by the UNFCCC. In the three decades that have passed since their formation, the concept of adaptation has advanced in strikingly parallel fashion, in ways that reflect their separate but interlocking mandates. Many other organizations in civil society and at other scales of government have addressed adaptation as well, with their discussions shaped by IPCC–UNFCCC exchanges.

This timing and form of origins have had a profound influence, assuring adaptation a central place in global climate thinking and action but also shaping and constraining it. Three general

constraints are mentioned here. First, these two organizations have firm boundaries, as the IPCC draws on academic experts and the UNFCCC on government officials. Entry to their conversations is available to some, but not to all. In theory, nearly the entire population of the world is represented, since all people are citizens of states that send delegates to UNFCCC, while academic research assessed by the IPCC examines all regions. But the directness of this representation is uneven, because it relies on the priorities of the governments and scientists who speak for them. In some cases, individuals within these two organizations can champion some specific groups or issues, though others, lacking such champions, will be less fully represented. As a result, some discussions of climate change that take place in communities and social movements outside these two organizations can receive little or no attention within the organizations. And, as discussed in greater detail below, some groups, such as women and Indigenous peoples, have faced obstacles to join in the discussions and to have their words taken equally even when they have gained admission to these forums.

Second, these two organizations have specific processes. Though these processes differ significantly between the two, they are similar in important ways. The drafting of documents is conducted by teams rather than by individuals, and final drafts are approved by consensus among government representatives rather than by majority vote. (Although academic researchers draft the IPCC reports, government officials vote to approve them, as they do for the policy decisions of the UNFCCC.) The officials who vote on UNFCCC and IPCC documents represent very different circumstances—developed and developing countries, petrostates and small island states, to name two contrasts—so achieving consensus is often challenging. As is discussed below, these processes lead to ambiguity in these documents, as it is easier for vague statements to receive unanimous support than precise ones. These processes often lead to long definitions with many components, as participants seek to add favored elements to draft versions of the definitions.

Third, these two organizations have specific perspectives. The UNFCCC draws on frameworks of national governments, particularly in areas close to climate change such as sustainable development, while the IPCC relies on approaches within published academic literature, especially in the natural sciences. Though these perspectives have enabled significant advances in some areas, they focus attention in certain ways, leading to relative neglect elsewhere. For example, issues that are sensitive to national governments, such as migration or minority rights, may be treated less prominently than issues that are more aligned with national priorities, such as economic development. Similarly, complex issues that are difficult to examine with existing scientific methods may be discussed less than simple ones that are easily studied.

The IPCC opened the discussion of adaptation in its First Assessment Report (FAR) in 1990 (17). Though it discussed both adaptation (sometimes called adjustment) and mitigation (termed limitation at that time), mitigation featured far more prominently, reflecting the growing concern to sharply reduce greenhouse gas emissions. The Policymaker Summary of Working Group III (Response Strategies) has a long section titled “Response strategies for addressing global climate change” that consists entirely of mitigation; a briefer section on adaptation appears at the end (17).

The UNFCCC underscored the centrality of mitigation even more firmly. Article 2 of the 1992 Convention famously states:

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. (18, p. 4)

Working groups of the IPCC: Since 2001, these have included Working Group I, Science; Working Group II, Impacts, Adaptation and Vulnerability; and Working Group III, Mitigation

This statement indicates that the single objective of the Convention is the stabilization of greenhouse gas concentrations, a matter of mitigation rather than adaptation.

However, several other elements important for the concept of adaptation are suggested in this statement as well. First, the temporality of adaptation, like other climate action, is complex; the Convention suggests the existence of delays, because stabilization of greenhouse gas concentrations does not lead to an immediate stabilization of the climate system. Second, it points to the notion of risk, which emerged in later decades, through its discussion of “dangerous anthropogenic interference.” Third, it suggests the importance of sustainable development, with its mentions of ecosystems, food, and economics.

The term “greenhouse gas” appears more than 30 times in the Convention, and the planned activities center on mitigation, emphasizing research, monitoring, reporting, and the development of technologies and policies to reduce concentrations. Nonetheless, the Convention refers to adaptation activities and contains five mentions of adaptation (a term it did not include in its list of definitions). Article 3 suggests, rather generally, that “[t]he Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects” (18, p. 4). Under the commitments, listed in Article 4, that parties (the member states) shall carry out is one to “formulate, implement, publish and regularly update” programs that include “measures to facilitate adequate adaptation to climate change” (p. 5) as well as mitigation measures. Article 4 also states: “The developed country Parties and other developed Parties included in Annex II [the countries with responsibilities to make financial contributions] shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects” (p. 8). The issue of finance, mentioned explicitly in the Convention, has played an important role in the development of the concept of adaptation.

2.2. The Pairing: Adaptation Joins Mitigation as the Second Pillar of Climate Action

In the following years, the UNFCCC held annual Conferences of the Parties (COPs), in which member states negotiated to produce policy agreements (called decisions), and the IPCC produced an assessment report every 5 to 7 years. Adaptation advanced slowly at first in both contexts, particularly in the UNFCCC, where COPs in the 1990s focused almost exclusively on mitigation.

Adaptation was mentioned in the IPCC’s Second Assessment Report (SAR) in 1995, which, like FAR, allocated much more space to mitigation than adaptation. It was covered in this report’s contribution from Working Group II (Impacts, Adaptations and Mitigation of Climate Change). Unlike FAR, SAR contained a glossary, which included an entry for adaptability:

the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate; adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions. (19, p. 863)

This first mention of adaptation includes three pairs of terms (projected or actual changes, spontaneous or planned action, responsive or anticipatory action); as discussed further below, the use of such dichotomies has proven to be a remarkably stable—one might say resilient—feature of adaptation, on the one hand offering a broad, inclusive scope and on the other hand including a range of distinct items that are difficult to compare. Because different types of adaptation may be amenable to measurement only by different metrics (the familiar challenge of comparing apples and oranges), researchers, policy makers, and others who seek to examine how much adaptation

has been planned or implemented are directed to tally actions by the kinds of adaptation, rather than to sum actions across all kinds.

Also significant for adaptation was the 2000 release of the IPCC's Special Report on Emissions Scenarios (SRES) (20). Such special reports are assessments of particular topics, more narrowly focused than the assessment reports and typically shorter. SRES contains elements that would later become significant for the concept of adaptation. The scenarios that it presents provide projections of net emissions, drawing on socioeconomic drivers of sources and sinks such as human populations, levels of economic activity, and technologies that are associated with energy use and land use. These socioeconomic drivers, presented in some detail, include information that could be linked to adaptation, though SRES focused primarily on matters of relevance for mitigation.

These scenarios replaced earlier sets of scenarios used in FAR and SAR, which were widely considered to include only a narrow set of greenhouse gases and economic and technological drivers and to draw on a limited set of models. They remained in use for the next two assessment reports. Their names—A1, A2, B1, and B2—signaled that they differed on two dimensions, with the A scenarios more focused on economic growth and the B scenarios including environmental and social sustainability, and with the 1 scenarios having a higher degree of globalization and the 2 scenarios having a greater regional focus. SRES also used the term “storyline,” offering a suggestion of the nascent reflexivity or self-awareness within the IPCC of the importance of communication, and of providing narratives that can be easily grasped.

The Third Assessment Report (TAR), published in 2001, covered adaptation more extensively. For the first time, adaptation was clearly separated from mitigation in the names of the working groups; Working Group II received the name Impacts, Adaptation and Vulnerability, and Working Group III became Mitigation. (Working Group I had referenced Science in its title since FAR; the word Impacts in the title of Working Group II serves as a bridge between the two.) The glossary included a separate item for adaptation, including additional dichotomies in its definition:

Adaptation: Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. (2, p. 982)

TAR also marks the arrival of adaptation in the figures accompanying the text of the assessment reports. One figure appears to treat adaptation and mitigation equally, placing both terms in boldface and indicating their parallel roles in feedback loops; however, the report as a whole speaks more firmly and extensively about mitigation, indicating the relative potential of different forms of action on greenhouse gas concentrations (**Figure 1**). The discussion of adaptation in TAR notes a wide variety of adaptation actions in different sectors and regions, with examples for both elements of the various types listed in the definition. It also mentions the limits on the ability of researchers to evaluate the effects of adaptation activities on impacts and vulnerability. It emphasizes the importance of enhancing adaptive capacity and notes the greater vulnerability of underdeveloped countries.

Though adaptation was becoming more prominent as the assessment reports advanced, some researchers, policy makers, and nongovernmental organizations (NGOs) questioned the full equality of adaptation. They noted that adaptation could be a moral hazard, postponing action on mitigation by making impacts less urgent (21, 22). Moreover, adaptation could compete with mitigation for attention and for funds; they also raised concerns about competition with development, by downplaying nonclimate priorities which could reduce vulnerability generally, or by

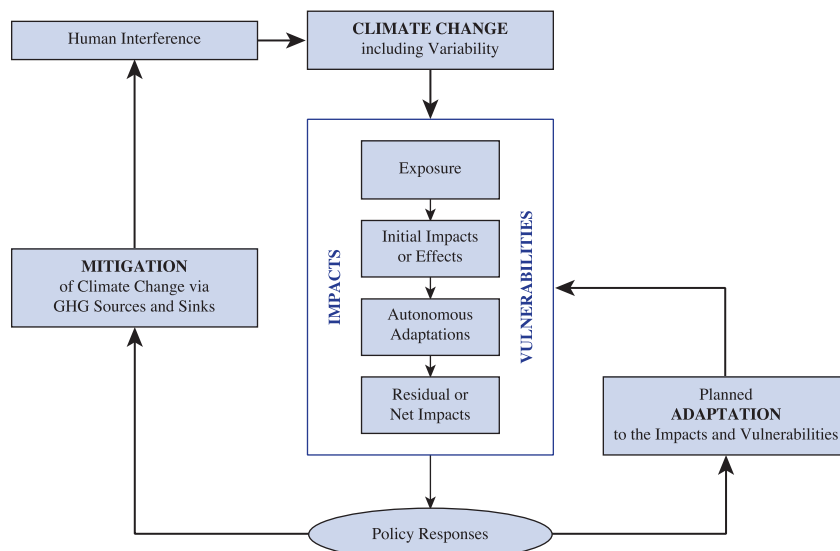


Figure 1

Scope of the Working Group II assessment of the Intergovernmental Panel on Climate Change's Third Assessment Report, Technical Summary. Abbreviation: GHG, greenhouse gas. Figure reprinted from Reference 2.

artificially separating climate impacts from other development needs (23, 24). Nonetheless, as climate change impacts became increasingly evident (25), and as voices from developing countries and international NGOs pressed for their recognition and for greater attention to adaptation (26–28), lingering concerns about the relation between adaptation and development were rephrased as an examination of the cobenefits and trade-offs between the two (29, 30).

Adaptation grew in visibility in the UNFCCC as well, reflecting the activity of the poorest countries, known as least developed countries (LDCs). The formal category of LDCs had been established by the UN General Assembly in 1971, coming at the end of the United Nations' first development decade (1960–1970), which recognized that the economic gap between the richest and poorest countries had widened rather than reduced. The Third UN Conference on the Least Developed Countries, held in early 2001 in Brussels, generated a declaration that included a commitment to reducing vulnerability and protecting the environment and noted the adverse effects of climate change (31). It stated that LDCs were contributing the least to the emission of greenhouse gases, while being the most vulnerable and having the least capacity to adapt to the adverse effects of climate change. COP7, held in Marrakech in late 2001, established the requirement for LDCs to develop National Action Plans for Adaptation (NAPAs), which could be financed through newly created UN funding mechanisms. This action builds on the call in the UNFCCC itself that specifies the provision of attention and support to “the developing country Parties that are particularly vulnerable to the adverse effects of climate change” (32–34). COP11, held in Montreal in 2005, marked the formation of the Nairobi Work Program (under the UNFCCC, work programs are established to develop approaches and programs to address emerging issues), which compiles methods for the assessment of climate impacts, vulnerability, and adaptation and facilitates knowledge exchange to identify gaps in knowledge that impede adaptation. It prioritizes working in LDCs and small island states. In addition, it marks the highly significant inclusion of nonstate actors among the participants.

NGO:
nongovernmental
organization

LDC: least developed
country

NAPA: National
Action Plan for
Adaptation

2.3. The Year 2007 as a Watershed

The year 2007 serves as a marker of the advance of adaptation and can be taken to mark the full acceptance of adaptation as a central goal of climate action, broadly on a par with mitigation. First, 2007 was the year of release of the IPCC's Fourth Assessment Report (AR4). AR4 included more extensive reporting on adaptation activities across all regions and sectors (35), as well as fuller descriptions of examples which showed the hard and soft mechanisms that were employed to address specific risks, and detailed the factors which supported or limited the actions. It took a few additional steps: It made efforts to assess the costs and benefits of adaptation activities that had been proposed, planned, or implemented, as an initial step toward measuring their effectiveness. It noted that many adaptation responses addressed extreme events rather than gradual trends—a point that would grow in importance in later years. And it offered more sustained discussion of limits to adaptation than the scattered references in earlier assessment reports.

Two related, more general elements within AR4—the concepts of impacts and scenarios—also represented an advance for the concept of adaptation. The expansion of research after TAR allowed AR4 to report on a larger number of climate change impacts on natural and social systems at higher levels of confidence and to disaggregate these impacts by region and sector. Building on earlier efforts in TAR, AR4 used the scenarios released in SRES to trace different levels of impacts for different emissions scenarios, thus associating different levels of adaptation needs with different scenarios. This association marks a closer association between adaptation and mitigation.

AR4 made more extensive use of scenarios than earlier assessment reports, relying on models that influence the narrative framing of adaptation as well as mitigation. These emissions scenarios allow three groups of modelers to work together: climate modelers, who explore relations of greenhouse gas concentrations and global climate; integrated assessment modelers, who examine the feedbacks between socioeconomic models (which include population, income, technology, land use, and energy use) and emissions and climate models (36); and users of impact, adaptation, and vulnerability (IAV) models, who build on the first two on various spatial and temporal scales to describe future levels of vulnerability, adaptive capacity, and overall adaptation. IAV models can include a wide variety of variables, such as levels of international trade, health, the Gini index of income inequality, and the UN Human Development Index, though others, such as governance, are harder to include. However, adaptation does not fit easily into such models, because it is difficult to establish variables which measure adaptation; as a result, the scenarios tend to emphasize mitigation over adaptation and to prioritize variables that describe physical systems over those that describe social systems. The models generate relatively smooth trends on timescales of decades, whether or not these are relevant to organizations undertaking adaptation.

Second, 2007 was the year of COP13, held in Bali. It marked the establishment of the Bali Action Plan, a new negotiating process to address climate change. Though it was concerned with ensuring emissions reductions, it also addressed adaptation as one of its priority areas. This inclusion reflects pressure from the LDCs and small island states, on behalf of which Tuvalu submitted a document entitled the International Blueprint on Adaptation, which called for steady funding of adaptation at sufficient levels (37).

Third, the IPCC received significant international attention in 2007 when it was awarded the Nobel Peace Prize, jointly with Al Gore Jr., for its “efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change” (see <https://www.nobelprize.org/prizes/peace/2007/summary/>). Finally, 2007 marked the public appearance of a memorable phrase that yoked mitigation and adaptation, describing them as “avoiding the unmanageable and managing the unavoidable” (38)—a phrase that was widely repeated. Adaptation was becoming more familiar,

with many specific forms gaining recognition. For example, to address sea level rise, people built sea walls and planted mangroves; to address the effects of higher temperatures and drought on agriculture, they changed crop varieties and shifted from row to drip irrigation; and to address natural hazards that increased in frequency and intensity, they installed early warning systems. Such actions illustrated the relative manageability of the unavoidable impacts, much as the reduction of greenhouse gas sources and the increase of sinks offered the promise of avoiding unmanageable impacts.

As adaptation gained prominence, the difference between adaptation and mitigation came to the fore. First, they differ in terms of scale. Mitigation is a global goal, as the differences in concentrations of greenhouse gases typically differ by less than 1% (39); adaptation is multiscale as a goal, often local or regional, because impacts vary significantly across space. Second, though both include a range of actions, and both include what can be called hard or technological elements as well as soft or social and policy elements, the range is much broader and more disparate for adaptation. On the mitigation side, much of greenhouse gas reduction is accomplished by reducing sources, particularly energy production, agriculture and land use, and manufacturing, as well as by enhancing terrestrial and marine sinks. For adaptation, there is a great variety of types of actions, as suggested above. Third, mitigation is often easier to measure than adaptation. Greenhouse gas concentrations can be measured directly, and projections for future concentrations can be developed from models, but risk reduction is harder to assess, because it covers a variety of risks for a variety of people in a variety of settings and sectors (40).

3. THE CONSOLIDATION OF ADAPTATION ON THE GLOBAL STAGE (2007–2015)

3.1. Overview

After 2007, the position of adaptation as the second pillar of climate action was confirmed by the IPCC, the UNFCCC, and other organizations. This fundamental position was cemented by the prominence accorded to adaptation in two major documents released in 2015, the UNFCCC's Paris Agreement (41) and the IPCC's AR5 (42, 43). Moreover, adaptation activity increased in this period across different regions, sectors, and scales, with new organizations engaging in it along with more extensive discussions of adaptation planning and finance; this expansion contributed to increased efforts to measure adaptation. Nonetheless, the relations between adaptation and mitigation remained unresolved. This lack of resolution continued despite another significant change in this period, one that took place within the modeling exercises used to make climate change projections. In newer models, the concept of pathway grew in importance, partially displacing the concept of scenario. Though this shift in modeling approaches and terminology was announced in a way that offered a clearer relation between mitigation and adaptation, significant ambiguity remained, as described below.

The measurement of adaptation—a key step toward assessing the effectiveness of adaptation actions and established priorities—advanced slowly in this period, despite several conceptual shifts, particularly the increasing prominence of the concept of risk, linked to the concept of hazards. Two additional concepts, resilience and transformation, also grew in importance, influencing the narratives used to describe adaptation.

As these narrative elements emerged, the division of time frames between short-term and long-term action grew sharper, leaving only weak links between the two temporal scales. Though this division had been present earlier, it grew more significant in this period. This separation of the two time frames was paralleled by the increased importance of a pair of types of adaptation—incremental adaptation, associated with short time frames, and transformation, associated with

long time frames (44). The separation between the two contributed to the ongoing challenges to construct a single measure of adaptation.

A significant advance in the efforts to measure adaptation came forward at the close of this period. The 2015 Paris Agreement, whose major contributions resided largely in the domain of mitigation, also influenced adaptation by announcing a “global goal on adaptation,” strongly suggesting a unified character of adaptation that would link the disparate types; it also established steps to monitor and report on adaptation (41). In this way, it showed that political will—the consensus on the need for greater action on climate change—could promote conceptual changes as well.

3.2. International Negotiations

To examine these conceptual shifts in the period 2007–2015, this section focuses on the UNFCCC, where attention centered on establishing a temperature target, expanding funding mechanisms, promoting different forms of national planning, and responding to the demand from developing countries to recognize Loss and Damage (discussed below) as a separate pillar of climate action, rather than as a component of adaptation. The IPCC is discussed more extensively in Section 3.3.

Some advances in adaptation occurred during these years, though mitigation continued to be more prominent than adaptation, featuring more significantly in the decisions taken at the COPs. The Copenhagen Accord—the output of COP15, held in 2009 in that city—failed to meet hopes for significant progress on concrete steps toward mitigation. It did, however, declare that “deep cuts in global emissions are required so as to hold the increase in global temperature below 2°C” (45, p. 2), citing AR4 as having documented that this temperature limit would meet the UNFCCC’s goal “to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”

The Copenhagen Accord provided a rhetorical statement on adaptation, strong on goals but lacking concrete steps and commitments:

Adaptation to the adverse effects of climate change and the potential impacts of response measures is a challenge faced by all countries. Enhanced action and international cooperation on adaptation is urgently required to ensure the implementation of the Convention by enabling and supporting the implementation of adaptation actions aimed at reducing vulnerability and building resilience in developing countries, especially in those that are particularly vulnerable, especially least developed countries, small island developing States and Africa. We agree that developed countries shall provide adequate, predictable and sustainable financial resources, technology and capacity-building to support the implementation of adaptation action in developing countries. (45, p. 4)

Despite the firmness of the modal verb “shall,” the absence of timetables, levels of support, and mechanisms for allocating responsibilities to provide financing left these as hollow promises.

In one of the characteristic shifts between stasis and advance in COPs that one UNFCCC-watcher compared to a roller coaster (46), COP16 in Cancun in 2010 brought a number of significant accomplishments. It led to the Cancun Adaptation Framework, which established an Adaptation Committee tasked with gathering information, monitoring adaptation activities, strengthening networks of organizations, and making recommendations for COPs. It also set up the Green Climate Fund to support mitigation and adaptation, especially in the most vulnerable communities.

COP17, held in Durban in 2011, established what it termed a process for creating National Adaptation Plans (NAPs), replacing the earlier NAPAs (47). Despite the similarity in name, the two approaches were quite different. The word “process” signaled a key distinction. NAPAs tended to be collections of individual projects, targeted at funding sources, whereas NAPs were designed

Loss and Damage:

refers to the political discussions within UNFCCC negotiations; “loss and damage” represents a broader constellation of harms, risks, and impacts

NAP: National Adaptation Plan

with the hope that they would integrate different components into an overall country-specific approach; the rigid structure of NAPAs was replaced with a more flexible set of components. Moreover, the term “process” indicated that the NAPs should bridge from short- and medium- to long-term action—a striking attentiveness to timescale. In addition, NAPs would extend to all developing countries, whereas NAPAs were restricted to LDCs. NAPs also received more extensive support for capacity building than the NAPAs. In 2012, a UNFCCC expert group developed a detailed set of NAP technical guidelines to assist developing countries, especially LDCs, with adaptation planning. In 2013, UN agencies created a support program to help these countries launch their NAPs; their efforts were complemented by other initiatives such as the NAP Global Network and by support from bilateral donors. The national scale of both NAPAs and NAPs derives in part from the specific mandate within the UNFCCC to pay particular attention to developing countries, especially the most vulnerable ones. This scale arises in part from the salience of national questions for the delegates (all representing specific nations) who vote at the approval sessions for decisions at COPs and for key texts at IPCC meetings, and in part from the national focus within the broad field of sustainable development that formed the context from which the UNFCCC emerged. However, these plans face obstacles, including scant and uneven financing, procedural difficulties from international donors, and institutional challenges to cross-sector coordination (48). In addition, these plans are typically drafted by powerful groups at the national level; as a result, they often have little participation from representatives of vulnerable groups and therefore neglect the needs of these groups (49).

Following pressure from developing countries, COP19 in Warsaw, held in 2013, marked a significant advance of a very different conceptual (and legal and political) approach to adaptation, one that had been present for over a decade: the recognition of its limits, using the term “loss and damage.” Though there is no single accepted definition of the term, it generally refers to the risks and impacts that lie beyond the capability of adaptation to address and thus is linked with other concepts like residual risk and limits to adaptation. COP19 created the Warsaw International Mechanism on Loss and Damage, which acknowledged that “loss and damage associated with the adverse effects of climate change includes, and in some cases involves more than, that which can be reduced by adaptation” (50, p. 1). It followed directly from a decision at the previous COP (COP18 in Doha) to establish an international mechanism to address loss and damage. The Warsaw International Mechanism is governed by an executive committee that was assigned general tasks—expanding knowledge and understanding of loss and damage, strengthening discussions and coordination, and enhancing action and support—though the Warsaw International Mechanism steered clear of assigning responsibility for loss and damage to particular countries, especially high emitters, and also avoided developing financial mechanisms for compensation. Debate over loss and damage has continued, with another striking dichotomy, in which “Loss and Damage” refers to the political discussions within the Warsaw International Mechanism, and “loss and damage” represents a broader constellation of harms, risks, and impacts (51).

The idea of loss and damage had surfaced more than two decades earlier in UNFCCC circles with an early proposal by the Alliance of Small Island States for insurance and compensation, reflecting the links of the idea to insurance and to tort law more broadly (52). The idea progressed slowly, with steady support from vulnerable countries and with growing awareness of the powerful effects of extreme events. It was included rather generally in the 2007 Bali Action Plan, and a work program on loss and damage was established in 2010 in Cancun. Despite the limitations of the Warsaw International Mechanism, it marked the full arrival of the concept of loss and damage and, in that way, the closure of the period characterized by the optimistic slogan “avoiding the

unmanageable and managing the unavoidable,” since the phrase loss and damage refers to impacts that are neither manageable nor avoidable. In the last few years, some observers have proposed that loss and damage constitutes a third pillar of climate action, along with mitigation and adaptation (53).

Of particular significance was COP21, held in 2015. The international treaty that it produced, the Paris Agreement, has been widely recognized for the advances it brought to mitigation, particularly through the development of nationally determined contributions (NDCs), which addressed long-standing structural obstacles to emissions reductions. It also strengthened transparency and reporting and included firmer commitments to periodic review and updates (54). Also of note is its commitment to “[h]olding the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels” (41, p. 3).

The Paris Agreement contributed to adaptation as well, inching the UNFCCC toward more balanced attention between mitigation and adaptation. Especially important is Article 7, which lays out a “global goal on adaptation” of “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change” (41, p. 9). This statement demonstrates the characteristic ambiguity of international agreements, where wiggle room is left in to allow for broad support for a final agreement. In this case, the ambiguity lies in the unresolved contrast between the firmness of proclaiming a single global goal (with its strong implication of measurement) and the irresolution of listing multiple components within this goal without a clear indication of how these components are defined, how they are weighed, or how they interact (consequently rendering the measurement more complex). The Paris Agreement binds countries to engage in adaptation planning processes and states that countries should “submit and update periodically” (p. 11) adaptation communications. It recognizes the need for financing and technical support for adaptation, particularly in developing countries. This article also references the Cancun Adaptation Framework, reinforcing the central place for the Adaptation Committee within international discussions.

Article 7 is followed by Article 8, which focuses exclusively on loss and damage. This prominent location, as the subject of an entire article rather than one of several components of an article, sends an important political signal of the recognition that some impacts are so severe or irreversible that they cannot be addressed by adaptation. The opening language [“Parties recognize the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage” (41, p. 12)] is also strong. Later sections detail concrete actions of cooperation and facilitation and mention the Warsaw International Mechanism, bringing it within the purview of the Paris Agreement. However, Article 9, which centers on finance, opens with the pointed omission of loss and damage: “Developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation in continuation of their existing obligations under the Convention” (p. 13). In addition, the decision through which the COP adopted the Paris Agreement states explicitly that “Article 8 of the Agreement does not involve or provide a basis for any liability or compensation.”

NDC: nationally determined contribution (to the Paris Agreement)

3.3. A Suite of New Concepts: Risk, Resilience, Transformation, Pathways

Significant shifts to the concept of adaptation appeared in two IPCC reports in this period, the 2012 Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) (55) and AR5. SREX marked an increase in attention to short-term

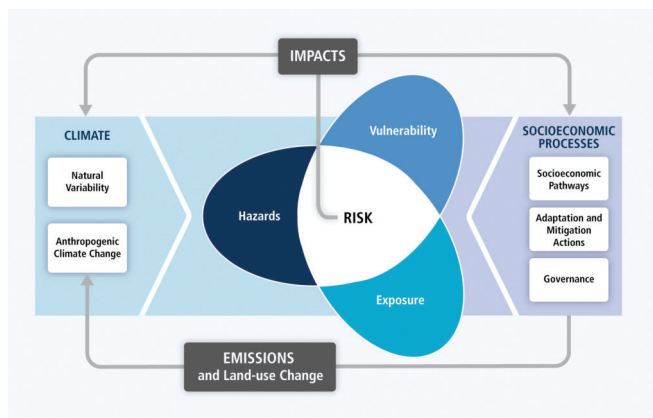


Figure 2

The “risk propeller” figure from the Summary for Policymakers of Working Group II’s contribution to the Intergovernmental Panel on Climate Change’s Fifth Assessment Report (42), showing the complementarity of (a) natural sciences (climate, linked to hazards) and (b) social sciences (socioeconomic processes, linked to vulnerability and exposure). On the right, it accords mitigation and adaptation full parity, giving them equal billing in the box that lists actions, though the priority of mitigation appears once again in the large arrow labeled “Emissions and land-use change.” Also significant is the line that connects impacts and risk, which suggests that individual impacts create individual risks. Figure reprinted from Reference 2.

hazards and events. This focus on extreme events and disasters had affinities with the expansion of framing impacts in terms of risk, perhaps because of the more episodic and spatially uneven nature of such events, in contrast to the slower-evolving trends that had been the principal focus in earlier times. SREX included a version of the “risk propeller” diagram that presented weather and climate events, vulnerability, and exposure as the three components of disaster risk. This figure would appear three years later in AR5 in a more generalized form, with hazards, vulnerability, and exposure as the three components of climate risk at large (Figure 2).

Drawing on current research (53), SREX presented resilience and transformation as core concepts, bringing them into discussions of adaptation more extensively than before. SREX uses the latter concept as the basis of another dichotomy in the typology of actions: incremental and transformational. It stated the contrast directly: “Incremental steps aim to improve efficiency within existing technological, governance, and value systems, whereas transformation may involve alterations of fundamental attributes of those systems” (55, p. 20). As shown below, the concepts of resilience and transformation proved to be influential in shifting two major components of the concept of adaptation—narratives and measurement. Both appeared in two major documents in 2015, the Paris Agreement—the key set of decisions taken at COP21 in Paris—and the IPCC’s AR5.

AR5, published in 2015, contains significant changes in elements of importance to the concept of adaptation. These include a shift in overall framing from vulnerability to risk; a shift in narrative focus from scenarios to pathways, along with an increased emphasis on resilience and transformation [both featured in a list of central terms in the Summary for Policymakers (SPM)]; and several steps linked to measurement of adaptation.

The shift to risk is represented by the prominence allocated to the risk propeller figure (Figure 2), a variant of the disaster risk figure in SREX (56). This figure illustrates the rise of the term “risk” and the decline of vulnerability in the texts of SPMs (Table 1). This differentiation of risks is supported by another innovation of AR5, the introduction of the terms “key risk”

SPM: Summary for Policymakers (the summary statement of each assessment report and working group report)

Table 1 Frequency of appearance of key terms in text of SPMs in IPCC assessment reports^a

Term	FAR (1990)	SAR (1995)	TAR (2001)	AR4 (2007)	AR5 (2014)	AR6 (2022)
Risk	8	24	53	41	231	241
Vulnerability	12	4	72	32	58	97
Adaptive capacity	1	0	30	19	3	10
Resilience	1	0	3	4	37	105
Scenario	48	6	21	21	25	36
Pathway	0	2	0	5	23	29
Feasibility	14	7	0	0	0	44
Effectiveness	0	4	3	4	19	47
Success	0	2	0	1	4	3
Maladaptation	0	0	2	0	3	21
Losses and damages	0	0	0	0	0	17
Transformation	0	1	0	0	11	12
Incremental	0	1	0	0	5	4
Urgency	3	0	0	0	0	4
Ambition	0	0	0	0	1	0
Limit	0	6	8	7	43	51
Governance	0	0	0	0	12	23
Finance	31	3	4	1	10	47
Barrier	3	3	0	2	3	5
Enabler	0	1	0	1	2	32
Solution	0	0	0	2	5	9
Justice	0	0	0	0	0	47
Equity or inequity	4	0	3	3	2	40
Marginalised	0	0	0	0	4	7
Gender	0	0	0	0	4	19
Indigenous	0	1	4	2	13	17
Cascading	0	0	0	0	1	11
Solar radiation modification or geoengineering	0	1	0	0	0	4

^aWorking Group III for FAR; Working Group II for all others. Search terms included closely related forms of the terms (e.g., resilient along with resilience, vulnerable along with vulnerability) but excluded uses with other meanings (e.g., barrier in Great Barrier Reef).

Abbreviations: AR4, -5, -6, Fourth, Fifth, and Sixth Assessment Reports; FAR, First Assessment Report; IPCC, Intergovernmental Panel on Climate Change; SAR, Second Assessment Report; SPM, Summary for Policymakers; TAR, Third Assessment Report.

and “representative key risk” (57). As the scientific basis of the study of climate change expanded, additional risks could be attributed to climate change. As a result, full lists of risks became cumbersome in length, so certain risks of particular importance or significance were deemed key risks, and some of them were selected as representative key risks to be discussed in particular detail (their distribution across regions and across nations by level of development, the projected increase in different possible futures, etc.). Associated with individual risks were specific actions, such as “heat health warning systems; urban planning to reduce heat islands; new work practices to avoid heat stress among outdoor workers” for “increased risk of heat-related mortality” (38). Although in theory all three of the propellers—hazards, vulnerability, and exposure—contribute equally to risk, hazards are featured most prominently. Most key risks are defined by hazards, and each key risk listed in the SPM is associated with one or several climate drivers. This approach has the powerful

RCP: Representative
Concentration
Pathway

SSP: Shared
Socioeconomic
Pathway

positive consequence of allowing scientists to link different levels of risk with different levels of warming; however, it can also deflect attention from the social, economic, and political drivers that were more readily visible in the earlier formulation, which centered on vulnerability (58).

A shift that would prove to be important for the concept of adaptation can be found in the AR5 Working Group II report, where the term “pathways” is substituted for “scenarios.” More specifically, the new term “Representative Concentration Pathways” (RCPs) replaced the well-established term “emissions scenarios.”

Centered on mitigation, each RCP—there were four in the first set—was designated by a single number corresponding to a physical variable, the radiative forcing (increased radiant flux per unit surface area per unit of time caused by greenhouse gases) that would occur by the year 2100. These rest on a single physical dimension; although higher numbers indicate more heating, an understanding of the significance of the specific values—2.6, 4.5, 6, and 8.5—requires some background in atmospheric physics. These RCPs are associated with modeling that has been supported by major energy and climate research institutes around the world. They draw directly on integrated assessment models that bridge the climate system (with its atmospheric, oceanic, and terrestrial components) and social systems (the global economy, land use, energy, population, and other elements). Whereas the emissions scenarios built from socioeconomic elements (economic versus environmental policy emphases, global versus regional scales of governance) to construct emissions trajectories and to project warming levels and climate impacts, the RCPs describe emissions trajectories resulting in a specific level of climate driver (the forcing levels) by 2100. The RCPs were featured prominently in the projections of future greenhouse gas concentrations and impacts in AR5. An overview of the RCPs describes in detail the difference between the earlier sequential approach of linking models and the newer parallel approach (55).

Potentially important for the concept of adaptation is the way that the RCPs created the possibility of other pathways that would more explicitly include adaptation in quantitative modeling, drawing on the social and economic variables that were included in the earlier emissions scenarios and in the IAV models. This possibility was realized in the approach of Shared Socioeconomic Pathways (SSPs), which expand on IAV models and on more general discussions of development pathways. These SSPs were designed to offer a set of alternative pathways for key aspects of society, including population, economics, technology, institutions, governance, and environmental policies, which could be shared among modelers (59). The two types of pathways, RCPs and SSPs, form the two sides of a grid or matrix, with modeling efforts to assess which combinations of the two are possible. For example, such efforts could examine whether an SSP emphasizing economic growth and fossil fuel technology would be compatible with an RCP associated with low levels of emissions and, hence, warming (60).

Drawing on this earlier research, the SSPs were developed at a workshop in 2011 (61) and appeared in the academic literature during this period, notably in a special issue of the journal *Climatic Change* in 2014 (62). For this reason, the SSPs are included in this section, despite some delays in their application. Although the participants in the 2011 workshop hoped to have the SSPs sufficiently fleshed out to be used extensively in AR5 (55), the modeling work on them advanced slowly. They were mentioned only briefly and featured among the “leading knowledge gaps” (63). The full SSPs would not be published until 2017 (64), and not until the IPCC’s 2019 special report on climate change and land (65) and the 2022 AR6 (66) were SSPs sufficiently well developed for inclusion.

The SSPs are based on scenarios of projected social and economic changes, running through 2100. They can be linked with climate policies, which in turn are linked with different emissions scenarios or pathways. These pathways represent the four combinations of high and low

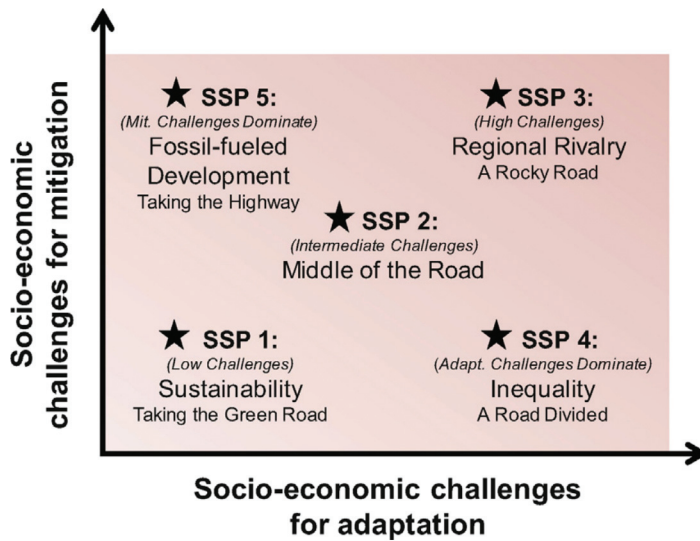


Figure 3

Shared Socioeconomic Pathways (59). Reprinted from Reference 2.

mitigation and adaptation, with a fifth combination representing intermediate mitigation and adaptation. The SSPs are numbered 1 through 5. The numbers and general storylines for the SSPs were retained, though the names were changed to emphasize the road metaphor that was present from the start (**Figure 3**). The road metaphor is connected to the emerging notion of solution space (67), in which pathways appear as roads across a bounded territory within which adaptation remains possible.

In summary, the SSPs carry forward the pattern, discussed in the introduction of this review, of mitigation dominating a discussion in ways that put adaptation in a secondary role. Though the design of SSPs implies equal emphasis on mitigation and adaptation, they have provided little support to discussions of adaptation. The challenges to adaptation which they include center on quantitative socioeconomic variables such as income inequality, low investment in education, and slow development, which can be directly incorporated into suites of models (59). The narratives associated with the SSPs also mention other qualitative elements, such as the strength and flexibility of institutions, which are relevant for adaptation, but these elements receive little attention because they do not lend themselves as readily to modeling (68).

With this shift from vulnerability to risk and from scenarios to pathways, the term “resilience” simultaneously gained great prominence. This concept received a cumbersome definition in the glossary:

The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation. (43, p. 1772)

This inclusion of “transformation” within the definition of resilience creates significant ambiguity, as the first portion of the definition says that resilient systems do not change (“maintain their essential. . . structure”), whereas the second half says that such systems can change (“maintaining the capacity for. . . transformation”).

As noted above, resilience had been mentioned by COPs in this period and was featured in SREX. However, it occurred more frequently in AR5 than in earlier assessment reports, appearing frequently in the term “climate-resilient pathways” (Table 1). The use of resilience suggests that the trajectories of impacts and responses are not smooth but bumpy, characterized by extreme events that cause declines in system function, typically of relatively short duration. Resilience, which was mentioned infrequently in AR4 (2007) (69), was featured prominently in the second influential special report, the Special Report on Extreme Events (2012) (55), reflecting the increasing attention to natural hazards within the climate adaptation community. As the glossary definition shows, the affinity of resilience to risk is direct. Its link to scenarios is less immediate, though both are tied to long-term trajectories, as demonstrated by the metaphors for resilience. The phrase “bouncing back” has been widely used to describe it (70), and it also has been compared to “bumps in the road” (69), with the latter picking up the “road” element of the SSPs. Graphical representations of the SSPs generally rest on smooth curves, with time on the x axis and a key system variable of index on the y axis. The representations which incorporate resilience differ in form, since they include dips, downward segments followed by upward segments (71).

The concept of transformation also appears more frequently in AR5 than in earlier assessment reports. AR5 offers it as one element of an additional pair of types, contrasting it with incremental adaptation, adopting the usage in SREX. Transformation is defined in the AR5 glossary as “a change in the fundamental attributes of natural and human systems,” but the SPM gives a fuller account: “Within this summary, transformation could reflect strengthened, altered, or aligned paradigms, goals, or values towards promoting adaptation for sustainable development, including poverty reduction” (72, p. 5). This statement aligns transformation with climate-resilient pathways, another important element of AR5. It also considers transformation as an end state or outcome, rather than as a process, and hence treats it as a long-term goal, rather than seeing it as the consequence of a sequence of short-term actions.

3.4. Increasing Efforts to Measure Adaptation

Decisions made at COPs contributed to efforts to measure adaptation. In particular, COP17, held in Durban in 2011, established the Durban Platform for Enhanced Action, which established a space for countries to post submissions of information, views and proposals on various topics, including adaptation. To improve the information base on adaptation and help countries prepare their submissions, UNEP prepared annual adaptation gap reports, the first of which was published in 2014. These reports provide an overview of adaptation planning, finance, and implementation. They mark a major advance in efforts to measure adaptation in a consistent manner at a global scale. They draw on the model of UNEP emissions gap reports, which began in 2010—another instance of adaptation following the lead of mitigation.

The First Adaptation Gap Report also set the pattern, followed in later reports, of using NAPs (another element in the Durban Platform) as one of the key sources for information. It underscored the need for additional financing. It noted that adaptation could generally be associated with reductions in impacts and risks but was difficult to measure precisely (73). Despite this difficulty, it proposed developing goals, targets, and metrics for adaptation, citing the Sustainable Development Goals (which also examine goals, targets, and indicators) as a model. The two most recent reports have modified this focus, concentrating on the presentation of information on adaptation planning, finance, and implementation.

Efforts to measure adaptation, the importance of which was signaled in the First Adaptation Gap Report (73), received further attention in the Paris Agreement the following year. Article 9 of

the Agreement uses the firm verb “shall,” stating that “[d]eveloped country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation” (41, p. 13) then shifting to a softer verb “should,” stating that “the provision of scaled-up financial resources should aim to achieve a balance between adaptation and mitigation” (p. 13) an additional step toward fuller parity between the two. A complementary call appears in Article 14, which states that COPs shall periodically “take stock of the implementation of this Agreement to assess the collective progress towards achieving the purpose of this Agreement and its long-term goals” (p. 18). These global stocktakes, the first of which is scheduled to be completed by the end of 2023, strengthen the commitment to action by rendering it more visible and by calling for both mitigation and adaptation: “The global stocktake shall be conducted in a comprehensive and facilitative manner, considering mitigation, adaptation and the means of implementation and support, and in the light of equity and the best available science” (p. 18). The discussion of balance points to a precise sort of measurement, the calculation of expenditures, and the discussion of assessment of progress indicates a second kind of measurement, which remains less precise.

3.5. The Gap Between Short and Long Timescales and the Missing Middle Ground

Taken together, the new elements described above—the risk approach and the use of pathways—contribute to a feature that appears in AR5. It consists of a division of attention to adaptation into two separate components, with a focus on either short time frames (often local in scale, and focused on individual sectors) or long time frames (often national in scale, and sometimes integrating different sectors), often neglecting the middle ground in which specific small-scale actions link up to create larger directions for effort. This gap also contributes to a lack of coordination around the measurement of adaptation, as the two time frames could suggest different units of analysis to measure.

Although elements of this split between time frames were present from early on, it expanded in this period. In particular, AR4 did not clearly distinguish between the two. In its discussion of adaptation, the AR4 Working Group II SPM used general terms such as “adaptation options” and “adaptive responses,” rather than terms that distinguish different temporal and spatial scales; it did not separate planning from other responses but rather included it as one component within a wide-ranging “portfolio of measures” (69).

The gap between the two timescales corresponds to the division between two forms of adaptation: pathways and projects. The central elements of the large-scale approach are pathways. As discussed in detail above, the pathways (both RCPs and SSPs) are generalized, abstract projections stretching over many decades, their smoothness a result of the models (climate models and integrated assessment models) that generate them. The availability of data sets at large spatial scales and the technical challenges of modeling at smaller scales further support the big-picture nature of the pathways. These characteristics help them address the likelihood of the core goal of prevention of “dangerous anthropogenic interference with the climate system” (45, p. 4) which promotes long-term thinking about a single system of planetary scale.

By contrast, the central elements of the small-scale approach are projects. In many discussions of adaptation, actions are understood to consist of projects rather than programs or other forms of activity by public, private, or civil society organizations. Projects typically have a narrow focus on specific goals and measurable outputs, which lend themselves to monitoring and evaluation. They tend to unfold through a series of defined stages on short timescales of several years. They

are usually financed on a one-off basis, often by external sources. Programs, by contrast, tend to support the ongoing operations of an organization, agency, or sector; their activities are typically financed internally as a regular part of budgeting cycles of public or private entities. Though programs can also undergo monitoring and evaluation, their outputs and outcomes are often less concrete and tangible than the outputs of projects.

This focus on projects arises from several sources. Projects align well with overall institutional patterns of financing, because it is generally easier to raise money for a project than to create new line items in budgets for programs. Analysts have shown that the focus on projects demonstrates the “donor driven” nature of climate finance, as projects are easier for donors to manage than programs (74, 75). The fragmentation of climate finance into many sources and its notorious unpredictability also lead to a short-term focus, linked to projects, because programs require reliable long-term finance more than projects do. The dominant presence of loans rather than grants in this finance further contributes to the concreteness and immediacy of projects (76). In addition, a good deal of activity within sustainable development overall takes place within project framing. Projects also align with the importance of institutions that focus on sectors (e.g., water, agriculture, health, energy), corresponding to government ministries and bodies within the UN system, rather than on entire systems or on intersector linkages, sometimes termed nexuses (e.g., food–energy–water). Although projects can provide cobenefits in other sectors, these are often proposed and included on a case-by-case basis rather than as part of a larger and more coherent strategy. To many analysts, it is a simple fact that adaptation finance will be allocated to support projects (77).

There is an affinity between projects and risks. The IPCC reports seek to determine which risks can be connected to climate change, utilizing techniques of detection and attribution, in which a risk’s existence is established (detected) and associated with climate change (attributed). The techniques are more straightforward to apply in the case of individual risks than in the case of multiple, interacting risks, often termed compound or cascading risks (78). For example, it is simpler to establish the level of the risk of wildfire, the risk of heavy precipitation events, and the risk of debris flows than to establish the risk of debris flows induced by heavy precipitation events on areas affected by wildfire, because the latter entails complex systems with varying time lags in the interactions between elements (79). The attention to individual risks, in turn, promotes attention to specific actions, which often take the form of short-term projects.

Planning for climate action, both mitigation and adaptation, has the potential to promote middle-ground action by linking different sectors and scales across multiple time frames. This approach has achieved some successes, especially in developed countries and in sectors with histories of long-term investments, such as water and urban infrastructure. Elsewhere, this middle ground remains neglected. Conceptual and organizational challenges impede such integration across timescales. First, the separate methods for assessing short- and long-term adaptations (statistical analyses of large sets of projects for the former, modeling and scenario building for the latter) impede coordination. Second, the recent emphasis on the distinction between incremental and transformative adaptation reinforces the distinction between short- and long-term action, since incremental action is often considered as consisting of specific projects, while transformation is associated with broad narratives. This formulation suggests that the latter is more powerful, but often leaves it imprecise and vague. In summary, this separation between timescales may have contributed significantly to the slow progress in this period toward measuring adaptation because it split such measurement between the two scales, with different methods and criteria for evaluation.

4. NEW NARRATIVES OF ADAPTATION ON THE GLOBAL STAGE (2015–2023)

4.1. Overview

The period 2015–2023 has been marked by a great deal of activity around the concept of adaptation. The Paris Agreement of 2015 set a timeline of action that will culminate with the first global stocktake in 2023, wherein the UNFCCC will review progress in the implementation of NDCs, examine areas where action toward this implementation has fallen short, and develop approaches for greater effort toward achieving climate goals. Though the primary focus of the Agreement is on mitigation, it devotes significant attention to adaptation as well, reflecting the importance of the global goal on adaptation (see Section 3.2). This attention is linked to a growing sense of urgency and an increased concern over the delays in scaling up climate action. As the world approaches the 1.5°C threshold, it becomes clearer that both mitigation and adaptation must advance rapidly, or both will become increasingly costly and difficult or wholly impossible. The IPCC's Sixth Assessment Report (AR6), released in 2021 and 2022, also contains a good deal of new research on adaptation.

This period has also been marked by active debates about ways to translate this growing awareness into action. These debates have led to the emergence of several different narratives of adaptation, linked both to the urgency of the moment and to the increased presence of a range of civil society organizations and social movements in climate debates. This article proposes the terms “orderly narratives” for accounts of progress toward firmer methodologies for assessing levels of adaptation and toward greater levels of adaptation, and “critical narratives” for accounts that problematize adaptation by examining the unevenness of adaptation, with close attention to those who are being left behind by adaptation actions or whose conditions are worsening as a result of these actions. Critical narratives include alternative narratives that further problematize adaptation by challenging the firmness of the central notions of knowledge and governance on which the UNFCCC and IPCC rest. This section explores each type of narrative following a review of international negotiations in this period.

4.2. International Negotiations

After the great moment of the approval of the Paris Agreement in 2015, progress on adaptation at the next several COPs was slow. COP22, held in Marrakech in 2016, began development of some details of the adaptation communications and of biennial transparency reports that countries were asked to submit, and approved a 5-year work plan for the Warsaw International Mechanism for Loss and Damage. The next three COPs focused on mitigation, seeking to complete guidelines for action on several features of the Paris Agreement, particularly finance, transparency of reporting, and details of carbon markets; they also provided some details of Adaptation Communications. COP25 in 2019, hosted by Chile and held in Madrid, brought some small progress to the topic of Loss and Damage by creating the Santiago Network, which provides technical assistance to various organizations to implement approaches to reduce and address Loss and Damage, though the critical question of finance for this area remained unanswered. This COP included a Ministerial Dialogue on Adaptation Ambition, at which the global goal on adaptation was discussed.

COP26, held in Glasgow in 2021, was the site of extensive discussions of the global goal on adaptation. A significant output was the decision (made at the meeting of the Parties to the Paris Agreement, which was held simultaneously) to establish the Glasgow–Sharm el-Sheikh Work Program on the global goal on adaptation (80). This work program, which will run for 2 years, includes additional work on how to track progress toward the global goal. It recognizes the multiplicity of approaches toward tracking progress and lists eight objectives that will support “reviewing the

overall progress made in achieving the global goal on adaptation” (81). Though it discusses planning and implementation, the work program uses the single term “adaptation action” to cover short-term projects, medium-term programs, and long-term pathways. Under this work program, parties will submit documents that state their “views on how to achieve the objectives” mentioned above, which will be discussed in a set of four workshops that, in turn, will result in a synthesis report that will discuss measures to track progress toward achievement of the global goal. This effort to track progress has been supported by the African Group within the UNFCCC since 2015 but was only established in 2021 (82).

COP26 also was marked by a more extensive discussion of Loss and Damage than most previous COPs. Several strong statements were included in draft decisions but were later deleted. In the end, the phrase featured as the topic of an article in the final decision, the Glasgow Pact. This article acknowledges the existence of Loss and Damage and creates the Glasgow Dialogue between parties on loss and damage, to convene from 2022 to 2024, though the only commitment to financing was the modest step of directing developed countries to provide funding to support the Santiago Network. However, the greater prominence of the topic can be seen as its emergence, at least for some, as a third pillar of climate action.

AR6 was released in 2021 and 2022, with the section most focused on adaptation, the Working Group II report, appearing in February 2022 (83). This report represents a significant advance in the study of adaptation, both empirically and conceptually. A discussion of its conceptual contributions is presented elsewhere in this section, linked to the different types of narratives that emerged in this period. Its empirical advance lies in the very large scale of evidence on concrete adaptation activities. This scale provides more detail on specific practices in different regions and allows this report to state that many of its statements are made with a high or very high confidence level. It contains some positive messages, such as: “Progress in adaptation planning and evidence has been observed across all regions and sectors, generating multiple benefits (very high confidence)” (66). It notes particular progress in water-related risks such as floods and drought, through a variety of specific mechanisms (e.g., land use planning, forest management, wetland restoration, and early warning systems for floods; irrigation, soil moisture conservation, and on-farm management for drought). It presents a sustained emphasis on the value of ecosystem-based adaptation and directs attention to the climate risks and adaptation responses in cities.

The Working Group II report (83) also notes that the progress of adaptation is distributed unevenly across regions and sectors and that there are adaptation gaps, particularly in developing countries and among the poor. It projects that adaptation gaps will continue to grow, unless the rates of adaptation planning and implementation increase sharply. It offers other notes of concern: Efforts are often short term and sector specific rather than transformational, and many of them remain at the stage of planning, rather than advancing to implementation. Making more extensive use of SSPs than earlier assessment reports, this report draws on both RCPs and SSPs to project levels of warming and associated impacts, warning that many adaptation responses that are currently effective will not remain so at higher levels of warming. Though recognizing that vulnerability and exposure can influence risk, this report allocates more space to hazards as a source of risk (**Figure 2**); its categorization of key risks rests largely (though not exclusively) on the hazards that cause them, and the projections of future risks include fuller discussion of hazards than of vulnerability to exposure. [Strikingly, the AR6 Working Group III report draws on another category of pathways, Illustrative Mitigation Pathways, which build on the Illustrative Pathways used in the IPCC Special Report on Global Warming of 1.5°C (84). These present different portfolios of actions to reduce emissions and greenhouse gas concentrations, with benchmarks for 2030, 2050, and 2100 (85).]

These concerns about the unevenness of progress, especially the deficiencies of adaptation activities that address the poor, are reflected in this report's attention to equity and justice. The former term appeared a few times in most of the previous SPMs but its use significantly increased in this report (**Table 1**). "Justice," which had not been mentioned at all in the earlier sources, appears 47 times. Associated words, like "Indigenous" and "marginalized," also show increases from earlier reports. This is a case of a lag between action in the UNFCCC and in the IPCC, since the former had noted climate justice in the preamble to the 2015 Paris Agreement. The chapter-by-chapter outline of the AR6 Working Group II report, which had been approved in 2017 at the forty-sixth session of the IPCC, mentions equity only three times and does not mention justice at all, suggesting that the attention to this topic expanded during the period of drafting this assessment report (83).

Despite advances within the UNFCCC in tracking progress toward the global goal on adaptation, there has been only limited headway in filling the missing middle ground between short-term and long-term adaptation, in both IPCC and scholarly research (see Section 3.5). The pairs of terms that characterize the taxonomic approach to adaptation reinforce the separation of short-term and long-term action. This is particularly true for the contrast of incremental and transformational adaptation (in which transformation is regarded as a final outcome rather than an ongoing process) but also in the dichotomies between autonomous and planned adaptation and between reactive and anticipatory adaptation; the elements in these pairs are regarded as opposed rather than complementary. The structure of AR6 also reinforces the separation, with relatively little integration between the focus on short-term decisions in Chapter 17 (titled Decision Making Options for Managing Risk; 86) and Chapter 18 (titled Climate Resilient Development Pathways; 87).

Especially in developing countries, evidence for middle-ground adaptation activities that link short- and long-term approaches, though not entirely absent, remains sparse. Some projects, such as FRACTAL (Future Resilience for African Cities and Lands), have promoted codevelopment of intermediate-term climate narratives in several southern African cities and have influenced the development of city planning, though implementation remains incomplete (88). A recent study (89) of three major multilateral agencies shows that they have recently sought to make adaptation funding more transformational, creating opportunities to link short-term projects with long-term pathways. To meet this goal, the agencies are developing criteria to evaluate projects on their transformational potential, some of which—making long-term financing more secure, strengthening institutional and regulatory frameworks—could support this middle-ground view and move away from the narrow project focus. However, progress is slow, and the agencies have not deeply engaged with calls for a longer-term focus within the academic literature on transformation (89).

The term "pathways," prominent in AR6, is often linked with long-term action, particularly the decades-long frameworks of RCPs and SSPs. However, some researchers have recently used it to suggest a bridging of short- and long-term actions; **Figure 4** from AR6 can be read as suggesting such linkages. A recent paper (90) presents a systematic review of adaptation pathways, showing that the term is now being used to describe planning and management of adaptation activities, with little reference to the modeling that underpins the SSPs. The authors of this paper discuss 19 cases in which this concept has been applied, most of them since 2016. Some examples are based on extensive participation, collaboration, and learning, coming most closely to linking the two time frames. The short-term focus seems to dominate in other examples, in which adaptation planning includes predetermined future decision points wherein outcomes are based on thresholds of key variables; conversely, still other examples concentrate on the long-term focus, centering on transformation as a target decades in the future. The article underscores uncertainty over future conditions as a motive for integrating short- and long-term actions across all these examples.

There is a rapidly narrowing window of opportunity to enable climate resilient development

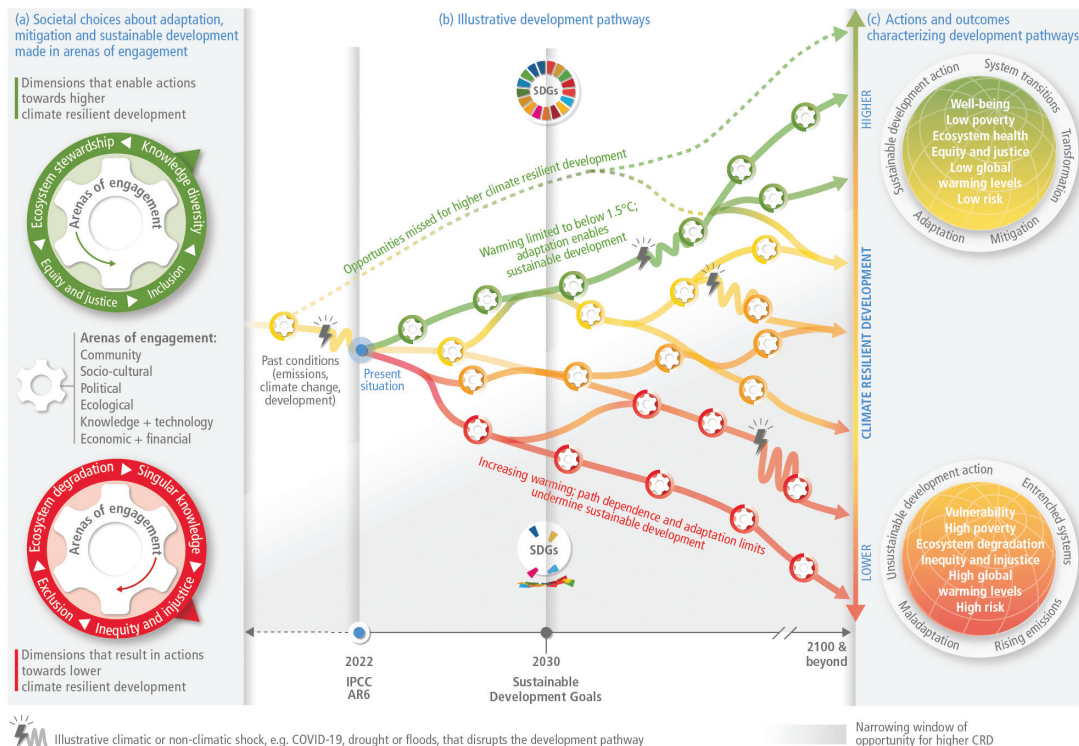


Figure 4

Climate-resilient development (CRD) is the process of implementing greenhouse gas mitigation and adaptation measures to support sustainable development. Cumulatively, societal choices, which are made continuously, shift global development pathways toward higher (green) or lower (red) CRD. Past conditions (past emissions, climate change, and development) have already eliminated some development pathways toward higher CRD (dashed green line) (63).

Another element in AR6 (57) that promotes such bridging of time frames can be located in its fuller recognition, in comparison to earlier assessment reports, of complex, compound, and cascading risks. The discussion of such risks centers on the nature and timing of the risks themselves, rather than the means to address them, which often lie in the middle space. The SPM makes several statements about learning, though only with medium confidence, and mentions “iterative learning” once; this theme points to middle-term action (for a significant precursor to this idea, see 91). There is also a brief discussion of the need for integrated risk management and a review of some strategies for such management, including addressing the food–energy–water nexus (92) and using ecosystem-based adaptations to address multiple risks.

Some researchers have issued general calls for an examination of the middle ground that links short- and long-term actions (64), though others have suggested that it would be more effective to focus on short-term decisions because of the greater accuracy of forecasts and the greater immediacy of benefits in this time horizon (93). Other researchers have noted the importance of sequencing actions and of selecting robust actions (94) for the better coordination of projects, moving beyond simply listing the cobenefits that individual projects provide. Such steps would allow for more learning and skill acquisition by individuals and organizations, as well as tighter connections between organizations and civil society (95). For example, adaptive water management techniques, including scenario planning, learning-based approaches, and flexible and low-regret

solutions, can help create resilience to uncertain hydrological changes and impacts due to climate change, suggesting that this sector is witnessing middle-term action (47). Despite these positive examples, the middle ground, if no longer wholly missing, remains sparsely populated.

4.3. Faster Narratives: Calls for Accelerated Action

The period 2015–2023 is marked by an even stronger sense that climate action has been insufficient in scope and slow to advance. For many researchers, policy makers, and groups in civil society, the 2020s provide the final opportunity to prevent significant damage from climate change. The 2015 Paris Agreement contributed to feelings of urgency (96) to address climate change and to calls for more ambitious action.

AR6 Working Group II underscores this urgency in the final sentences of its SPM: “The cumulative scientific evidence is unequivocal: Climate change is a threat to human well-being and planetary health. Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a livable and sustainable future for all (very high confidence)” (66, p. 35). It also invokes the need to take action by referencing solar radiation management, a form of geoengineering, thereby emphasizing the significant environmental and social risks accompanying this highly uncertain technology. This topic—mentioned a few times in early assessment reports and the subject of a 2011 3-day meeting of the IPCC, but wholly absent from other recent reports—points to the dangers that the world may face if delays in mitigation and adaptation lead some to undertake these extreme and poorly understood actions.

A key element of acceleration is the emergence of calls for greater “ambition,” which has supplemented and at times supplanted calls for “enhanced” action. The term “ambition,” with its strong implication of a desire for a shift to higher levels of action, was not entirely new (the 2011 Durban Plan for Enhanced Action used it 8 times, though forms of the word “enhanced” appeared 52 times in that document). It achieved great prominence in Paris, due largely to the efforts of an organization called the High Ambition Coalition. Founded by the Republic of the Marshall Islands in 2014, it grew rapidly to a membership of more than 100 nations, whose representatives wore distinctive pieces of coconut palm fronds from atoll nations, distributed at the Paris COP (97). This organization pushed for strong action on mitigation, though it included adaptation in its goals. It was instrumental in establishing the target as “well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels”—a stronger statement than the calls at COP15 and COP16 for a 2°C target (98). The word “ambition” and related forms appeared six times in the Paris Agreement, referring four times to mitigation and twice to both mitigation and adaptation. (It was mentioned only once in the AR5 SPM, which was released earlier in 2015.) The High Ambition Coalition also addressed ambition by calling for earlier deadlines for emissions reduction, for higher levels of climate finance, and for balancing financing for adaptation and mitigation.

This emphasis on the 1.5°C target led directly to the IPCC’s 2018 Special Report on 1.5°C Warming (84), which directed attention to adaptation overall by showing the significant increases in risk at that temperature level and the greater increase at 2°C. This report also marked a change from the 2012 SREX (55) and the 2014 AR5 (42, 43) in its observations of extreme events up to the present (in contrast to projections for the future). In this way, it parallels the advance of Loss and Damage in recent COPs: These discussions also show the severity of climate change impacts in the present. The report also discussed ambition, which appeared seven times in its SPM.

The Special Report on 1.5°C Warming contributed to the narrative of acceleration by underscoring the importance of the ambitious goal of transformation (discussed in Sections 3.1 and 3.2). This special report marked the first appearance of this term in a glossary, which defined

transformational adaptation as “adaptation that changes the fundamental attributes of a socioecological system in anticipation of climate change and its impacts” and incremental adaptation (also appearing for the first time) as “adaptation that maintains the essence and integrity of a system or process at a given scale. In some cases, incremental adaptation can accrue to result in transformational adaptation” (84, p. 542). Though these definitions include the possibility of incremental adaptation leading to transformational adaptation, the difference between the two is stark: In one, systems change, and in the other, they maintain their essence and integrity.

Although the need for rapid and profound change is unquestionable, the emerging distinction between incremental and transformational change raises questions that have troubled the concept of adaptation: How can adaptation actions be measured, and how can individual actions be located within one of a pair of types? The academic literature on this topic includes suggestions that transformational adaptation is more deliberate (99), that it includes linked transitions in a number of sectors or systems (100, 101), and that it is longer term and deeper (102). Several authors have proposed different sets of dimensions along which specific adaptations could be examined and categorized as incremental or transformational (103, 104). In summary, this concept of transformational adaptation, which some hoped would advance the understanding and practice of adaptation, has promoted an expansion of the scope of adaptation while also creating a new area of conceptual ambiguity and leaving the short- and long-term scales of action weakly connected.

4.4. Orderly Narratives: Measuring Progress Toward Adaptation

In this period of acceleration, some narratives—termed orderly narratives in this review—focus on the rapid growth of adaptation actions and of reports and studies of these actions. Even though the need for adaptation is also increasing, as emissions, temperature, and impacts continue to increase, this current period presents opportunities to press for further adaptation action. The term “orderly narratives” refers to this notion of a steady expansion of adaptation and conveys a positive sense as well—if not a sense of optimism (the present is too challenging for that), then a sense of confidence, or at least a sense of assurance that the scope of adaptation is large and expanding—in brief, a view that the adaptation glass is half full. Some feel that the orderly nature of adaptation is sufficiently well established to propose a field of “adaptation science” (105). Two key elements of orderly narratives are their use of a language of progress and their focus on measurement.

The language of progress is contained explicitly within the Paris Agreement, which states that the global stocktake shall “review the overall progress made in achieving the global goal on adaptation” (106). Progress and measurement are complementary concepts. A focus on progress can lead to efforts to observe progress and to “review” it, in the language of the Paris Agreement, and hence to measure it. And, in a general sense, it seems obvious to ask whether adaptation works—or, in other words, to see whether adaptation activities, which are undertaken to reduce risk, are indeed reducing risks.

More broadly, the emphasis on progress has an affinity with the consolidation of the concept of pathways and the associated metaphor of roads, as the RCPs and SSPs can be understood as a set of concrete routes that lead forward. This positive outlook is also represented by the partial shift from focusing on barriers and limits to adaptation to examining enablers and catalyzers of adaptation. These terms were used sparsely through AR4, but the use of “limits” increased significantly in AR5, possibly reflecting the attention to Loss and Damage at COP19 in 2013. In a sense, there is little difference between saying that inadequate finance, weak governance, or scant climate information serves as a barrier to adaptation and saying that finance, governance, and information are enablers; the shift toward the latter is an element of the framing within orderly narratives.

Use of the term “solution,” in reference to adaptation action, has steadily increased from AR4 to AR5 to AR6 (Table 1). This term is overtly positive, unlike the more neutral terms “action,”

“option,” and “response.” It also appears in the phrase “solution space,” which a recent study defined as “the space within which opportunities and constraints determine why, how, when, and who adapts to climate risks” (67). While this article discusses how solution space can expand or contract, it offers a generally positive view of how this concept can be mobilized to create new opportunities and suggests that the concept itself can enable policy makers to plan action.

The AR6 Working Group II report draws on other positive language. It relies heavily on the word “resilience,” which appeared only infrequently in the first four ARs, increased to 37 uses in AR5, and further increased to 105 in AR6 (83). Though, like earlier reports, AR6 makes relatively little use of the term “success” to describe adaptation (107), it references “effectiveness” more than earlier reports (108), defining it as “the extent to which an action reduces vulnerability and climate-related risk, increases resilience, and avoids maladaptation” (109, p. 6). It also draws heavily on “feasibility”—defined as “the potential for an adaptation option to be implemented”—a word that appeared only in the first two assessment reports, largely in reference to mitigation (110). AR6 assesses the feasibility of several adaptation responses to various representative key risks, examining each along its component dimensions (economic, technological, institutional, social, environmental, and geophysical). It shows that many of these responses have benefits for ecosystems and for marginalized groups and that they bear generally positive relations with Sustainable Development Goals. The UNFCCC Adaptation Committee recently noted the importance of “effective adaptation”; although it linked this idea to data availability, risk, and local needs, it provided no definition of the concept (111). Moreover, the call to recognize that adaptation faces limits, because of the discussions of Loss and Damage that show the existence of impacts for which adaptation is no longer possible, points to the need to measure adaptation as well.

4.4.1. IPCC conceptual models of risks and impacts. At least four major efforts to measure adaptation have been carried out since 2015. First, there have been efforts to build on the IPCC’s conceptual models of risks and impacts, tied particularly to projections of future risk under different scenarios. More than 20 years ago, TAR (2) addressed “reasons for concern” and characterized them, using expert assessments, through the well-known “burning embers” image (**Figure 5**). The colors in this image range from white through yellow to red, corresponding to specific levels of little or no risk, some risks, and more widespread or larger risks (112). In later versions of the image, purple was added to indicate very high risk (113). This notion of a continuous scale of risk was included in the general conceptual model of the First Adaptation Gap Report (73). It was developed further in the IPCC’s Special Report on Oceans and the Cryosphere (114), which used an expert assessment of peer-reviewed literature to assess the differences in risk reduction between low and high levels of responses, in the specific case of risks associated with sea level rise by the year 2100 in four types of coastal settings, under two different RCPs (**Figure 6**). Although this assessment is based on four broad levels of risk rather than on precise numerical measures, it powerfully demonstrates the contrasts between low and high levels of response, between settings, and between RCPs. In particular, it indicates a greater potential for risk reduction in the wealthiest setting—resource-rich coastal cities—than in others, and it shows that the ability of adaptation to reduce risk will be smaller at higher levels of warming than at lower levels of warming, especially for more exposed and vulnerable societies. AR6 contains several such expert assessments of risk reduction for particular risks, settings, and RCPs, carried out through expert judgment and by tallying of published research.

4.4.2. UNEP adaptation gap reports. The adaptation gap reports, published annually since 2014 (except for 2015 and 2019) by UNEP, measure adaptation, treating countries as units and tracking their stages of planning and implementation through examining NAPs and other

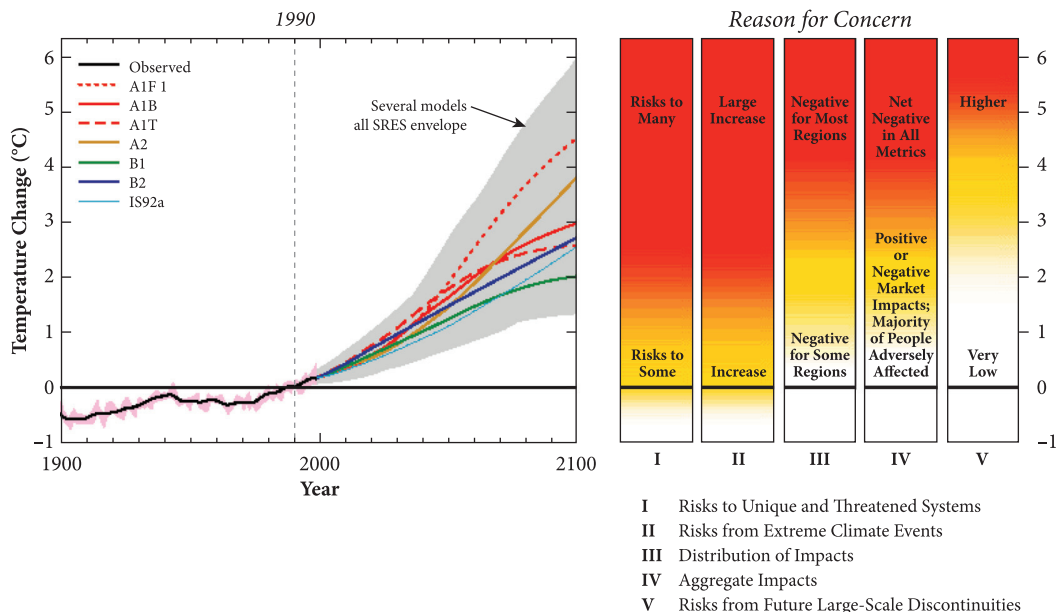


Figure 5

The “burning embers” figure from the Working Group II Contribution to the Third Assessment Report of the Intergovernmental Panel on Climate Change, showing levels of risk associated with specific systems, termed “reasons for concern,” at different levels of warming. Risk level is indicated by color. Figure reprinted from Reference 2.

documents. As the IPCC’s AR5 noted in 2015, climate risks and impacts were increasing and would fall more heavily on developing nations, especially on the poorest and most vulnerable. The report indicated a need to scale up adaptation efforts substantially, to specify the size and nature of future risks and impacts, and to understand how they can be effectively addressed.

The First Adaptation Gap Report (73) recognized that no single metric for adaptation corresponded to carbon for mitigation. As a first step, it defined “the adaptation gap” as “the difference between actually implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts, and reflecting resource limitations and competing priorities.” It identified three areas to discuss in the “assessment of the gap between adaptation needs and reality”: finance, technology, and knowledge (115). It suggested that the Sustainable Development Goals, also released in 2014, could support the definition of adaptation goals. In addition, it associated adaptation with risk reduction, particularly of impacts of what the IPCC terms “representative key risks” and “reasons for concern,” and noted that methods exist to assess whether the levels of risk are low, medium, or high (Figure 6). However, it also noted a wide range of definitions of adaptation goals and several different methods for measuring it.

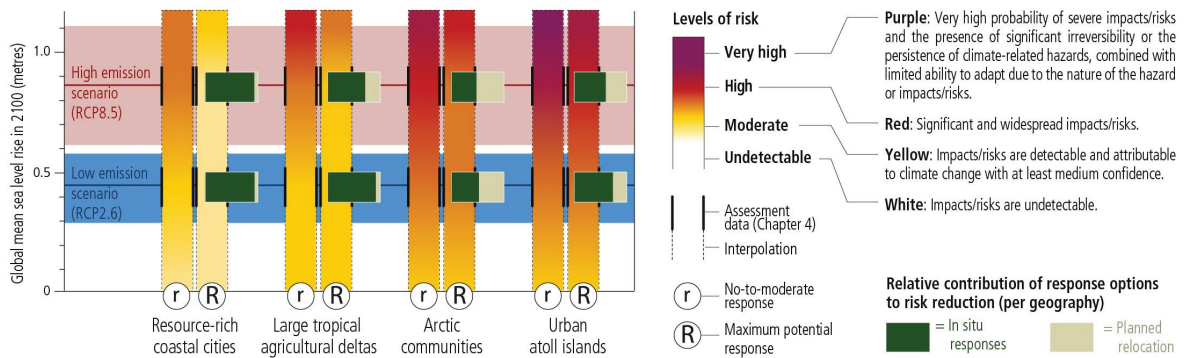
By 2021, the adaptation gap reports had disaggregated national plans into their components. They applied five criteria of assessment: comprehensiveness (whether options address assessed risks), inclusiveness of stakeholder participation, implementability (the existence of instrument and funding), integration (between sectors and between levels of governance), and levels of monitoring and evaluation. An additional 13 subcriteria provide details. Recent reports have paid particularly close attention to integration of activities across sectors and across levels of governance, noting that the former was generally more advanced than the latter. The 2021 assessment tallied the 197 member countries, indicating whether the criteria have been fulfilled,

Sea level rise risk and responses

The term response is used here instead of adaptation because some responses, such as retreat, may or may not be considered to be adaptation.

(a) Risk in 2100 under different sea level rise and response scenarios

Risk for illustrative geographies based on mean sea level changes (medium confidence)



In this assessment, the term response refers to in situ responses to sea level rise (hard engineered coastal defenses, restoration of degraded ecosystems, subsidence limitation) and planned relocation. Planned relocation in this assessment refers to proactive managed retreat or resettlement only at a local scale, and according to the specificities of a particular context (e.g., in urban atoll islands: within the island, in a neighbouring island or in artificially raised islands). Forced displacement and international migration are not considered in this assessment.

Figure 6

Figure from the Intergovernmental Panel on Climate Change's Special Report on Oceans and the Cryosphere, showing sea level rise risks and responses. The term "response" is used here instead of "adaptation" because some responses, such as retreat, may or may not be considered adaptation. Abbreviations: AR6, Sixth Assessment Report; SDG, Sustainable Development Goal. Figure reprinted from Reference 114.

partially fulfilled, or not fulfilled at all. It found uneven progress, with only three of the subcriteria having been fulfilled by a majority of the countries. Another notable finding is that fewer than one-third of the countries have planned or undertaken evaluations. Though these reports offer a global assessment, it is notable that this tallying treats nations with widely varying populations as equivalent cases (116). The adaptation gap is associated primarily with long-term projections and pathways; although there is some potential to examine the middle ground through the criteria of integration and of monitoring and evaluation, these are assessed largely by simply noting the existence of mechanisms for these activities, rather than by examining their activities directly. The risk frame, with its attention to individual risks, contributes to the emphasis on the diversity of risks (the criterion of comprehensiveness), impeding comparison and measurement.

4.4.3. The Global Adaptation Mapping Initiative. The Global Adaptation Mapping Initiative (GAMI), a global network of more than 100 researchers, was developed to support AR6. It has conducted a review of the peer-reviewed literature on adaptation published since 2013, the cutoff date for inclusion in AR5. With well-defined methods for deciding which articles to include and how to code them, GAMI reviews published research on adaptation that is at least one order of magnitude larger than previous efforts. A number of papers examining specific topics are in press or in preparation.

The first major presentation of results appeared in a paper titled "A systematic global stocktake of evidence on human adaptation to climate change" (117). Reporting on a sample of 1,682 published articles, the authors of this paper note the distribution of studies by region (with Africa and

GAMI: Global Adaptation Mapping Initiative

Asia as the most frequently reported) and by sector (with food and agriculture as the most common, followed by health and poverty reduction). They categorize responses by type, noting that individual articles could report more than one type. Behavioral responses are the most common, followed by technical or infrastructural responses and ecosystem or nature-based responses; institutional responses are the least common. The authors also note that responses are largely local in nature and that they are fragmented and incremental. They find limited evidence of transformational adaptation, and very few studies directly assessed risk reduction. Although these points were not entirely new, this effort provided much firmer support for them than was previously available; in particular, the authors underscore the scarcity of efforts toward transformational adaptation as well as ongoing deficiencies in measurement of risk reduction.

This initiative generated other papers. Araos et al. (118) examine issues of equity and inclusion, reviewing articles in the GAMI database for inclusion of marginalized groups in adaptation planning and implementation. More than half of the papers they review consider equity, with particular attention to Africa and Asia. The authors find that low-income groups are the ones most often considered, followed by women and Indigenous peoples. Poverty reduction, oceans, health, and food and agriculture are the sectors in which equity is most often reported. Another recent GAMI article examines 1,549 articles on adaptation decision tools, reporting on the use of different types of tools in specific regions and sectors, and noting that many tools target either transformation or justice and equity, but that very few consider both (119).

Other GAMI papers focus on specific risks or regions, drawing on the subsample of papers that address the topic. Turek-Hankins et al. (120) examine the 301 articles in the GAMI database that document adaptation actions to high heat. These articles, providing data on 98 countries, indicate that heat is treated as a health issue in high-income countries, especially in urban areas, while in low- and middle-income developing countries the focus is on agriculture and livelihoods, often in conjunction with drought. In both settings, most articles feature local, autonomous adaptations. Similarly, Leal Filho et al. (121) focus on another risk, water scarcity in Africa. In their review of 240 articles, they found that most responses are limited to small-scale adjustments, while planned adaptation efforts do not coordinate effectively across sectors and regions.

This highly promising undertaking faces two limits. The first is that, following IPCC guidelines, it draws on peer-reviewed literature and thus reflects the selective biases of the world of journals on which topics to cover and what sorts of evidence to include. The second limit is that, by counting articles, it treats all studies as equivalent data points even though they consider actions on very different scales—some report on individual communities, others on larger regions. This difficulty parallels the challenges facing the adaptation gap reports in tallying nations.

4.4.4. The Global Adaptation Progress Tracker. The Institute for Sustainable Development and International Relations (IDDRI), a French think tank, has developed a Global Adaptation Progress Tracker, which measures reductions of climate-related risks at the national level through a set of expert assessments. These assessments consider 6 criteria—knowledge about climate change risks, adaptation planning and policy tools, the adequacy of adaptation actions taking place to reduce climate risks, the level of capacity within adaptation governance, evidence of risk reduction, and the consideration of pathways for long-term adaptation—with a set of 19 subcriteria that provide finer detail (122). All of these criteria are ranked on a 5-point scale, ranging from 0 (no progress identified) to 4 (high contribution to adaptation progress). The first application of this method examines a representative risk—coastal adaptation in the face of sea level rise—in Senegal and Mauritius, assigning them overall scores of 1.8 and 1.5, respectively, out of a maximum possible score of 4 (122). Unlike the other efforts, this approach directly assesses populations and societies rather than simply tracking nations, like the adaptation gap reports, or

research, like GAMI. However, it is unclear how this project could scale up and how it would address the scarcity of data for many risks, regions, and sectors. Another, potentially more serious issue is the uniform application of a single scale, given that risks vary greatly in the severity of the consequences. Closely related to this issue is the matter of hard limits to adaptation, which implies that the highest possible score for risks could be lower than 4.

4.5. Critical Narratives: Addressing Injustices

In contrast to orderly narratives, which emphasize measurable, often steady progress toward a unitary goal of adaptation, critical narratives develop the growing sense that adaptation is uneven and that adaptation actions can increase risks as well as reduce them. They also challenge the sense of progress that is often implicit in measurements of adaptation. If orderly narratives raise the questions of “How soon?” and “How fast?” about adaptation, critical narratives (123, 124) ask, “For whom?” They are aware that any action, even if it reduces risks for some or for many, may increase risks for others, either in the area of the action or elsewhere, either at present or in the future. In some cases, adaptation efforts have directly favored the powerful at the expense of the poor and marginalized (125). In this way, critical narratives disaggregate adaptation into different human groups and into different consequences, whereas orderly narratives typically examine collectivities as wholes. Thus, critical narratives question the road metaphor implicit within the discussion of scenarios; they do not take for granted that all are traveling down the same road.

This attention to inclusion within adaptation processes and outcomes is paralleled by a reflexive attention to justice and inclusion within the IPCC and the UNFCCC. One recent study found that influential researchers in climate-related fields are predominantly male and from developed countries (126). The gender balance among IPCC authors has improved across the assessment reports but remains unequal; moreover, a set of barriers place stronger limits on the participation of female versus male authors (127; **Table 1** shows that the term “gender” did not appear in SPMs until AR5). Similar obstacles operate within the UNFCCC; internal efforts to address them were established through the Enhanced Lima Work Program on Gender at COP20 in 2014, which aimed to achieve and sustain full, equal, and meaningful participation of women in the UNFCCC process. More recent COPs have continued to address this issue. The underrepresentation of Indigenous peoples within these organizations has also been the subject of scrutiny, with some efforts toward fuller inclusion (128, 129). Attention to Indigenous topics has increased since AR5 (**Table 1**), with a particular focus on the value of Indigenous knowledge in assessments, the vulnerability of Indigenous peoples, and the importance of full Indigenous participation in the planning and implementation of adaptation actions.

Two key elements in these critical narratives are the topic of Loss and Damage and maladaptation. Because Loss and Damage is discussed extensively in Sections 3.2 and 4.2, above, it suffices here to mention the reasons for its inclusion within critical narratives. It shares some elements with orderly narratives, particularly the idea of solution space, as Loss and Damage can be found outside this space. However, it disrupts the central idea within orderly narratives of steady, measurable progress, as it points to the difficulty of tracing the neat boundary that surrounds the solution space (**Figure 7**). Different groups in society with different values might locate this boundary differently. Thus, the critical negotiations within COPs to locate Loss and Damage within policy frameworks are paralleled by challenges to locate it conceptually; as mentioned in Section 4.2, as a result of an awkward compromise the term “Loss and Damage” is reserved for UNFCCC negotiations, while “loss and damage” is treated as the component of risk which cannot be reduced to zero (sometimes also termed “residual risk”). This duality—one located at the edges of the concept of adaptation rather than at its core—is particularly evasive. The term “residual risk,” in

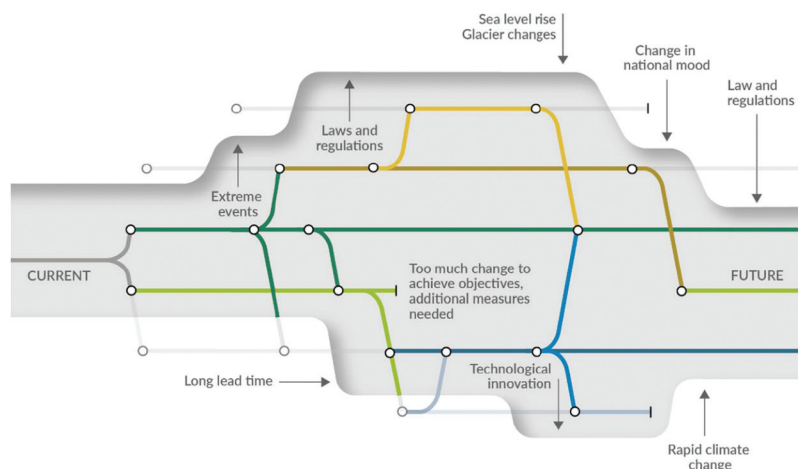


Figure 7

Solution space. Conceptualization of the solution space (*gray area*); possible shaping actions, changes, and shocks (*arrows*); and alternative adaptation pathways in the solution space (*colored lines*). A changing solution space can indicate that adaptation options and pathways become available, thus opening up the solution space (*dark colors*), or becoming unavailable/not possible to implement, thus closing down the solution space (*pale colors*). Figure reprinted from Reference 67 (CC BY 4.0).

turn, carries a tone—of a small, acceptable remnant—which belies the strength of calls to treat the topic more seriously. Strikingly, the Working Group II AR6 report discusses Loss and Damage extensively and includes references in the SPM to “losses and damages,” a more diplomatic phrasing that received unanimous support at the approval session. By contrast, the preceding assessment report, AR5, had only a handful of references in the main text, and none at all in the SPM.

The concept of maladaptation, taken broadly to include the negative consequences of climate adaptation, has been discussed for more than 20 years. An early paper (130) described it in detail and offered specific cases, such as coastal management programs that build seawalls and lead people to move to flood-prone areas and fishery management projects that use hatcheries to supplement fish populations but reduce their genetic diversity and long-term viability (131). The term appeared in the glossary of the TAR, which defined it as “[a]ny changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead” (85, p. 378). It continued to appear in the academic literature, including in a review of short-term responses in the historical past which led to overall societal declines (132). An influential paper presented five “pathways to maladaptation,” which include placing burdens on the most vulnerable and closing off future choices (133). Eriksen et al. (134) discussed the broad importance of trade-offs: Because adaptation actions have multiple consequences, some of them may well be negative. Building in part on attention to maladaptation within the UNFCCC, particularly the Nairobi Work Program, Working Group II in AR5 included a short section titled “Addressing maladaptation” in Chapter 14, Adaptation Needs and Options (42, pp. 857–59), that discussed the risk of negative outcomes, including increased vulnerability.

Drawing on these earlier studies, attention to maladaptation expanded rapidly in this period after AR5 and the Paris Agreement. An influential article (116) grew out of a conference on the topic, held in 2012 at the Rockefeller Foundation Center in Bellagio, Italy. Building on the

discussions at the conference, the article presented a systematic framework of maladaptation as a process, showing that it interacts with multiple drivers across different spatial and temporal scales, and illustrated the framework with four case studies from developing countries. The literature has rapidly grown since then. The AR6 Working Group II report provides a fuller treatment than earlier IPCC reports. It notes the growing body of empirical studies that report on maladaptation in many regions and sectors and warns that, in particular, it “can create lock-ins of vulnerability, exposure and risks that are difficult and expensive to change and exacerbate existing inequalities” (66, p. 28). The report also notes the importance of inclusivity—of different social groups, sectors, and time frames—to avoid maladaptation. Strikingly, there has been very little discussion of the term “malmitigation,” which has been defined as the “failure to consider vulnerability to climate-fueled extremes in emissions-cutting efforts” (135, p. 181). This lack of attention reveals a difference between mitigation and adaptation; discussions of mitigation typically recognize the uneven distribution of costs and the disturbances associated with rapid transitions of energy and land use systems. These themes are highlighted in the AR6 Working Group III report focused on mitigation, which does not use the term malmitigation at all (109).

The increasing calls for attention to equity and justice in climate adaptation, particularly from developing countries and social movements, have led broadly to an awareness of procedural equity (Who influences and participates in climate decision-making?) and distributive equity (What are the allocations of positive and negative outcomes of climate action?). This awareness, in turn, has led to greater attention to the politics behind climate decision-making, including the selection of values by which alternatives are judged. Nightingale (136) examined the struggles for authority and recondition within local adaptation plans for action in Nepal. She studied the messy politics behind many apparently value-neutral technical choices—the scale of action, the ministries to which projects are assigned, the measures of vulnerability—and showed how the most vulnerable can be further marginalized by adaptation actions. Atteridge & Remling (137) examined the politics of adaptation more broadly, showing that adaptation actions often reduce risk for some only at the cost of increasing it for others. Recent studies push this point further, suggesting that maladaptation is not simply an occasional error but rather a systematic product of policy systems favoring technical, top-down solutions. These top-down solutions have a number of specific, interconnected consequences that lead to maladaptation: They prevent the full participation of vulnerable or marginalized groups, they focus on short-term actions, and they use shallow definitions of adaptation success (138, 139).

At times, these concerns about maladaptation create doubt about any specific adaptation response, serving as a basis for extreme caution that at times borders on inaction (140). Much as the calls for transformational adaptation suggest that more conventional incremental adaptation is inadequate, these views of maladaptation might imply that adaptation is so fraught with potential dangers that it should be approached warily. This fear of negative consequences led one researcher to propose “the trolley problem of climate change” (141), referring to the familiar thought problem in moral philosophy. It posits a trolley driver who sees five people ahead on the tracks, knowing that there is no time to stop the trolley and that they will consequently be killed; it further posits a side track, with only one person on it, onto which the driver could divert the trolley. The question is whether the better choice is to let five die through inaction or cause one to die through action; a related issue is that the difficulty of this choice can lead to hesitation or a refusal to act. Adaptation actions might seem similar to this dilemma, though climate change adds new wrinkles to the familiar problem: Deaths (or impacts) may continue for some time, rather than being single events, and they may involve people of different groups. Moreover, the trolleys are becoming more deadly, their brakes fail more often, and the tracks are much more crowded.

However, nearly all scholars of maladaptation counsel careful action rather than inaction. Some authors have proposed steps to avoid these pervasive sources of maladaptation. Schipper (142), for example, recommends fully inclusive planning, a focus on long-term consequences as well as short-term outcomes, and attention to the root causes of vulnerability. Lahsen & Ribot (143) make a similar call to address root causes, arguing that only the extirpation of pervasive injustices will allow vulnerabilities to be reduced. Others have reflected on the COVID-19 pandemic and adopted the notion of “turbulence,” suggesting that the pandemic has revealed an unevenness and a tendency for disruption that can be seen in climate issues as well, and proposing that disruption itself can lead to transformation, especially in cases where participation is broad, and decisions can evolve through inclusive debate rather than top-down management (144, 145).

Indigenous scholars have long made similar calls to address root causes and confront systemic injustice. Several identify colonialism as the fundamental frame and consider climate change as only one manifestation of this inherently exploitative system (146, 147). They argue that narratives of acceleration and calls for urgency miss the need to address root causes. Moreover, they regard the alienation that separates humanity from nature as the basis for the exploitation of nature itself, including the reliance on fossil fuels and the destruction of habitat that has led to rapidly increasing extinction rates (146–148). Such calls parallel research showing that many Indigenous peoples and local communities address what others term climate change through culturally specific lenses, as shown for Bangladesh (149, 150), Papua New Guinea (151), Nepal (152, 153), and South Africa (154; for broader explorations of this issue, see 155). A promising line of research examines the individuals, organizations, and contexts through which Indigenous peoples, local communities, and other groups encounter the global climate change frameworks exemplified by the IPCC and the UNFCCC. These studies show the improvisations and reworkings of concepts that can lead to new forms of action in such settings in Zambia (156); Peru, Italy, and the USA (157); Tanzania (158); and Bangladesh (159). A recent review discusses such cases through a lens of “climate change reception,” showing the diversity of forms of reception and the range of analytical perspectives on reception (160).

It remains to be determined whether these orderly and critical narratives will be brought into a coherent perspective that can guide action, or whether their points of disagreement will remain, leaving a field of contentious debate. There are some points of connection between them. Some elements within orderly narratives allow for multiple values and perspectives, as shown by the recognition of different criteria for transformation, or in the numerous indicators within adaptation measurement assessments by GAMI and IDDRI. And among the diverse voices within critical narratives, there generally remains a call for reduction of impacts, especially for the most vulnerable.

However, the gap between the two narratives remains strong. Orderly narratives tend to emphasize the central importance of experts and their quantitative, science-based knowledge. All four forms of measurement discussed in Section 4.4 rely on expert knowledge, whether expert assessments within the IPCC, IDDRI, and the UNEP adaptation gap reports or academic researchers within GAMI. In contrast, critical narratives press for the centrality of public participation and the importance of experiential, contextual knowledge from across society, with Indigenous narratives calling for recognition of alternative worldviews.

The major international organizations are, as always, facing a balancing act. For the UNFCCC, the Glasgow–Sharm el-Sheikh work program, which will release its results in 2023, is a significant initiative, larger than other adaptation programs at recent COPs. It preserves something of the orderly narratives (the Paris Agreement proposed a single “global goal” of adaptation, unified climate responses under the term “actions”) while offering some space for critical narratives through

the acknowledgment of the value of divergent approaches and seeking to recognize the rights of Indigenous peoples, women, and other marginalized groups.

5. CONCLUSIONS

Where does the world stand now on adaptation, as temperatures continue to rise toward the 1.5°C threshold and the toll of climate impacts increases? Recent studies show that adaptation is growing in every region of the world and in every sector of human and natural systems. Such studies also show that the need for adaptation is growing even faster, creating adaptation gaps that affect primarily the poor and marginalized and will continue to grow unless action expands significantly.

This article has argued that such expansion of action is impeded not only by a lack of political will but also by the ambiguity and confusion that have plagued the concept of adaptation from its start. To address these problems, the article reprises the three issues raised in Section 1 and examined in Section 2—the relation of adaptation and mitigation; the difficulties of defining and measuring adaptation; and the tendency to consider short- and long-term adaptation actions separately, neglecting their complementarities and overlooking intermediate-term actions. Moreover, as noted above, these questions about adaptation—its relation to mitigation, its definition and measurement, and the relations of its dynamics on different timescales—compound one another, as the relations between adaptation and mitigation cannot easily be established if adaptation is not clearly defined and systematically measured and if the timescales on which the relations between the two unfold remain weakly connected. Although the fuzziness and ambiguities that have marked the concept since its entry into climate discussions persist, some conceptual progress on each of the three features mentioned in Section 1 has occurred. This conceptual progress, in turn, can support concrete action.

The relationship between mitigation and adaptation—the first of those features—is still not fully resolved. In particular, the SSPs that are central to projections of future conditions continue to emphasize mitigation over adaptation (40, 46). The calls in the Paris Agreement for balance between the two in climate finance also leaves the relationship vague and sets them as rivals rather than allies. However, related concepts from recent years bring them together more clearly. The idea of climate-resilient development, showcased in the IPCC's AR6 Working Group II report, explicitly presents the two as complements. This report's emphasis on the "rapidly narrowing window of opportunity to enable climate resilient development" suggests that the world must soon accomplish both mitigation and adaptation, or it will lose the chance to accomplish either. Both are also present in the concept of transformation, understood in recent IPCC reports as transitions from current to different future states across systems (e.g., energy, ecosystems; cities, infrastructure). These system transitions support both mitigation and adaptation—importantly, demonstrating that they are complements rather than competitors for attention or financing. The greater attention to existing and emerging limits to adaptation, and to the growth of losses and damages, adds to this sense of urgency to accomplish both and brings them together. The issues of justice and maladaptation—other emerging concepts—apply to mitigation as well as to adaptation, further linking the two.

The definition of adaptation retains the heavy emphasis on taxonomy that has characterized it from its beginning—the second issue—as the list of dichotomies has increased with recent additions, notably transformational and incremental adaptation, maladaptation, and successful adaptation. Nonetheless, adaptation metrics and construction of adaptation data sets have witnessed impressive development. These contribute both to the assessment of adaptation feasibility and effectiveness and to the fuller study of adaptation limits and of loss and damage. The global goal of adaptation, announced as part of the 2015 Paris Agreement, serves as a powerful focus for the

IPCC and the UNFCCC's Adaptation Committee, both of which receive wide input on these topics.

The separation between short- and long-term adaptation—the third issue—remains strong, with different forms of assessment of needs and planning of actions. The emerging notion of transformation remains aligned with long-term outcomes, despite its potential, still largely unrealized, to provide insights into the processes through which incremental actions build to larger systemic changes. Nonetheless, there are some positive elements in AR6 and in the most recent research, which indicates that monitoring and evaluation can contribute to learning and show how an openness to adaptation pathways can also lead to iterative, cumulative change. Similarly, the term solution space, which points to short-term resolution of individual risks, opens up consideration of longer-term trajectories of change. The growing awareness of complex, compound, and cascading risks supports an integration of multiple short-term actions (161). Some formerly marginalized voices, particularly of Indigenous scholars and activists, also call for action that will address both pressing short-term needs and long-term structural drivers. Taken together, these efforts are beginning to populate the missing middle ground.

As the world moves from the start to the middle of the 2020s, the decade widely seen as the last opportunity to prevent massive climate disruptions, what contributions does the concept of adaptation bring to galvanize action? It remains well established as the necessary complement to mitigation. It is assured a place in international discussions, through the prominence accorded by the global goal on adaptation. It is included in planning in many national governments and ministries. It plays a major role in cities and civil society, sometimes directly, sometimes through its connection with the more sanguine notion of resilience. And there has been some progress on the decades-old conceptual obstacles mentioned above. Despite the swerving that adaptation's complex history has entailed, despite its persistent impulse to evade conceptual clarity and closure, it has retained an essential element, perhaps its most important feature, the one that allows it to inspire action: hope.

SUMMARY POINTS

1. The concept of adaptation has a very long history and a more recent expansion, following its entry into the space of climate research and action along with mitigation in the late 1980s, close in time to the formation of two key institutions, the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC).
2. The concept of adaptation forms part of a larger global set of frameworks of environmental governance and sustainable development.
3. The widely recognized insufficiency of climate adaptation arises from three key conceptual ambiguities that both reflect and contribute to the contentious nature of climate policy and politics and that exacerbate delays in climate action.
4. The first ambiguity is the unclear relation between adaptation and mitigation, which can present the two concepts as rivals rather than as complements.
5. The second ambiguity is the difficulty of providing a succinct definition of adaptation that would support measurement of adaptation and assessment of effectiveness; instead, definitions tend to be taxonomic, providing lists of distinct types of adaptation that are not directly comparable.

6. The third ambiguity is a separation of climate action into actions on short-term and long-term horizons, leaving a “missing middle ground” of intermediate horizons; as a result, there has been little research on the ways that short-term action can promote movement toward long-term goals.
7. Several important new concepts have entered into the discussions around adaptation, including terms that emphasize enablers of progress, such as resilience, transformation, and pathways, and others that emphasize obstacles to progress, such as maladaptation and Loss and Damage; the former are termed here “orderly narratives” and the latter “critical narratives.”
8. The growing sense of urgency in recent years, particularly following the 2015 Paris Agreement and the IPCC’s Special Report on 1.5°C Warming, has led to expanded discussions of the concept of adaptation and to greater activity; positive elements include discussion of adaptation pathways, major advances in measurement of adaptation, and an international consensus around the global goal on adaptation, though accelerated action remains especially important.

FUTURE ISSUES

1. The concept of transformation remains incompletely developed, with competing definitions that present different, overlapping sets of criteria; clarification of this topic could promote action.
2. The major efforts to measure adaptation within the IPCC, the UN Environment Programme (UNEP), the Global Adaptation Mapping Initiative (GAMI), and nongovernmental organizations (NGOs) use different analytics and examine different units and scales; efforts to reconcile these differences could promote assessment of effectiveness and guide action.
3. Recent research on adaptation has emphasized the enablers of adaptation, including governance, finance, and knowledge, which serve as preconditions that are necessary though not always sufficient to stimulate action. This research also considers the catalyzing conditions that can overcome inertia. Several different accounts of such enablers and catalyzing conditions exist; a synthesis of these discussions could promote action.
4. Although the IPCC and the UNFCCC have increasingly emphasized diversity, equity, and inclusion, many groups remain underrepresented and thus do not contribute as fully as they could to advancing the concept of adaptation and to advancing adaptation action.
5. A fuller recognition of alternative worldviews could significantly expand the concept of adaptation and climate action. An important set of examples can be found in Indigenous worldviews, which often emphasize a reciprocity or kinship between humanity and nature, entailing respect and care, rather than a managerial or economic view of nature as a set of resources to be used. These Indigenous worldviews often stress the long, violent history of colonialism as a root cause of environmental disruption, including climate change.

6. An expansion of methodologies to examine cases of adaptation could promote a fuller understanding of the limited engagement of many communities around the world with climate change frameworks. Such research could build on recent efforts to examine the individuals and organizations that operate at the interface of global climate institutions and local communities and Indigenous peoples, as well as to understand the interactions among different conceptual frameworks and worldviews.

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