Adaptation Committee

AC22/TP/6A

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Version 01.0

Technical paper

Methodologies for assessing adaptation needs and their application

Summary

The CMA, in its decision 11/CMA.1, requested the AC, with the engagement of the Intergovernmental Panel on Climate Change Working Group II, as appropriate, to prepare a technical paper on methodologies for assessing adaptation needs and their application, as well as on the related gaps, good practices, lessons learned and guidelines, for consideration and further guidance by the SBSTA at its fifty-seventh session (November 2022) in the context of its consideration of the report of the AC. The technical paper is mandated to draw on an inventory of relevant methodologies for assessing adaptation needs, including needs related to action, finance, capacity-building and technological support in the context of national adaptation planning and implementation, available on the adaptation knowledge portal, as well as submissions by Parties and observer organizations on the development and application of methodologies for assessing adaptation needs, including needs related to action, finance, capacity-building and technological support.

The technical paper contains key concepts and definitions, an overview of existing methodologies and experiences, analyses of lessons learned, emerging good practices and gaps, as synthesis, as well as conclusions and recommendations.

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Abbreviations and acronyms

AC	Adaptation Committee
AILAC	Independent Association for Latin America and the Caribbean
AOSIS	Alliance of Small Island States
AR	Assessment report of the Intergovernmental Panel on Climate Change
BAEF	barrier analysis and enabling framework
BDP 2100	Bangladesh Delta Plan 2100
BTR	biennial transparency report
BUR	biennial update report
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CTCN	Climate Technology Centre and Network
DTU	Technical University of Denmark
GEF	Global Environment Facility
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
LDC	least developed country
LEG	Least Developed Countries Expert Group
LoCAL	Local Climate Adaptive Living Facility
NAP	national adaptation plan
NAP Global Network	National Adaptation Plan Global Network
NAPA	national adaptation programme of action
NDC	nationally determined contribution
NWP	Nairobi work programme on impacts, vulnerability and adaptation to climate change
PCCB	Paris Committee on Capacity-building
PROVIA	Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCF	Standing Committee on Finance
SDG	Sustainable Development Goal
SSP	Shared socioeconomic pathway
TNA	technology needs assessment
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WFO	World Farmers' Organisation

I. Executive Summary

1. Adaptation needs refer to the actions and resources required to complete all stages of the adaptation process, from assessment of risk and vulnerability to planning, implementation, monitoring and evaluation of adaptation measures. They also refer to actions and resources needed to address the underlying causes of climate vulnerability. Categorizing adaptation needs as biophysical and environmental needs; social needs; institutional needs; and information, capacity and resource needs, as described in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, provides a framework for planning and conducting comprehensive assessments. Adaptation needs are situation-specific and dynamic, and depend on perceptions of adaptation goals and policy trade-offs that are likely to differ among stakeholder groups. Adaptation needs also reflect the scale and complexity of analysis and the methods used for analysis. They will evolve as the understanding of climate risks and adaptation options increases, technologies for adaptation continue to be developed, the underlying drivers of vulnerability change and as other factors including critical social and cultural dimensions change.

2. Assessing adaptation needs is a fundamental part of enhancing climate resilience, and links to the UNFCCC process through adaptation planning and implementation (i.e. through national adaptation plans), reporting and communications (e.g. nationally determined contributions, adaptation communications, biennial reports), analyses and assessments (e.g. determining the needs of developing country Parties, technology and capacity needs assessments), and reviews of progress (e.g. global stocktake). Discussion of methodologies for assessing adaptation needs is complicated by the inconsistent use of the terms “methodologies”, “methods” and “tools” in the literature and reporting. At a general level it is possible to distinguish between top-down (impact or modelling-based) and bottom-up (vulnerability-based) methodologies, with most recent assessment approaches incorporating elements of both. Currently employed methodologies have largely been developed through a learning-by-doing process, often following broad guidance provided by the UNFCCC.

3. Experience of Parties and organizations in the application of existing methodologies for assessing adaptation needs, as well as the latest scientific information, suggests that no single approach, methodology, or suite of methodologies, is likely to allow a comprehensive assessment of adaptation needs in all situations. This experience also highlights that assessing adaptation needs is a continuous process that should be undertaken within a broader policy context and integrated with national development and economic planning. Best available information, including indigenous knowledge and local and practitioner experience, about climate risks and societal vulnerabilities is the starting point for assessing adaptation needs. Many existing processes, including vulnerability, risk and capacity assessments, contribute to assessing adaptation needs but generally fail to address the full scope of such needs. In many developing countries, further support on capacity, technology and finance is needed to undertake more comprehensive assessments of adaptation needs.

4. Information contained in submissions from Parties and organizations, Parties’ reports under the Convention, the Fifth and Sixth Assessment Reports of the Intergovernmental Panel on Climate Change, and other academic and technical literature is used to identify six emerging good practices for assessing adaptation needs that could support any methodology:

(a) Use participatory approaches;

(b) Use multiple climate and socioeconomic scenarios;

(c) Consider both transboundary and domestic or local climate risks, as well as compound and cascading risks;

(d) Employ an adaptive risk management or pathways approach;

(e) Consider transformational adaptation options in addition to incremental actions;

(f) Conduct integrated assessments of capacity, technological and financial needs.

5. A five-step general process for assessing adaptation needs is presented to assist Parties and others in further consideration of their adaptation needs and to promote additional work on methodologies. The process starts with defining adaptation goals and recognizes that assessing national adaptation needs will draw on existing knowledge and data concerning climate risks, vulnerabilities, adaptation plans and adaptation actions. This information will likely be unequal with respect to scope, detail and geographic scale, having been collected at different points in time using different methods and tools. New activities will include filling key gaps and synthesizing existing information into a coherent national overview.

6. Recommendations for future work related to assessing adaptation needs highlight the importance of:

(a) Continuing to share practical experiences;

(b) Developing and testing updated guidance on methodologies, methods and tools;

(c) Strengthening engagement and collaboration among UNFCCC constituted bodies.

II. Introduction

A. Background and mandate

7. Planning and implementation of adaptation measures and actions at any scale is generally preceded by an assessment of adaptation needs. While many methods and tools are available to undertake such assessments, guidance on the selection and application of these methods and tools is limited, which presents a challenge to decision makers on how best to proceed (PROVIA, 2013; Stafford-Smith et al., 2022). In recognition of this challenge, and with a view to assisting developing countries without placing undue burden on them, the CMA requested[1] the Adaptation Committee to prepare a technical paper on methodologies for assessing adaptation needs and their application, and on related gaps, good practices, lessons learned and guidelines. The paper was to be prepared with the engagement of the IPCC,[2] as appropriate. It was to draw on the inventory of relevant methodologies for assessing adaptation needs, submissions[3] from Parties and observer organizations expressing their views, and information on the development and application of methodologies for assessing adaptation needs. The decision notes that the scope should encompass needs related to action, finance, capacity-building and technological support. The technical paper was to be available for consideration and further guidance by SBSTA 57.

8. Improved understanding of the development and application of methodologies for assessing adaptation needs benefits Parties and a wide range of public and private sector institutions and organizations as they continue to plan and implement adaptation strategies and actions and the support thereof. Consideration of methodologies and their application is not an end in itself, but rather a step towards enriching discussion on a range of adaptation issues. Within the UNFCCC process, assessment of adaptation needs informs the development of many plans and reports

[1] Decision 11/CMA.1, para. 17.

[2] Reviews of and discussions on previous drafts of this paper with several authors of Working Group II to AR6 are gratefully acknowledged.

[3] Submissions are available at https://www4.unfccc.int/sites/submissionsstaging/Pages/Home.aspx (clear all tags and enter "assessing adaptation needs" in the search field").

involving adaptation (e.g. NAPs, adaptation communications, NDCs, BURs, BTRs). The findings of this paper may be relevant to discussions by Parties on those topics as well as discussions of adaptation technology, finance and capacity-building, the global stocktake, the global goal on adaptation and the global finance goal.

9. Assessment of adaptation needs is relevant on a wide range of spatial scales, from local and project-specific to national, regional and global perspectives. The focus of this paper is on methodologies that contribute to understanding adaptation needs at the national scale, which includes understanding adaptation needs at local and sub-national scales. It is informed by, and builds on, the findings of the first NDR (see box 1; SCF, 2021) and will hopefully contribute to strengthening future NDRs. Methodologies for, and challenges of, assessing adaptation needs at the regional and global level are discussed elsewhere, including in Africa's adaptation gap technical report (Schaeffer et al., 2013) and the UNEP Adaptation Gap Reports (e.g. UNEP, 2017, 2021). Information on adaptation needs at the national, subnational and local level enhances the understanding of collective adaptation needs at the global level.

Box 1
First report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement

The COP, in decision 4/CP.24, requested the SCF to prepare, every four years, a report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement. The first NDR (SCF, 2021) provides an overview of qualitative and quantitative information on mitigation and adaptation needs identified by developing countries on the basis of a review of 563 documents, including NDCs, adaptation communications, NAPs, NAPAs, TNAs and technology action plans. The report is not an assessment of needs, but a synthesis of existing data and knowledge, and a review of currently used methods and tools. It recognizes that countries are at different stages with respect to assessing their needs, and hence it is not possible to compare countries. It also acknowledges the challenges of assessing needs and that some countries have significant gaps in available data, tools and capacity. It notes the lack of a common framework and methodologies for assessing adaptation needs, and a need to enhance existing methodologies.

10. Finally, this technical paper takes a broad perspective on assessing adaptation needs and draws on experience and case studies from both developing and developed countries. While recognizing that work on this topic under the Convention is to be undertaken with a view to assisting developing countries without placing undue burden on them,[4] the broader perspective is justified by the fact that all countries have significant work to do in assessing adaptation needs and that this technical paper is intended to serve as a foundation for continued work on this topic. The approaches and tools described herein vary in their level of complexity and the resources required to implement. Furthermore, aspects of the emerging good practices may only be applicable at a limited scale given the capacity constraints of some countries. Consideration of what constitutes an undue burden can be more appropriately addressed in future work focused on providing guidance for assessing adaptation needs.

B. Sources of information

11. This technical paper draws on a wide range of information sources. In establishing the context for this work, emphasis is placed on the findings of AR5 and AR6, peer-reviewed literature from academic and technical institutions and other United Nations bodies (e.g. UNEP, 2021), and existing technical guidance on using relevant methods and tools (e.g. PROVIA, 2013). This information is complemented by knowledge and practical experience with the application of methodologies contained in

[4] Decision 11/CMA.1, chap. III.

submissions[5] from Parties and observer organizations in response to the call in decision 11/CMA.1, documents submitted to the secretariat by Parties, and information contained in the first NDR. It builds on previous work undertaken by various UNFCCC bodies, including the AC, the CTCN, the LEG and the SCF, and draws from a range of case studies and other information contained in the inventory of methodologies for assessing adaptation needs available on the adaptation knowledge portal.[6] Sources of knowledge are referenced throughout the paper.

C. Scope

12. Following this introductory chapter, the technical paper contains a consideration of concepts fundamental to the mandate of this paper in chapter II and includes a box with definitions of key terms used in the paper, including emerging concepts that are only beginning to be part of adaptation policy discussions.

13. Chapter III provides an overview of existing methodologies, methods and tools for assessing adaptation needs, and of experience using these approaches on the basis of submissions made in response to decision 11/CMA.1, as well as the findings of the first NDR. It also discusses existing guidance for applying these methods and tools.

14. Chapter IV represents the analytical core of the paper. Building on the challenges, opportunities and gaps identified in the first NDR, it presents lessons learned, good practices (illustrated through case studies) and gaps identified through the application of existing assessment methods. It also presents a five-step general process for assessing adaptation needs that reflects key concepts.

15. Chapter V presents brief conclusions and recommendations for possible future actions both within and outside of the UNFCCC process that could help further develop the understanding of methodologies for assessing adaptation needs and their application.

III. Key concepts and definitions

16. The volume of literature concerning climate change adaptation, including methods and tools, has greatly increased over the past decade. This growth has led to the development of new (or newly defined) terms relevant to this paper (see box 2). In addition, there are three concepts of fundamental importance to understanding the scope of this paper: adaptation needs, methodologies, and risk and uncertainty.

Box 2
Key technical terms used in this paper

Adaptation limit – the change in climate where adaptation is unable to prevent damaging impacts and further risk.

- **Soft limits** occur when additional adaptation may be possible if constraints are able to be overcome.
- **Hard limits** occur when no additional adaptation is possible (IPCC, 2022a).

Adaptation need – circumstance requiring action to ensure safety of populations and security of assets in response to climate impacts (IPCC, 2014a, 2022a).

Adaptive management – process of iteratively planning, implementing and modifying strategies for managing resources in the face of uncertainty and change. It involves adjusting approaches in response to observations of their effect and

[5] Available on the submission portal at https://www4.unfccc.int/sites/submissionsstaging/Pages/Home.aspx.
[6] https://www4.unfccc.int/sites/NWPStaging/Pages/Home.aspx.

changes in the system brought on by resulting feedback effects and other variables (IPCC, 2014a, 2022a).

Cascading impact – effect that arises when a hazard generates a sequence of secondary events that result in physical, natural, social or economic disruption, whereby the resulting impact is significantly larger than the initial impact (IPCC, 2022a).

Incremental adaptation – adaptation action where the central aim is to maintain the essence and integrity of a system or process at a given level (IPCC, 2014a).

Maladaptation – action that may lead to increased risk of adverse climate-related outcomes (IPCC, 2022a).

Pathway – temporal evolution of natural or human systems towards a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures to solution-oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic or socio-behavioural trajectories and involve various dynamics, goals and actors across different scales (IPCC, 2022a).

- **Adaptation pathways** – a series of adaptation choices involving trade-offs between short- and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation (IPCC, 2022a).
- **Climate-resilient development pathway** – trajectory that strengthens sustainable development and efforts to eradicate poverty and reduce inequalities while promoting fair and cross-scalar adaptation to and resilience in a changing climate. It raises the ethics, equity and feasibility aspects of the deep societal transformation needed to drastically reduce emissions to limit global warming and achieve desirable and liveable futures and improve well-being for all (IPCC, 2022a).
- **Climate-resilient pathway** – iterative process for managing change within complex systems in order to reduce disruptions and enhance opportunities associated with climate change (IPCC, 2014a, 2022a).

Risk – potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change (IPCC, 2022a).

Risk assessment – qualitative or quantitative scientific estimation of risk (IPCC, 2014a).

Trade-off – circumstance that arises when a policy or measure aimed at one objective reduces outcomes for one or more other objectives owing to adverse side effects, thereby potentially reducing the net benefit to society or the environment (IPCC, 2022a).

Transboundary climate risk – climate risk that crosses national borders. It is associated with the transboundary impacts of climate change and the transboundary effects of adaptation made by one or more countries that have repercussions for others (Stockholm Environment Institute submission).

Transformational adaptation – adaptation that changes the fundamental attributes of a social-ecological system in anticipation of climate change and its impacts (IPCC, 2022a).

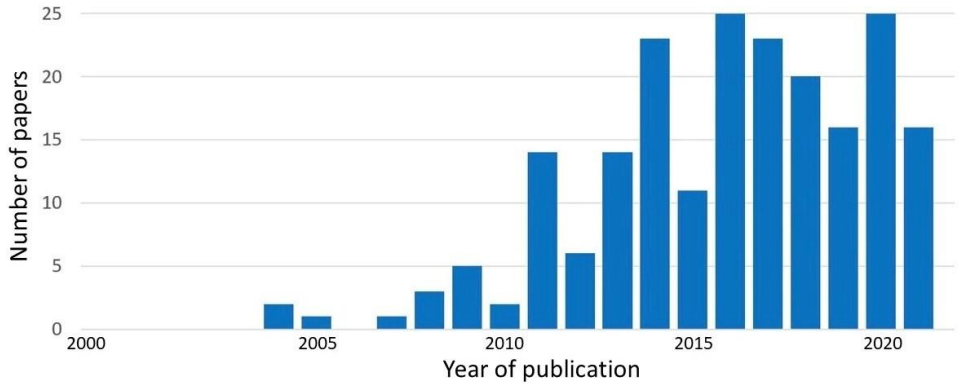
Uncertainty – state of incomplete knowledge that can result from a lack of information sources, imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can be represented by quantitative measures or by qualitative statements (e.g. reflecting the judgment of a team of experts) (IPCC, 2022a).

A. Adaptation needs

17. While understanding adaptation needs is integral to addressing climate change, the term "adaptation needs" is not formally defined under the Convention. However, they are clearly captured in, for example, Article 4 of the Convention, which refers to the specific needs and concerns of developing country Parties arising from the adverse effects of climate change. Article 4 also makes clear that the scope of adaptation needs includes both technical and financial needs. The term "adaptation needs" appears in subsequent decisions under the Convention, including the 2010 Cancun Adaptation Framework,[7] and in Article 7, paragraphs 4 and 7, of the Paris Agreement.

18. The term 'adaptation needs' also appears quite commonly in the academic literature, but again is generally undefined. A brief survey of English language literature published between 2000 and fall 2021 notes a marked increase in use of the term in the last decade (see figure 1), possibly a response of the research community to policy direction provided by the UNFCCC.

Figure 1
Number of academic publications per year using the terms "climate" and "adaptation needs" in the title, abstract or keywords since 2000



Note: Results as determined from a search using Scopus on 4 November 2021.

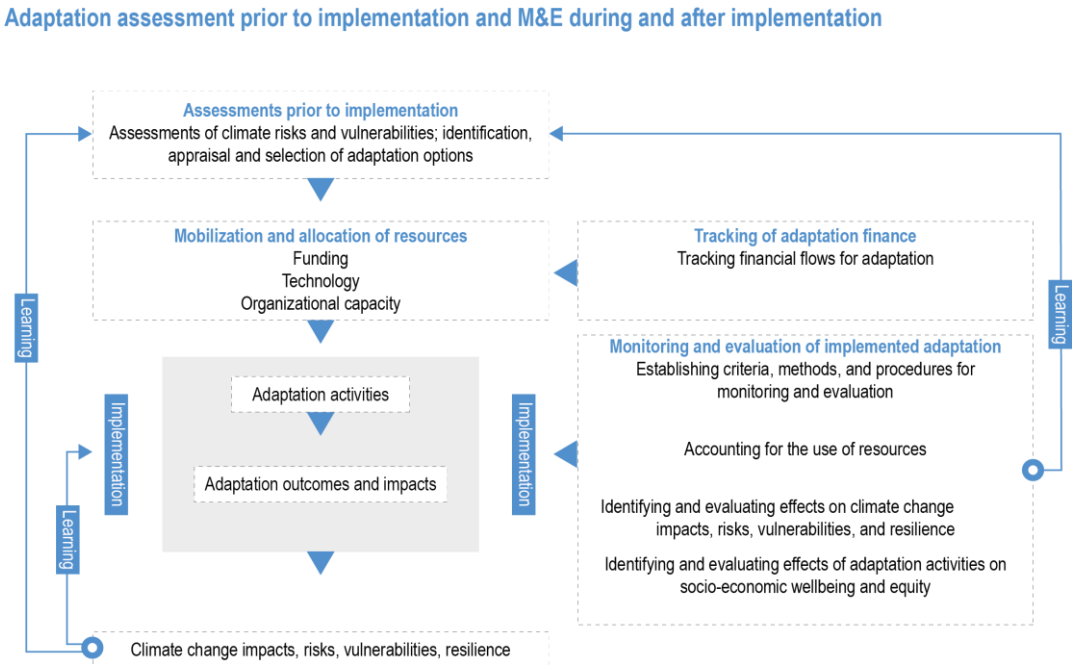
19. The IPCC first included the term "adaptation needs" in the glossary of the contribution of Working Group II to the AR5 and the concept is discussed in detail in chapter 14 of that report, by Noble et al. (2014). Expanding on the formal definition (see box 2), adaptation needs are the gap between what might happen as the climate changes and what is desired (Noble et al., 2014, p.836), including the actions and resources needed to address that gap. This definition indicates that adaptation needs encompass both actions taken to address climate risks and actions taken to benefit from any opportunities that climate changes may present. The scope of the term has expanded over time. In early discussions the term was used primarily to refer to immediate and near-term needs and focused almost exclusively on biophysical impacts (e.g. the example of NAPAs is discussed by Noble et al., 2014). Assessing adaptation needs requires analysis of both what adaptation is addressing (observed and projected climate change impacts and non-climate drivers) and how adaptation will occur (the capacity and resources needed to undertake actions) (GEF, 2002; PROVIA, 2013). Capacity analysis has expanded over the past 15 years to include consideration of the underlying causes of vulnerability to climate change, with Füssel (2007) among the first to highlight the importance of this broader analysis.

20. Of significance for the scope of this paper, adaptation needs are no longer considered simply a starting point for the adaptation process but rather refer to actions and resources required for the entirety of that process – from assessment of impacts and vulnerability through adaptation planning, implementation, and monitoring and evaluation (referred to as the adaptation cycle in this paper; see figure 2). This point was highlighted in several submissions from Parties (e.g. Paraguay on behalf of the

[7] Decision 1/CP.16.

AILAC Group of countries, Malta and the European Commission on behalf of the European Union and its member States).

Figure 2
The cyclical nature of assessing adaptation needs



Source: Modified from the contribution of Working Group II to the AR6, figure 1.8.
Notes: Figure encompasses actions and resources needed for assessing climate risks and vulnerability through adaptation planning, implementation, and monitoring and evaluation, with future needs assessments informed by learning.

21. Building on the work of Burton et al. (2006), Noble et al. (2014) identified five categories of adaptation needs, four of which are as follows[8] (see Noble et al., 2014, for additional references):

(a) Biophysical and environmental needs – ecosystem services critical for the maintenance and enhancement of human health, livelihoods, safety and security: many terrestrial, freshwater and marine ecosystems are already under severe stress as a result of climate change and non-climate factors, and need protection. Under this category, attention is drawn to the need for enhanced ecosystem monitoring in recognition of the risks presented when critical thresholds are crossed. Valuation of the ecosystem benefits of adaptation actions remains limited;

(b) Social needs – material and non-material elements necessary for groups and individuals to act on behalf of their own interests in addressing climate change: vulnerability to climate change varies greatly from the local to the global level, with profound inequities resulting in vulnerable populations having little capacity to undertake adaptation actions. The scope includes emotional and psychological needs that can be seriously affected by climate change. Shared learning, including education

[8] The fifth category of needs highlighted by Noble et al. (2014) is the need for engagement of the private sector (ranging from small farmers to small- and medium-sized enterprises to multinational corporations). They note that the private sector reduces risks and vulnerability through internal risk management, thereby contributing to public sector initiatives and responding to opportunities presented by climate change. It also serves as a source of direct financing for adaptation actions, which complements the responsibilities of the public sector, and can provide financial incentives to undertake actions that reduce risk (e.g. insurance). This paper recognizes the critical role of the private sector, but rather than highlighting its engagement as a distinct category of need, it highlights the role it can play in addressing the four other categories of adaptation needs identified by Noble et al. (2014).

and improved access to information, is important as adaptation is fundamentally a social learning process (Mimura et al., 2015);

(c) Institutional needs – the critical role played by formal and informal institutions in building adaptive capacity and implementing and incentivizing adaptation actions: emphasis is often placed on the role of governments at all levels (from national to local) as well as international and global institutions (including the UNFCCC) that can help enable enhanced action on adaptation. Effective institutional design includes having the flexibility to deal with the uncertainty inherent in climate change, the ability to integrate (mainstream) adaptation into short- and long-term policymaking, and the means to facilitate effective communication and coordination within and across relevant institutions. Mechanisms for coordination across multiple levels of government are seen as particularly critical given the key role that local governments play in adaptation. Non-government organizations, professional organizations and the private sector, including financial institutions, all have important roles in adaptation and benefit from cross-institutional coordination mechanisms;

(d) Information, capacity and resource needs – all stages of the adaptation cycle (see figure 2) require information and capacity, including human, financial and technological resources: considerable attention has been given to enhancing availability of information, including through the development of climate service institutions. Inclusion of multiple knowledge types (e.g. scientific, indigenous knowledge, local knowledge, experience of local practitioners) greatly enhances the utility of such information. Specific initiatives under the Convention have been established to help address capacity and technology needs (e.g. the CTCN and the PCCB). The significant gap between the financing required for adaptation and that which has been made available to developing countries through various financial mechanisms is well documented and continues to widen (e.g. New et al., 2022a; SCF, 2021; UNEP, 2021). The SCF further recognizes that the lack of available data, tools and capacity makes estimating the cost of adaptation needs difficult for many developing countries[9] (SCF, 2021; also see chap. IV below).

22. Several Parties made note of these, or similar, categories in their submissions on this topic. For example, the submission from Portugal and the European Commission on behalf of the European Union and its member States provides examples of five factors of importance in identifying adaptation needs:

(a) Biophysical and environment-related factors;

(b) Social, cultural or economic factors;

(c) Inequalities within a society;

(d) Institutional factors, rules and regulations;

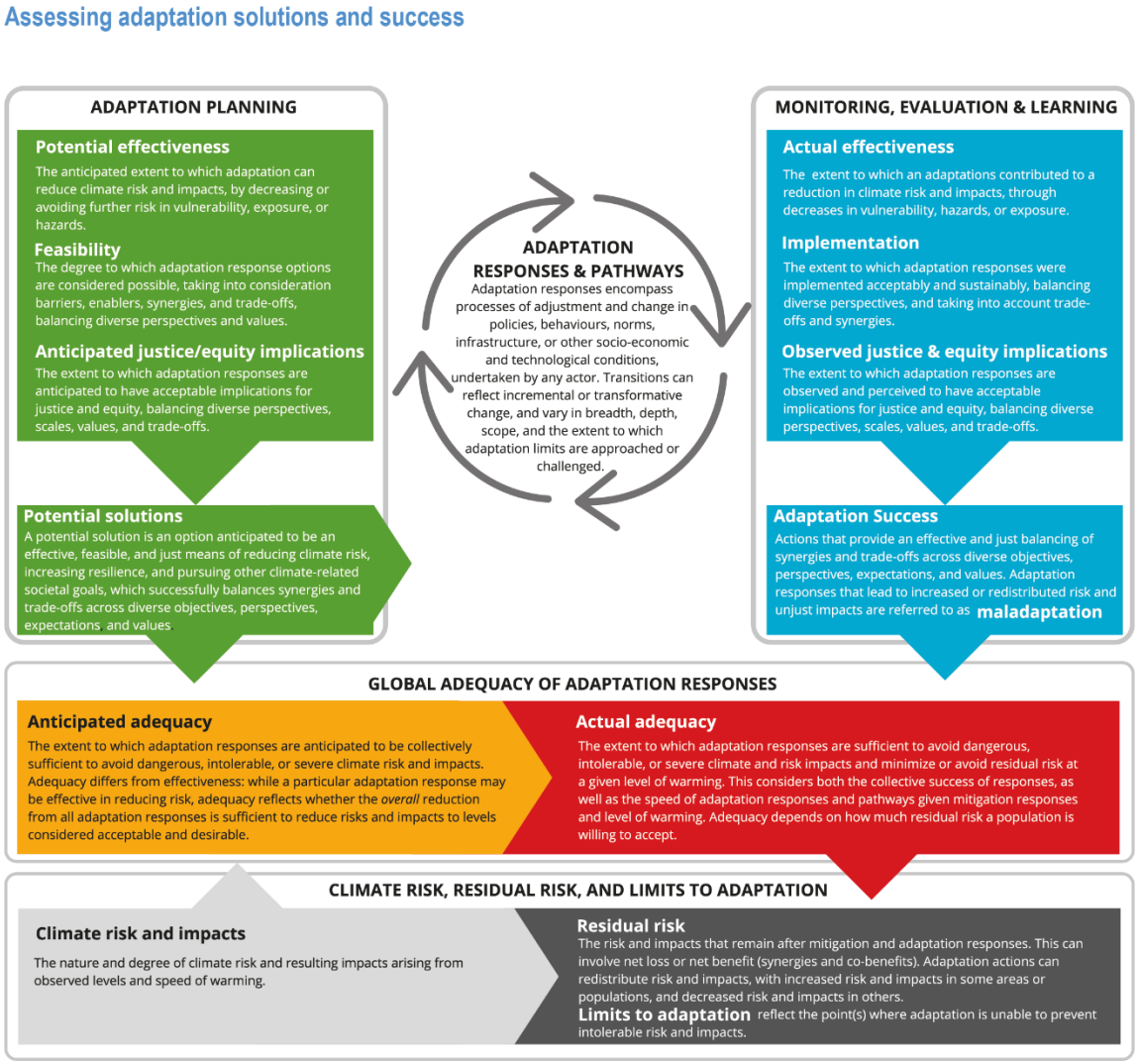
(e) Access to information, capacity and resources.

23. Parties also highlighted that adaptation needs are location- and context-specific and dynamic.

24. Building on the conceptual framework of adaptation needs put forward by Noble et al. (2014), the Working Group II to the AR6 addresses adaptation needs as a cross-cutting topic that relates to all chapters of the report. Important additional insights include recognition that adaptation needs depend on subjective perceptions of adaptation goals and associated policy trade-offs (Begum et al., 2022). As different people and populations will have different perspectives of the costs and benefits of various adaptation options, their adaptation needs will also differ. These differing perspectives are key to the overall framing of adaptation solutions and success in the AR6, which highlights the critical importance of equity, justice, adequacy and effectiveness (see figure 3).

[9] This topic will be expanded on in a future synthesis report on the efforts of developing countries in assessing and meeting the costs of adaptation, which is being prepared in response to decision 19/CMA.1.

Figure 3
Key concepts from the Intergovernmental Panel on Climate Change Working Group II Sixth Assessment Report related to assessing adaptation solutions and success



Source: Figure 1.7 of Begum et al. (2022).
Note: Solutions are defined as adaptation options that are effective and feasible, and conform to principles of justice, which can be assessed as part of adaptation planning, and through monitoring and evaluation during and after implementation. A set of responses is adequate if they sufficiently reduce climate risk to levels considered tolerable.

B. Methodologies

25. The terms "methodologies", "methods" and "tools" are frequently used interchangeably, even in technical literature. Broadly speaking, a methodology provides a conceptual framework for analysis, methods are the systematic procedure of conducting the analysis and tools are the vehicles used for collecting and analysing information. A methodology is likely to involve several methods, while methods may involve the use of multiple tools. Confusion arises as the word "methodology" is commonly used to refer to a specific way of performing an operation (yourdictionary.com, 2022), which indicates that each method and tool could have a unique methodology.

26. In the climate change adaptation literature, emphasis is generally placed on describing methods and tools, with relatively less attention given to characterizing methodologies. The same is true for the submissions from Parties and observer

organizations on this topic. All adaptation assessments have methodologies, and usually these are clearly laid out as part of the assessment process. However, a typology to categorize these methodologies is lacking. The submission from Paraguay on behalf of the AILAC group of countries states that many AILAC countries have not yet established a process to collect, categorize or systematize the methodologies used in the various processes to assess adaptation needs. The same is generally true at the global level. Establishing a systematic typology may assist in further understanding the range of methodologies being employed, as well as their relative strengths and weaknesses.

27. Adaptation assessment methodologies have frequently been characterized as being either top-down (impact driven) or bottom-up (vulnerability driven) (e.g. Noble et al., 2014). Top-down methodologies use climate model output as a starting point to determine the climate change impacts that would need to be adapted to, whereas bottom-up methodologies use an understanding of current vulnerability to climate change as the starting point for determining adaptation needs. The former is dominated by quantitative, modelling methods and frequently places an emphasis on economic needs, while the latter generally involves more qualitative, participatory research methods and is especially important for capturing social adaptation needs. Although there is utility in this distinction, assessments have evolved such that most recent examples employ hybrid approaches that allow analysis to benefit from the strengths of both approaches (Dessai et al., 2005; McKenzie Hedger et al., 2006; Noble et al., 2014; PROVIA, 2013). The terms "top-down" and "bottom-up" are used in a slightly different sense when discussing costing (see chap. III.B below). Africa's adaptation gap technical report notes that top-down approaches using integrated assessment models may be particularly useful for assessing long-term adaptation costs at the national and global level (Schaeffer et al., 2013).

28. In an operational framing of adaptation assessments, Fünfgeld and McEvoy (2011) distinguish between impacts, risk and vulnerability assessments, but do not use the phrase "adaptation needs assessments". Similarly, the first NDR differentiates between impact-, adaptation-, vulnerability- and risk-based approaches as the basis of national estimates of adaptation needs in developing countries. Several submissions from Parties and observer organizations use similar distinctions (see chap. II.C below), highlighting that existing processes and products contribute to assessing adaptation needs, but generally fail to address the full scope of such needs.

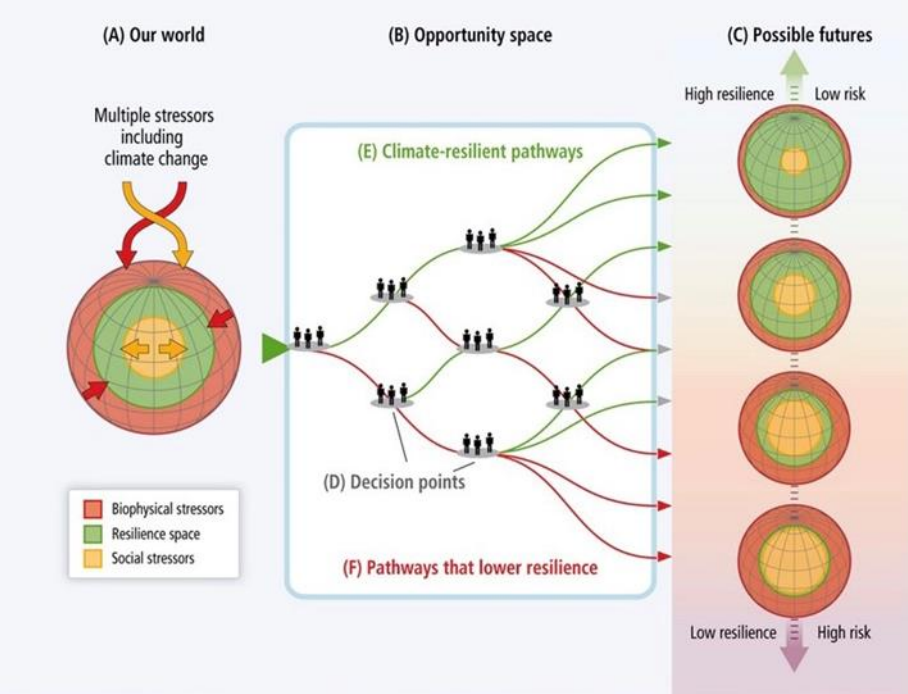
29. One example of a well-established methodology that has been instrumental in advancing adaptation knowledge globally is the process established by the IPCC over the past three decades involving expert assessment of previously published knowledge. This general methodology has been adopted by many countries for undertaking national assessments, some of which incorporate new analysis. For example, Japan's submission examines the probability and magnitude of climate change impacts, investigates the timing when impacts will be evident and when adaptation measures need to be in place and documents the level of confidence for all. Indigenous knowledge and local knowledge are increasingly recognized as critical elements of assessments undertaken by the IPCC and at the national level (e.g. Science Media Centre, 2022). Such approaches have proven useful for identifying priorities for further research and analysis and serve as a starting point for assessing adaptation needs, with additional methodologies used to assess capacity and other resource needs.

30. Detailed discussion of methods and tools for assessing adaptation needs is beyond the scope of this paper, although examples are discussed in the context of Parties' experience (see chap. II.C below). Readers are directed to a special issue of *Climatic Change* addressing decision support tools for climate change adaptation (Palutikof et al., 2019) and chapter 17 of the contribution of Working Group II to the AR6 (New et al., 2022a). Although a wide range of decision approaches are available and in use (Siders and Pierce, 2021), there is a lack of empirical evidence on the relative utility of different analytical methods for managing climate risks on the basis of their application by decision makers (New et al., 2022a).

C. Risk and uncertainty

31. Adaptation is fundamentally a process of managing risk – a concept central to IPCC assessments, particularly in the AR5 and AR6. Uncertain outcomes are a fundamental aspect of understanding risk, and hence dealing with uncertainty is an inherent element of climate change decision-making. Uncertainty arises from a number of sources (see definition in box 2), with uncertainties regarding human behaviour being perhaps the most difficult to address. A significant body of literature is devoted to the tools available for decision-making under uncertainty (see box 3; see also French, 2020, for overview and bibliography), with many linked to the concept of adaptation pathways (see figure 4 and box 3).

Figure 4
Simple depiction of the concept of adaptation pathways



Source: IPCC, 2014c.
Note: See figure 18.1 of Schipper et al. (2022) for a more complex depiction showing how pathways emerge from societal choices within multiple arenas, rather than simply resulting from discrete decision points.

Box 3
Dealing with uncertainty through adaptation pathways

Most decision-making related to climate change adaptation takes place in the context of deep uncertainty – defined as instances where experts or stakeholders either do not know or cannot agree on (1) conceptual models that adequately capture the various drivers and relationships in a system, (2) the probability distributions of uncertainty about key variables, or (3) how to weigh and value desirable alternative outcomes (Adler et al., 2022). Deep uncertainty characterizes many dimensions of assessing adaptation needs, and may relate to impacts, changing societal conditions, preferences and priorities, and responses over time. The assumption that scientific information is certain, when it is not, becomes a barrier to effective adaptation (Adler et al., 2022).

The most common approach for dealing with deep uncertainty is to focus on low-regret options, which are measures that deliver benefits over a wide range of climate and socioeconomic scenarios (Adler et al., 2022). However, such responses can be of limited scope in addressing adaptation needs, particularly in

the long term. The AR6 emphasizes that focusing on near-term risk reduction reduces the opportunity for transformational adaptation.

An alternative approach to dealing with deep uncertainties is to examine adaptation pathways. Pathways are iterative, continuously evolving processes for managing change in complex systems that involve a series of choices and trade-offs between short- and near-term goals (see figure 4; Adler et al., 2022; Denton et al., 2014). There is not a single, correct pathway to reach desired goals; rather, there are multiple possible pathways, with the most appropriate being dependent on many factors, including political, cultural and economic circumstances (Schipper et al., 2022). While there is no right path to achieving a particular goal (e.g. climate resilience), choices at any point in the process can lock in an undesirable pathway that may preclude reaching that goal (New et al., 2022a). The AR6 provides definitions for adaptation pathways, climate-resilient development pathways, climate-resilient pathways, development pathways and sustainable development pathways, which place different relative emphasis on adaptation, mitigation and sustainable development.

The approach of examining adaptation pathways stresses that choices made when assessing adaptation options represent one decision point in an ongoing process to achieve climate resilience. Choices will unavoidably involve trade-offs, with some populations affected more than others, which highlights the importance of understanding equity and justice implications (see figure 3; Begum et al., 2022). Initial steps may involve applying low-regret options that enhance flexibility rather than limiting future options (New et al., 2022a). It is anticipated that many pathways will involve both incremental and transformational actions (Denton et al., 2014).

1. Temporal scale

32. Adaptation needs assessments are undertaken knowing that risks will change over time. Although it is clear that adaptation needs increase as global warming increases (IPCC, 2018), uncertainty regarding both climate and non-climate factors increases with time. Considering multiple scenarios is a good way to address this uncertainty. The emission scenarios used by the IPCC capture a range of climate futures, while risk management dictates that consideration of low-probability (extreme) scenarios is appropriate when the consequences of impacts are potentially catastrophic (see chap. IV.B below).

2. Spatial scale

33. The complexity of assessing adaptation needs increases markedly when moving from site- or situation-specific needs to the national and global level. Most analysis of needs undertaken to date has happened at the project level, often within specific sectors. Scaling project-level data to inform a national-level needs assessment is challenging and increases uncertainty. Uncertainty is magnified within diverse economies where attention is often placed on the largest or most vulnerable sectors, and hence needs within other sectors remain largely unknown. Additional uncertainty regarding climate change risks and associated adaptation needs results from limited understanding of how climate change impacts outside of a country will necessitate adaptation actions within the country (see chap. IV below).

IV. Overview of existing methodologies and experiences

34. This chapter examines information on the experience of Parties and organizations applying methodologies and guidance for assessing adaptation needs, as documented in submissions made in response to the call in decision 11/CMA.1, the Adaptation Knowledge Portal and the first NDR. As noted previously, much of this information makes little distinction between methodologies, methods and tools. This information is synthesized in chapter IV below.

A. Inventory of methodologies submitted by Parties and organizations to the UNFCCC

35. The call for submissions to support the development of this technical paper elicited input from eight Parties and groups of Parties, and from 11 organizations. While the number of submissions was relatively small, they cover a wide range of Parties (developed, developing and least developed countries) and reveal significant commonalities among them. The submissions from organizations highlight sectoral perspectives; linkages with disaster risk reduction, sustainable development and other agendas; and emerging issues.

1. Overview

36. Most of the submissions acknowledge the broad scope of adaptation needs that encompass all stages of the adaptation cycle. Recognizing the context and situation-specific nature of adaptation needs, the submissions from Argentina, the European Union and its member States and IIED acknowledge that assessment of such needs should, to the extent possible, be undertaken within a broader policy context, integrated with national development and economic planning and recognizing linkages with other international agendas (i.e. the 2030 Agenda for Sustainable Development, the Convention on Biological Diversity, the Sendai Framework for Disaster Risk Reduction and the Ramsar Convention on Wetlands of International Importance). Although specific methodologies advocated within these different processes differ in terms of scale and approach, significant commonalities enhance synergies and can result in more efficient planning processes. The submissions stress that adaptation needs do not necessarily equate to, or replace, development needs.

37. The submissions also make clear that almost every country recognizes that there is not a single methodology, or suite of methodologies, appropriate for assessing adaptation needs in all situations. Given the differences in adaptive capacity between countries, reliance on a single methodology is not practical or desirable. For example, the LDCs and LoCAL have highlighted the need for methodologies to be simple, practical and deployable. Furthermore, since the methodology applied influences the outcome of the analysis, and the associated adaptation response, using more than one methodology will likely lead to more rigorous results.

38. Current experience of Parties assessing their adaptation needs has developed through a learning-by-doing process (AILAC submission). General guidance provided by the UNFCCC or other international entities often serves as a starting point, with individual countries and organizations developing detailed methodologies determined by their specific circumstances. These methodologies are often sector-specific (AOSIS submission). The submission from AILAC notes that the application of methodologies in that region is largely limited to the entities that developed them. This statement is likely true globally. While understandable in the sense that every situation is unique, this also explains the proliferation of methodologies and the lack of a framework for more systematic analysis.

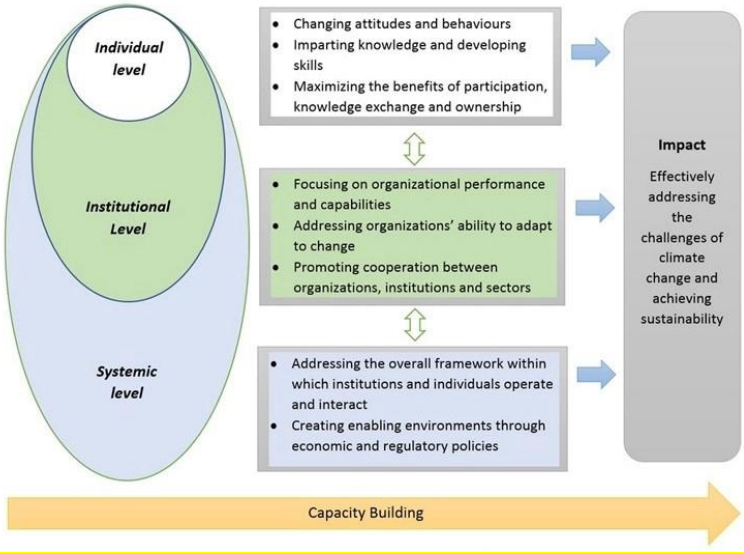
39. Parties generally advocate for a stepwise approach to assessing adaptation needs, with each step likely involving different methods. Many existing products and processes, including risk and vulnerability assessments, are essential steps in a broader assessment of adaptation needs. Submissions from Argentina, Cuba, the IIED and Japan highlight that the starting point is the best available scientific information and knowledge, including understanding the current and projected impacts of climate change and the underlying causes of vulnerability. The importance of transparency and participatory methodologies stressing equity and gender and social inclusion is commonly highlighted (AOSIS, IIED, LDCs and Nigeria submissions). Bottom-up approaches received the most attention, with submissions noting the need for consultations from multiple levels of government, the private sector, non-government organizations and civil society. Such approaches require significant time and human resources (Alliance for Global Water Adaptation submission).

40. Many submissions drew attention to the importance of assessing capacity, technological and financial needs. Methodologies developed or endorsed by the UNFCCC, for example the methodology for TNAs (see figure 5, box 4, and the UNDP Partnership[10] submission), tend to see broad application. The recent development of a toolbox by the PCCB may lead to greater rigour in analysing capacity needs (see figure 6 and box 5). It was also noted that the strong linkages between finance, capacity-building and technological support suggest that associated needs should be assessed in an integrated manner (Portugal submission).

Figure 5
The technology needs assessment process

Source: Haselip et al. (2019).

Figure 6
Scope of capacity-building in the UNFCCC process



Source: UNFCCC, 2022b

Box 4
Technology needs assessments

A formal process for assessing climate change technology needs has been part of the UNFCCC process since 2001 and hence is more mature than processes for assessing other needs. Since its start, more than 90 developing countries have completed TNAs. Efforts have increased since 2010, with the UNEP Copenhagen Climate Centre providing technical and methodological support to undertake assessments and the GEF providing financial support for TNA projects (UNFCCC, 2022a). The methodology is sector-focused, with agriculture, water and infrastructure the most frequently prioritized sectors for adaptation needs

[10] The organization is now called the UNEP Copenhagen Climate Change Centre.

(UNFCCC, 2022a). Recent experiences with the TNA process are found in Jehl Le Manceau et al. (2021).

The TNA methodology consists of three major steps (see figure 5). The first step, identification and prioritization of sectors and technologies, emphasizes stakeholder engagement and multi-criteria analysis. The second step, barrier analysis and enabling framework identification, includes market assessment and analysis of institutional capacity (see case study 7 below). The final step involves developing a technology action plan, which encompasses the vision to move from assessment to implementation (UNFCCC, 2022a). The process is supported by extensive documentation, including a step-by-step guide (Haselip et al., 2019), guidance for gender-responsive TNAs (De Groot, 2018), guidance for identifying and prioritizing technologies for climate change adaptation (Trærup and Bakkegaard, 2015), technology guidebooks including a taxonomy of climate change adaptation technology (Woo et al., 2021) and finance guidebooks including scaling up investments in climate technology (Haselip, 2021).

The TNA process may provide lessons learned regarding methodologies and guidance for broader assessments of adaptation needs. Shortcomings of the process have been identified, including limitations related to spatial scale (SCF, 2021). Perhaps the most important next step is moving TNA from being a stand-alone process to being part of an integrated assessment of adaptation needs. Steps in this direction are already evident through the inclusion of technology needs in the NDCs of many countries (UNFCCC, 2022a). Realizing the full potential of TNAs requires analysis of what is needed to implement existing NDCs, including better alignment with the priority sectors included in the NDCs (Charlery and Trærup, 2019).

Box 5
Assessing capacity needs

Capacity-building is a critical dimension of the Convention, with capacity-building frameworks adopted in 2001 (decisions 2/CP.7 and 3/CP.7), and the Paris Agreement. The concept of adaptive capacity is well established in the adaptation literature (e.g. Brooks and Adger, 2005; IPCC, 2007; Smit and Wandel, 2006; Smith et al., 2003). Key determinants of adaptive capacity, as highlighted by the IPCC (2007), are economic resources, technology, information and skills, infrastructure, institutions and equity, which also provide a useful framework for assessing capacity needs.

While capacity needs assessments are relatively new in the context of climate change and the UNFCCC (PCCB, 2020), they have long been an integral part of environment and development planning (e.g. GEF, 2001). Defined by UNDP (2008) as the analysis of desired capacities against existing capacities, capacity assessments identify areas where capacities need to be built or enhanced, as well as areas where existing capacities are strong and can provide a foundation for immediate adaptation actions. Capacity needs assessments at a national level should consider needs at three different levels – individual, institutional and systemic (see figure 6). They should also be viewed as an iterative, ongoing process rather than a one-off initiative (PCCB, 2020), consistent with the broader nature of adaptation needs assessment outlined in this paper. It is also noted that there is no universal metric for capacity, and that many factors, including national circumstances, ambition and access to resources, will affect the assessment process (PCCB, 2020). Furthermore, it is clear that no single methodology can be devised that can cover the entire spectrum of situations across all countries (GEF, 2001).

The PCCB has published a toolkit for assessing capacity gaps that includes methods, case studies and links to supporting resources, including guidance documents (PCCB, 2020). The literature (e.g. Bizikova, 2012; UNDP, 2008) stresses the importance of participatory assessment methods. Specific tools are available for assessing institutional capacity (e.g. Dixit et al., 2012; Gupta et al.,

2010; Unites States Agency for International Development, 2016), reflecting the key role of formal organizations in both leading and enabling adaptation. The inclusion of gender and other equity considerations is critically important for capacity assessments (e.g. Bryan et al., 2016).

41. With respect to financial needs, commonly used methods and tools for economic analysis, as well as newer multi-metric techniques see table 1), are beginning to see greater application with respect to climate change (see box 6). For example, Argentina noted its intent to use multi-criteria analysis for prioritizing adaptation options and cost–benefit or cost-effectiveness analysis to guide implementation decisions. Nonetheless, application of these methods for assessing adaptation needs is not widespread, particularly at the national level. The AR6 notes that all approaches for estimating financial needs for adaptation, from the national to the global level, have limitations that can result in over- or underestimating actual needs (New et al., 2022b). Those approaches include aggregation of individual case studies along with scaling to area of interest, and integrated assessment model simulations of climate impacts and adaptation costs. Limitations include the incomplete coverage of sectors and risks, the lack of understanding of soft and hard limits to adaptation, and the role of learning and innovation as climate change progresses (see also UNEP, 2020). Estimating the benefits of adaptation, in terms of damage avoided, also remains challenging (New et al., 2022b).

Table 1
Economic appraisal methods for adaptation decision support

Method	*Description*	*Level of complexity*
Commonly used appraisal methods		
Cost–benefit analysis	Appraises options in terms of their monetary value, weighing the life cycle costs of options against projected benefits, with the option with the highest net present value or benefit–cost ratio selected. Analysis requires establishing a baseline against which costs and future expected benefits are measured, which is challenging. The method does not explicitly deal with uncertainty.	Medium
Cost-effectiveness analysis	Identifies the most economically efficient option to achieve a specific adaptation goal. Useful when the primary benefit metric cannot be expressed in monetary terms. It can only be used to compare options in relation to a single benefit metric. Analysis requires establishing a baseline against which costs and future expected benefits are measured, which is challenging. The method does not explicitly deal with uncertainty.	Medium
Multi-criteria decision analysis	Uses multiple metrics in addition to economic efficiency to assess adaptation options in terms of achieving specified adaptation goals. It can combine qualitative and quantitative information, so it is useful when it is difficult to assign monetary values or otherwise quantify some outcomes. Analysis requires establishing a baseline against which costs and future expected benefits are measured, which is challenging. Uncertainty can be incorporated as an evaluation criterion, typically relying on the judgment of experts or stakeholders.	Low to medium
Approaches to explicitly incorporate uncertainty and risk		
Robust decision-making	Evaluates how different adaptation options perform under large ensembles of scenarios to identify options that are robust to many different futures (i.e. options that are not necessarily optimal but good enough and that minimize negative outcomes).	Medium to high

Method	*Description*	*Level of complexity*
	Particularly useful when future uncertainties are poorly characterized, and probabilistic information is not available.	
Portfolio analysis	Used to evaluate the trade-offs between the likelihood of a high degree of effectiveness in reducing a threat and the risk that the options under consideration will fail to be effective under certain future conditions. Helps identify a set of options that are effective over a range of plausible future conditions, as opposed to one option that is optimal for one future. Useful when there are many adaptation options available to achieve a goal and when good data are available.	High
Real options analysis	Explicitly assesses the level of flexibility in the timing for implementing one or more adaptation options. Also used to assess flexibility for adjusting an adaptation option over time, after it has been implemented. Evaluates whether it is better to invest in options that offer greater flexibility in the future. Useful for adaptation decisions involving large, upfront and irreversible investments, where there is flexibility in the timing of the investment, opportunity for new information to emerge and the ability to adjust the option in response to learning.	High
Adaptation pathways	Adaptation options in terms of (1) adaptation turning points (i.e. points in time beyond which options are no longer effective) and (2) what alternative adaptation options are available once a turning point has been reached. Rather than taking an irreversible decision now to implement an "optimal" adaptation option – which may not be needed depending on how future climate conditions evolve – it encourages decision makers to adopt a flexible plan where adaptation decisions are made over time and the plan is adjusted as pertinent information emerges. Additional options can be brought forward or delayed to a later time, depending on future conditions. Challenges relate to defining appropriate turning points and data to monitor.	Medium to high

Source: Adapted from Boyd and Markandya (2021).

Box 6
Methods of economic analysis

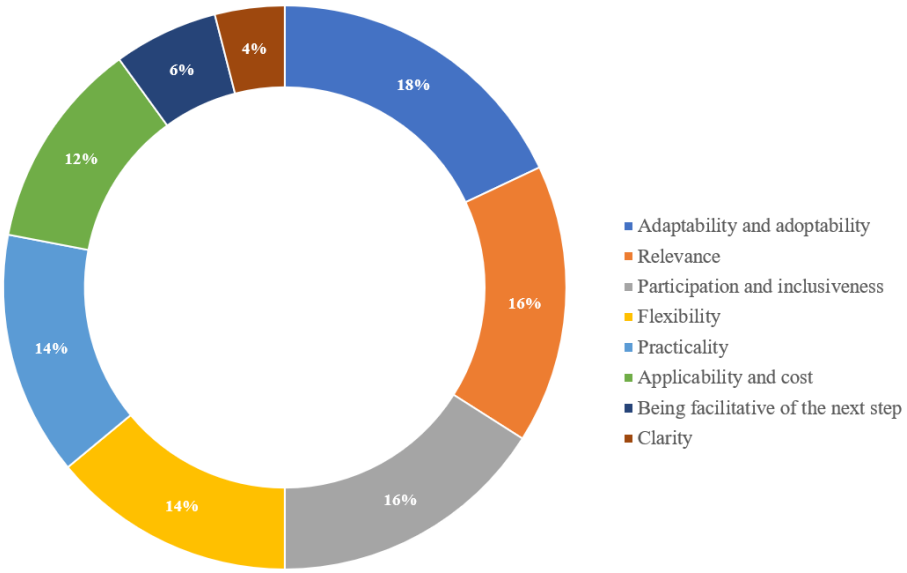
The past decade has seen significant evolution in economic thinking on adaptation. The historic focus on cost–benefit analysis and identification of best economic adaptations has given way to the application of multi-metric evaluations that include consideration of risk and uncertainty (Chambwera et al., 2014). These new approaches allow consideration of non-monetary and non-market measures, inequities and behavioural biases, and ancillary benefits and costs. Economic analysis is one key input but should not be the sole basis for final decisions (Chambwera et al., 2014). A focus on quantifiable costs and benefits can bias decisions against the poor and against ecosystems and those in the future whose values can be excluded or are understated. This evolution does not preclude the use of more traditional methods like cost–benefit analysis, particularly where uncertainty is not a significant factor and where adaptation actions are short term (Boyd and Markandya, 2021). Newer methods have primarily been applied at the

project or local level, rather than as a part of national assessments of adaptation needs.

Brief descriptions of major methods of economic analysis to support adaptation decision-making are contained in table 1. More substantive overviews of these methods and related issues, such as valuation, are found in UNFCCC (2011), PROVIA (2013) and Chambwera et al. (2014). Several Parties have stressed the importance of strengthened and more rigorous valuation of ecosystem services, particularly given the key role that nature-based solutions play in the adaptation responses of many developing countries. The IPCC Special Report on Climate Change and Land estimates that the value of the world's terrestrial ecosystem (on an annual basis) can be roughly equal to the annual global gross domestic product.

42. Of the guiding principles for assessing adaptation needs identified by the AC (see figure 7), all were mentioned in submissions as being important. The three that were highlighted most often were relevance, adaptability and adoptability, and participation and inclusiveness. This reflects the broader comments of the submissions, which noted the situation-specific context of adaptation needs. Methodologies employed need to be relevant to that context and have the ability to be modified to fit local circumstances. The emphasis on participatory approaches was noted above.

Figure 7
Relative importance of the principles for assessing adaptation needs



Notes: (1) Figure formulated by the AC, as highlighted in Party submissions; (2) not all submissions explicitly responded to question about principles.

43. Parties also stressed that adaptation needs evolve with time as a result of increased understanding of climate risks and adaptation options, technology development, changes in underlying drivers of vulnerability and many other factors. As such, assessing adaptation needs can be viewed as an ongoing learning process compatible with the concepts of adaptive management and the iterative nature of adaptation. This perspective highlights the importance of methodologies for assessing adaptation needs being part of a broader monitoring, evaluation and learning system (IIED submission) and the need for mechanisms to effectively share experiences with these methods (Nigeria and WFO Climakers submissions).

2. Methods and tools

44. Most submissions made in support of this paper included examples of methods and tools, as well as case studies of assessing adaptation needs. This input, as well as relevant content received through other submissions, can be found on the Adaptation

Knowledge Portal under methodologies for assessing adaptation needs. Descriptions of methodologies generally include an overview of the methods used in applying tools, but rarely address the overarching methodology. Methodological insights can be gained from many of the case studies submitted, although the lack of an analytical framework makes it difficult to draw conclusions about the relative value of various approaches.

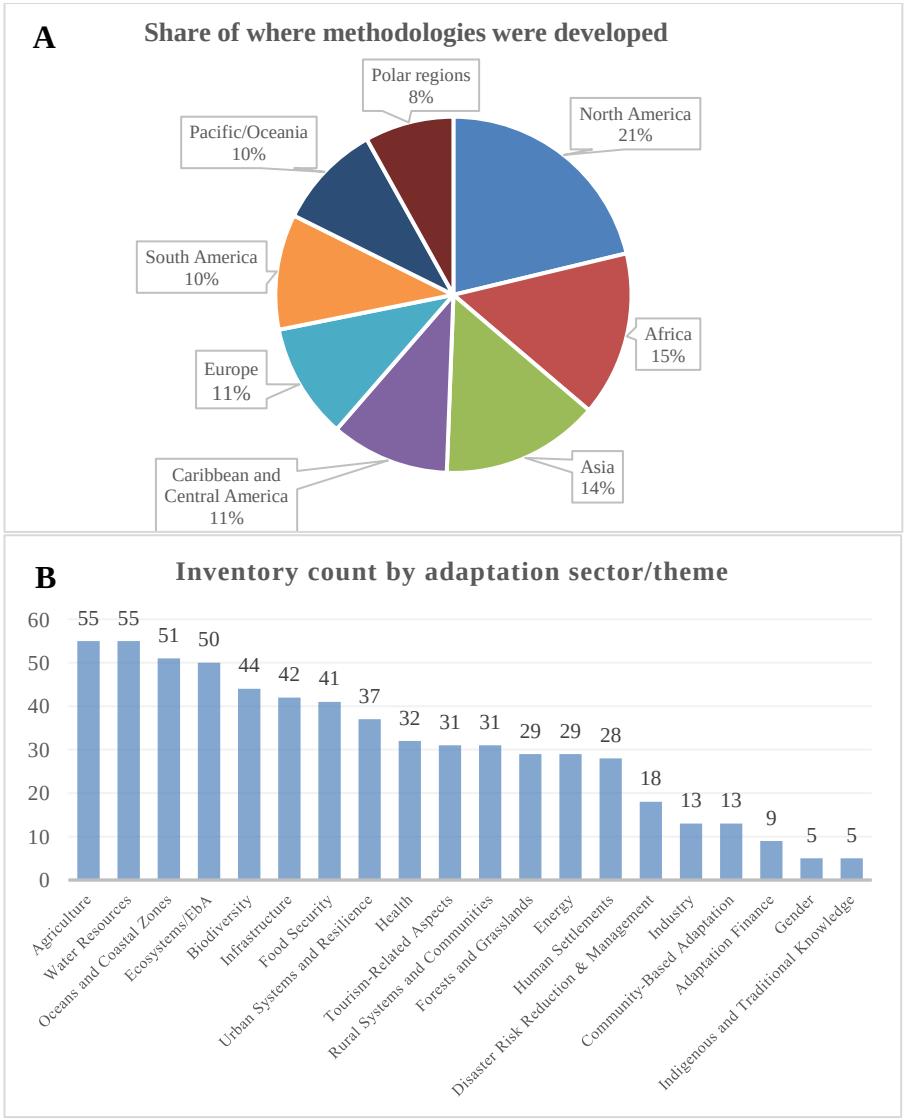
Box 7
Using the Adaptation Knowledge Portal

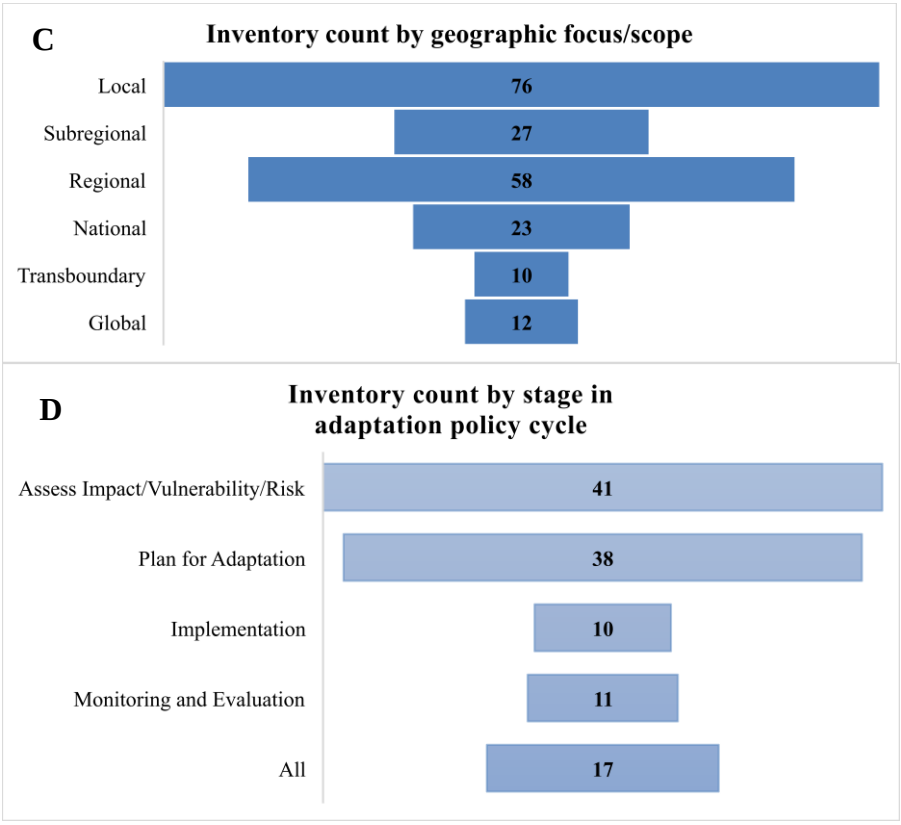
The Adaptation Knowledge Portal is an online resource of the UNFCCC knowledge-to-action hub on adaptation and resilience that provides open access to adaptation knowledge resources. As of February 2022, the portal included more than 1,750 entries, which are predominantly tools and case studies.

The portal includes an inventory specifically focused on assessing adaptation needs. Launched by the AC in collaboration with the LEG, NWP partners, and methodology users and developers, the inventory contains more than 250 entries, including case studies, tools, technical documents and reports, online portals, and educational and training materials. As with the rest of the portal, inventory users can type queries into the search bar and use tags from the drop-down bar above the search line to filter search results by region, geographic scale, adaptation sector/theme, adaptation element, climate hazard and target group.

45. Analysis of input received as at August 2021 shows that the inventory includes tools developed in all regions of the world, with North America (specifically the United States of America) contributing the most (see figure 8.A). Many of the tools have a sectoral focus, with agriculture and water resources being dominant, although most tools can be used to address multiple sectors (see figure 8.B). Consistent with the emphasis placed on bottom-up approaches, the majority of tools analysed are designed to address adaptation needs at the local level (see figure 8.C). It is noteworthy that fewer than 25 per cent of the tools included in this inventory focus on the national level. It is also not surprising to see the majority of tools relate to impact, vulnerability and risk assessment, with only a few encompassing the complete adaptation cycle (see figure 8.D). None of the submissions explicitly mentioned methods and tools for assessing adaptation needs related to monitoring and evaluation. A recently developed framework for monitoring and evaluation (Dinshaw and McGinn, 2019) may help address this potential gap.

Figure 8
Characteristics of tools contained in the inventory of methodologies for assessing adaptation needs





Source: Adaptation Committee document AC/20/INFO5C.

46. Additional work could increase the utility of the inventory. For example, it would be helpful to differentiate between methods and tools that yield quantitative versus qualitative output. The value of the case studies in the inventory, which are generally linked to specific tools, lies in their details. Some of these case studies inform chapter IV below.

B. First report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement

1. Overview

47. A comprehensive overview of developing country Parties' experience in assessing their needs, as documented in various types of reports submitted to the secretariat, is contained in the first NDR (see box 1). It includes both qualitative and quantitative information, with the former referred to as "needs" and the latter as "costed needs". Qualitative information was obtained from descriptions of national priorities, action plans and planned activities in reports submitted by each country. Quantitative information includes costed needs at the project level and results of economic modelling. The report highlights the critical importance of strengthening understanding of costed needs at the national level to better identify gaps where financial support is needed and ways to leverage public and private resources.

48. The NDR includes an overview of the processes and approaches that have been used by developing country Parties, as well as the methods and tools associated with those approaches. In the NDR, top-down approaches refer to modelling of specific sectors or the economy as a whole, with documented government priorities being key to identifying needs. Bottom-up approaches refer to needs identified from a project pipeline, with consultation with sectoral stakeholders being key for identifying needs. As with adaptation assessments, top-down approaches tend to yield quantitative output whereas bottom-up approaches typically yield more qualitative information.

49. While most countries have assessed their mitigation and adaptation needs separately, using different methods and tools, some have used the same methodologies to identify both mitigation and adaptation needs. The report notes that understanding the limitations of needs assessments undertaken to date provides an opportunity to enhance existing methodologies.

2. Analysis and recommendations

50. The NDR notes that the amount of detail in country reports on methodologies used varies greatly, while remaining compliant with reporting guidelines. The most commonly identified methodologies for adaptation needs relate to sector-based vulnerability assessments, with a focus on agriculture, ecosystems and biodiversity, water, and cross-cutting sectors. Other methods highlighted include impact-, risk- and adaptation-based approaches, as well as multi-criteria decision analysis (see box 6). A compilation of methodologies identified in national reports (annex E of the NDR) highlights the imprecision of the use of the term "methodologies". The list includes approaches (e.g. vulnerability assessment), methods (e.g. multi-criteria analysis), tools (e.g. community vulnerability and adaptation tool) and even projects (e.g. Coordinated Regional Climate Downscaling Experiment CORDEX145 model).

51. The approaches that have been undertaken to date vary depending on many factors, including institutional and human capacity, scope, cost, data availability and time frame. Bottom-up approaches are commonly used in assessing adaptation needs and include community-level actions. As noted in chapter III.A above, approaches developed or endorsed by the UNFCCC play a key role in helping developing countries assess their adaptation needs. In addition to well-established methodologies, such as that for technology needs assessments, the guidance established for NAPs has helped establish a framework for assessing broader adaptation needs.

52. The lack of a common framework or common methodologies for assessing capacity needs is highlighted as a gap, and a reason for the highly variable information currently available in country reports. The NDR notes that multi-criteria decision analysis, surveys and other consultations with stakeholders are methods employed to understand capacity needs.

53. With respect to financial needs, the report notes that many qualitative and quantitative reports of adaptation needs developed by countries are not accompanied by cost estimates. In some cases, estimated costs and financial needs were included without any information on the methodologies used to derive them. The fact that addressing adaptation needs requires long-term investments that cannot always be included in short-term projects likely contributes to the lack of costing information for needs developed through bottom-up approaches. The challenges of quantifying financial needs are well recognized, and the report notes that methodologies specifically developed to estimate such costs and needs are limited.

54. The report includes three recommendations directly relevant to methodologies for assessing adaptation needs:

(a) Encouraging developing country Parties to provide to the UNFCCC, where possible, information on needs related to methodologies employed in determining the needs in their national reports;

(b) Encouraging developing country Parties to consider the insights on methodologies identified in the first NDR when costing and determining needs;

(c) Encouraging Parties, multilateral and financial institutions, academia, methodology developers, research institutions and other relevant actors to continue to develop methodologies for determining adaptation and resilience enhancement needs.

C. Experience with existing guidance

55. Many submissions identified the need for improved guidance for assessing adaptation needs, ranging from general guidance on appropriate use (WFO submission) to detailed guidance on how to address uncertainties in climate and vulnerability data (Commonwealth Secretariat submission). The IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations (Carter et al., 1994) are widely considered to be outdated and were not referred to in any of the submissions related to this topic. Comprehensive guidance on assessing adaptation needs is generally lacking, with that contained in PROVIA (2013) (see box 8) being among the most complete, but somewhat dated.

Box 8
Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation guidance on assessing vulnerability, impacts and adaptation to climate change

The 2013 guidance document developed by PROVIA (renamed the World Adaptation Science Programme) provides an overview of information on key concepts, approaches to analysis, and methods and tools for participation and engagement, impact analysis, capacity analysis, scenario analysis, behavioural analysis, institutional analysis, formal decision-making and valuation. The scope covers the entirety of the adaptation cycle (termed "adaptation learning cycle" in that document), including implementation and monitoring and evaluation, and hence aligns well with the scope of adaptation needs used in this paper. The guidance is not prescriptive, but rather provides alternatives for all stages of the process. It also recognizes that the process is complex and often non-linear, and therefore includes decision trees for choosing approaches at multiple entry points. While some submissions noted the guidance, there has not been systematic analysis of its application and utility.

56. Numerous portals provide access to existing guidance for vulnerability, risk, adaptation assessments and other approaches that contribute to the assessment of adaptation needs. For example, guidelines on the preparation and implementation of NAPs are available on NAP Central[11] and are complemented by an evolving collection of supplementary material.[12] Additional resources are available through the NAP Global Network,[13] the National Adaptation Plan Global Support Programme,[14] and regional and national adaptation centres. While not developed as a means to comprehensively assess adaptation needs, many countries have used the process to formulate and implement NAPs as the basis for their current estimates (SCF, 2021).

V. Analysis

A. Lessons learned

57. Key lessons learned relevant to understanding adaptation needs, and the process of assessing those needs, include:

(a) Adaptation needs encompass all stages of the adaptation cycle, from assessment of risks and vulnerability to planning, implementation, monitoring and evaluation of adaptation measures;

(b) Adaptation needs include actions to address the underlying causes of vulnerability to climate change, as well the resources to undertake those actions;

11 https://www4.unfccc.int/sites/napc/Pages/Home.aspx.
12 See https://www4.unfccc.int/sites/NAPC/Guidelines/Pages/Supplements.aspx.
13 See https://napglobalnetwork.org/resources/?resource-type=86#resource_list.
14 See https://www.globalsupportprogramme.org/.

(c) The categorization of adaptation needs as presented in the AR5, particularly biophysical and environmental needs, social needs, institutional needs, and information, capacity and resource needs, may provide a useful framework for planning and conducting a comprehensive assessment;

(d) Adaptation needs are situation-specific and dynamic – they will change with time, with the scale of analysis, with climate scenarios and with the methods used for the analysis;

(e) Adaptation needs reflect perceptions of adaptation goals and hence different people and populations will have different adaptation needs when facing the same climate risks;

(f) Assessments of adaptation needs should be an ongoing process for which findings will reflect improved understanding of climate risks, adaptation options and trade-offs, technology development, changes in underlying drivers of vulnerability and other factors;

(g) Assessments of adaptation needs should be undertaken within a broader policy context, integrated with national development and economic planning, and explicitly recognizing linkages and trade-offs;

(h) In many developing countries, strengthened capacity, technology and finance is needed in order to undertake more comprehensive assessments of adaptation needs.

58. Lessons learned with respect to methodologies include:

(a) No single methodology or suite of methodologies allows for comprehensive assessment of adaptation needs in all situations;

(b) Broadly embraced principles for methodologies for assessing adaptation needs include participation and inclusiveness, relevance, replicability and responsiveness;

(c) Methodologies should be adaptable so that they can be applied in a range of circumstances, including having limited information and capacities;

(d) The best available scientific information about climate risks and societal vulnerabilities and goals, usually arising from risk and vulnerability assessments, is a starting point for assessing adaptation needs;

(e) Top-down and bottom-up methodologies have different strengths for assessing adaptation needs, and most recent approaches have incorporated elements of both;

(f) Currently employed methodologies have largely developed through a learning-by-doing process, often following broad guidance provided by the UNFCCC (e.g. the process to formulate and implement NAPs);

(g) Pathway approaches (e.g. adaptation and climate-resilient development pathways) are emerging as a powerful concept for understanding adaptation needs at a range of temporal and spatial scales;

(h) More progress has been made in assessing the needs for action in adaptation than in estimating financial or technological needs.

B. Emerging good practices

59. The following paragraphs provide examples of good practices associated with assessing adaptation needs. Several of the examples relate to emerging issues with only limited experiential evidence of how they can be applied in assessing adaptation needs, particularly at the national level. Not all countries, particularly those with limited capacity, will be able to incorporate all these practices into their assessment processes. Their inclusion here reflects the growing understanding of adaptation and may

encourage strengthening of methodologies related to assessing adaptation needs. Descriptions of good practices are accompanied by case studies briefly illustrating practical application of the practice. Emphasis is on methods as opposed to the findings of specific case studies. Although each case study focuses on a specific good practice, there are existing processes and projects that incorporate many of these good practices (e.g. adaptation to the impacts of climate change on water resources in the Andes; see Condesan, 2022; Quishpe, 2021).

1. Using participatory approaches

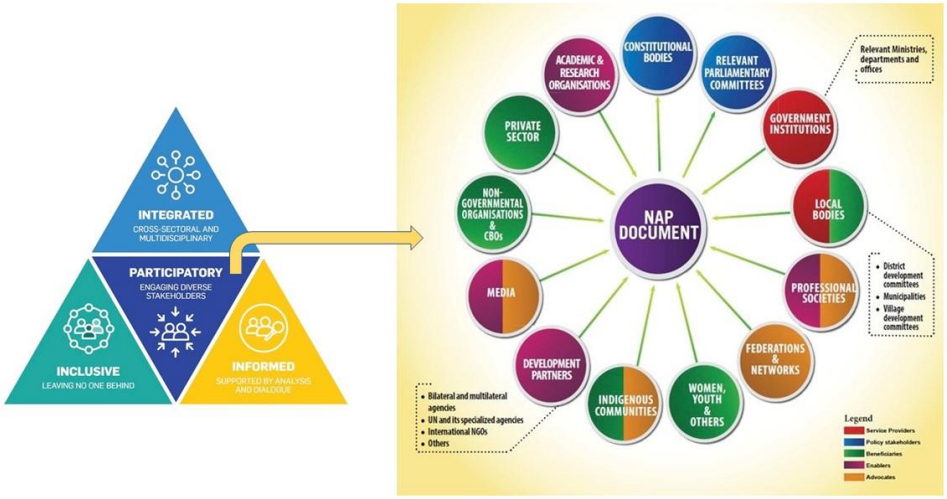
60. All submissions, and indeed almost every reference consulted in preparation of this paper, highlighted the importance of participatory approaches at all stages of the assessment process. Even in discussion of complex decision support tools under deep uncertainty, New et al. (2022a, p.17-5) noted, "These tools and methods have been shown to *support deliberative processes where stakeholders jointly consider factors*, such as the rate and magnitude of change and their uncertainties, associated impacts and timescales of adaptation needed along multiple pathways and scenarios of future risks" (emphasis added). Participatory approaches promote inclusiveness and transparency and embrace a number of ethical and social-justice considerations, including the structural inequities faced by women, youth, children, disabled and displaced people, indigenous peoples and marginalized ethnic groups. These approaches are essential for understanding the vulnerabilities that underlie environmental, social and institutional needs, as well as the existing capacity to address those needs. They also serve to broaden ownership of issues and leadership on adaptation solutions. Levels of engagement can range from one-time solicitation of local knowledge and perspectives to sustained participation of stakeholders throughout the assessment process. Many methods and tools, including facilitation toolkits and conflict resolution techniques, are available to undertake participatory processes (see PROVIA, 2013, for a comprehensive summary).

61. There are many examples of the effective use of participatory approaches in assessing adaptation needs. Case studies 1 and 2 present examples from the NAP processes of Nepal and Peru, both of which were completed in 2021.

Case study 1 – Nepal's national adaptation plan process

62. The recently completed NAP for Nepal contains a vision, goals, principles and outcomes, including priority programmes and enabling actions, developed through a multi-year process (Government of Nepal, 2021). In developing the plan, Nepal placed a high priority on stakeholder engagement and committed to an inclusive process that would "leave no one behind" (Nepal Ministry of Forests and Environment, 2018, p.17) (see figure 9). The process was led by the national government, with stakeholders treated as key members of the institutional arrangements. Thematic and cross-cutting working groups were established that brought together multiple levels of government, civil society organizations, research institutions and private sector associations, as well as a wide range of other stakeholders. Actors within each working group were initially characterized as service providers, policy stakeholders, beneficiaries, enablers or advocates (see figure 9). The diverse perspectives brought to the working group led to a thorough discussion of the opportunities for adaptation within defined theme areas (Nepal Ministry of Forests and Environment, 2018). Additionally, recognizing that "adaptation and equitable development can only be achieved if a fair share of benefits is distributed among all fraction [*sic*] of society, irrespective of their caste, class, ethnicity, gender, age and disability status" (Nepal Ministry of Population and Environment, 2017, p.29), emphasis was placed on ensuring that marginalized and disadvantaged communities and indigenous and traditional groups were engaged in the process, with special consideration for youth, women and people with disabilities (Nepal Ministry of Population and Environment, 2016). Gender equality and social inclusion were treated as both cross-cutting issues and stand-alone themes in the NAP process, with the goal of integrating climate change adaptation into investments that promote inclusive economic development and livelihood opportunities.

Figure 9
Unique features of Nepal's national adaptation plan process



Sources: The left figure is from the Nepal Ministry of Forests and Environment (2018) and the right figure is from the Nepal Ministry of Population and Environment (2016).

63. The working group process required significant investments in both time and resources, and still faced challenges in addressing multiple concerns and priorities of diverse stakeholders in a consensus-based process (Nepal Ministry of Forests and Environment, 2018). The challenge was further amplified as more organizations, often with limited capacities and understanding of adaptation, became part of the process. While the working groups were successful, it was recognized that additional stakeholder engagement platforms targeting subnational actors were needed to ensure broad and inclusive participation (Nepal Ministry of Forests and Environment, 2018).

Case study 2 – Peru's national adaptation plan process

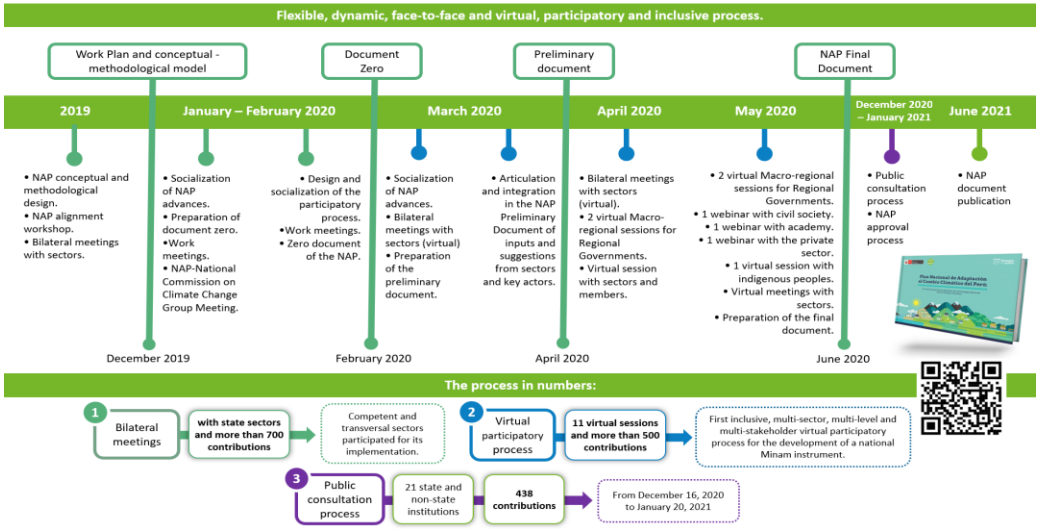
64. An inclusive, participatory process was instrumental to the development of the goals and commitments set out in Peru's NAP (Government of Peru, Ministry of Environment, 2021).[15] Building on previous analysis that had identified five priority sectors for action – agriculture, fisheries and aquaculture, forestry, health and water – the NAP process promoted opportunities for dialogue that would in turn drive action. The participatory strategy outlined guiding principles for communication and feedback, including an intercultural approach (incorporating the engagement of indigenous groups), an intergenerational perspective (using traditional knowledge alongside newer information channels that appeal to youth) and recognition of the importance of gender responsiveness. These principles helped lay a foundation for shared ownership of adaptation actions by stakeholders across the country.

65. The most important mechanism was the participatory process "Dialoguemos sobre Cambio Climático" (Let's talk about climate change), which the Peruvian government used to foster an inclusive, culturally responsive, participatory process. Implementation was complicated by the fact that much of the consultation took place during the global coronavirus disease 2019 pandemic, which resulted in a need to shift from face-to-face participation to a virtual interface without losing the inclusive and participatory approach (see figure 10). Virtual workshops took place in spaces that were customized to the type of actor or groups of actors engaged. In addition to facilitating participation, the virtual workshops were able to enhance understanding of the topics, including the need to incorporate a scalable monitoring and evaluation

[15] Available at https://www.gob.pe/institucion/minam/normas-legales/1955977-096-2021-minam

system in the NAP. Peru's NAP, which was finalized in June 2021, is the result of a multi-sector, multi-level and multi-stakeholder process led by the Ministry of the Environment in such a way that the entire population can identify with the challenges and opportunities presented by climate change and can work together to enhance resilience and sustainability.

Figure 10
Timeline for participatory development of Peru's national adaptation plan



Source: Submission to the secretariat by the Ministry of Environment.

2. Use multiple climate and socioeconomic scenarios

66. As adaptation is about managing climate risks, it is essential to consider a range of possible futures when assessing adaptation needs. Understanding adaptation needs under multiple climate scenarios illustrates the benefits of accelerated mitigation action and highlights how the costs of both climate impacts and adaptation will increase dramatically if global greenhouse gas emissions are not reduced rapidly (e.g. Schaeffer et al., 2013). A multiple-scenario approach also provides a foundation for adaptive management strategies, defining climate-resilient pathways, and insights on adaptation limits.

67. The scenarios profiled in IPCC assessment reports (i.e. representative concentration pathways of the AR5 and SSPs of the AR6) cover the likely range of climate futures, with the AR6 including a new SSP-based very low emission scenario (SSP1-1.9) to align with the global temperature goal of the Paris Agreement. The AR6 also notes that low-likelihood outcomes, including warming substantially more than the assessed very likely range of future warming, cannot be ruled out and should be part of risk management. Therefore, it is important that risk assessments consider high and very high emission scenarios (see case study 3), as well as scenarios compatible with the global temperature goal, to capture the range of possible adaptation needs and identify thresholds associated with hard adaptation limits. The socioeconomic pathways and assumptions that underlie the SSP-based scenarios provide a foundation for development of socioeconomic scenarios at the regional and national level. Although there are benefits to using standard scenarios, it is also possible to gain important insights into vulnerabilities using a 'what-if' scenario approach. In addition, new technologies and big data, including passively generated information data from digital devices, can be used to create georeferenced data sets on factors affecting vulnerability that are otherwise unavailable or outdated, especially in developing countries (Ford et al., 2016).

Case study 3 – Extreme scenarios of sea level rise

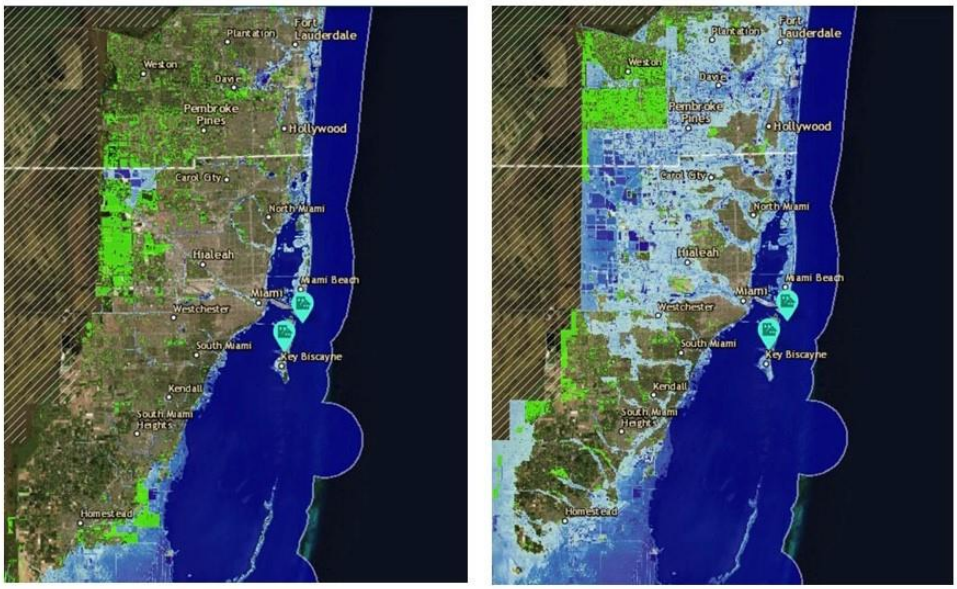
68. The projected mean global sea level rise for the end of the twenty-first century under a high emissions scenario (SSP5-8.5) is 0.77 m (likely range 0.63–1.02 m) (Fox-

Kemper et al., 2021). The upper limit of this likely range has sometimes been incorrectly termed a worst-case scenario and considered as the upper end for practical design – despite the fact that the IPCC did not define the likely range for that purpose (Seigert et al., 2020). Research on the physical processes associated with global sea level rise reveals that an extreme scenario of a 2.3-m increase by 2100 is possible (Fox-Kemper et al., 2021). The reasons for this large difference between the likely range and the extreme scenarios of sea level rise primarily relate to uncertainties regarding stability of the Antarctic ice sheet (Fox-Kemper et al., 2021; Seigert et al., 2020).

69. When assessing adaptation needs to reduce coastal risks, the sea level rise scenarios used should depend on the risk tolerance of stakeholders (Fox-Kemper et al., 2021; Oppenheimer et al., 2019). In many cases the likely ranges for SSP2-2.6 and SSP5-8.5 will be adequate for assessing needs. However, in situations where the consequences of low probability (but physically possible) change are severe, robust risk management includes consideration of more extreme scenarios (Fleming et al., 2018). Examples where this would be appropriate include planning for safety in coastal cities and long-term investments in critical infrastructure located near the coast (Oppenheimer et al., 2019). The long-term nature of sea level rise means that exceeding the current likely range of global sea level rise is a question of not if but when (Fox-Kemper, 2021). Aggressive global measures to reduce greenhouse gas emissions would ensure these upper limits are not exceeded for many centuries.

70. New technologies provide powerful tools for visualizing the impacts associated with different sea level rise scenarios (see figure 11) and assist adaptation planning by laying these scenarios over the distribution of critical infrastructure and social vulnerabilities. Examples are available from both developed countries (e.g. National Oceanic and Atmospheric Administration, Office for Coastal Management, 2022) and developing countries (e.g. Maillard et al., 2020). Assessments may benefit from the application of big data approaches, for example the synthesis and harmonization of various coastal data sets and handling satellite imagery, while recognizing that significant barriers to the use of big data approaches still exist in most situations (Pollard et al., 2017).

Figure 11
Scenario for the inundation of coastal water in southern Florida, United States of America



Source: Images captured from the sea level rise viewer (https://coast.noaa.gov/digitalcoast/tools/slr.html), which is part of Digital Coast (National Oceanic and Atmospheric Administration, Office for Coastal Management, 2022).
Note: Figure contrasts intermediate (left, 0.90 m) and high (right, 1.74 m) scenarios of sea level rise in 2090.

3. Transboundary versus domestic and local climate risks, as well as compound and cascading climate risks

71. Assessment of adaptation needs at the national level has largely focused on climate risks and vulnerabilities arising from climate impacts within countries, frequently based on sectoral analysis. The importance of cross-border and regional climate risks, particularly associated with transboundary drainage basins, has been identified by many countries in their NAPs. While involvement of multiple jurisdictions may complicate the planning process, experience of the Global Network of Basins working on climate change adaptation (see Water Convention, 2021) indicates that jointly addressing transboundary risks reduces uncertainties and makes adaptation more efficient through sharing data, costs and benefits, and by enhancing the planning scale and strengthening prioritization. There are several examples of adaptation plans developed on the basis of transboundary risk analysis in Europe (e.g. the Chu-Talas, Danube and Rhine rivers), and they are emerging elsewhere (e.g. Lake Chad, Lake Victoria, and the Mekong, Niger and Volta basins). All these examples used participatory approaches to assessing adaptation needs, with transboundary basin organizations playing a crucial role in coordination (Water Convention, 2021).

72. The concept of transboundary climate risks goes beyond shared biophysical systems to encompass trade links, financial interdependencies and the movement of people (Adaptation Without Borders, no date). The scope is not limited to climate impacts, as the adaptation actions taken to respond to climate impacts may affect other countries (e.g. trading partners). When factored into global analysis, the distribution of climate risk is quite different from that based exclusively on direct climate impacts within country borders (Benzie and Harris, 2020).

73. Systematic analysis of transboundary climate risks to date has largely been limited to developed countries, but the concept is equally applicable to developing countries. Available analysis shows transboundary risks to be of equal or greater economic significance than domestic climate risks (see case study 4). In the case of the United Kingdom of Great Britain and Northern Ireland, transboundary climate risks were found to be as much as 10 times greater than domestic climate risks in some sectors, particularly trade and investment and food supply chains (pwc, 2013). For most countries, transboundary climate risks represent a known unknown, with ongoing research initiatives focused on addressing this gap (Stockholm Environment Institute submission). With respect to institutional adaptation needs, responsibility for addressing transboundary climate risks often falls outside the jurisdictions of government departments, and likely requires cooperative actions be undertaken at multiple levels (Benzie and Harris, 2020).

74. A thorough understanding of transboundary risks also allows for more complete analysis of compound and cascading climate risks. Such analysis reveals that the total risk in any location may differ from the sum of individual risks if interactions (including the combined effects of multiple stressors acting together to cascade and compound interactions across sectors) within and between systems are not considered (Adger et al., 2018; Begum et al., 2022). Further risks may arise if adaptation responses do not achieve their intended objectives or result in trade-offs or adverse side effects for other societal objectives (Begum et al., 2022). Understanding the complex nature of climate risk is an important contribution of the AR6 that highlights the spatial and temporal variability in vulnerability, exposure and impacts, as well as system feedbacks, cascades and non-linear behaviour, all of which raise the potential of underestimating total climate risk.

Case study 4 – Transboundary climate risk analysis in Germany

75. Recognizing that, as a major player in the global economy, Germany would be affected by climate impacts beyond their borders, the national environment agency commissioned a research project to examine the potential impacts of climate change on

foreign trade flows (Peter et al., 2021).[16] Qualitative analysis performed to consider the influences of climate change on the German economy was complemented by quantitative analysis of selected impact chains using a global macroeconomic model. The project also considered possible adaptation measures to address the most significant global effects.

76. The project focused on foreign trade (see figure 12), which is only one dimension of transboundary climate impacts, by examining Germany's 10 largest trading partners. Key risks were associated with (1) severe storms, flooding and extreme heat affecting production facilities and warehouses in climate-vulnerable countries; (2) prolonged drought, extreme heat and rainfall affecting agricultural production; and (3) extreme weather events and sea level rise affecting transportation supply chains, including through impacts on shipping ports and container terminals. Imports were found to be affected by climate change much more than exports, and supply chains within Europe were less vulnerable than those beyond the continent. Declines in the purchasing power of countries more vulnerable to climate change would also have negative economic impacts for Germany as a trading partner. The study concluded that the economic impacts of transboundary climate risks on foreign trade alone are of similar magnitude as the economic impacts arising from domestic climate risks. Proposed adaptation measures included increased diversification of global trade and enhanced support for adaptation within vulnerable countries.

Figure 12
Overview of how climate change affects foreign trade in Germany

Source: Adapted from Peter et al. (2021).

4. Employ an adaptive risk management or pathways approach

77. Many of the lessons learned, including that assessing adaptation needs is a continual process that should be undertaken in the context of national development and economic planning, are integral to adaptive risk management (e.g. Lempert et al., 2018) and climate-resilient development pathways (see box 3) (e.g. Schipper et al., 2022). Uncertainties related to future climate change impacts and adaptation actions

[16] The document referenced is an abridged English version of the original document published in German.

are continually identified, assessed, prioritized, managed and revised on the basis of monitoring new information, experience and stakeholder input (Lempert et al., 2018). The approach entails an ongoing cycle of assessment, action, reassessment and response that will continue in perpetuity, rather than informing one-off decisions at a single point in time (Lempert et al., 2018). Decisions are made through consideration of a broad range of criteria, such as costs, benefits, equity, affordability, flexibility, trade-offs, co-benefits and co-impacts (Boyd and Markandya, 2021).

78. Such approaches stress that choices made when assessing adaptation options represent one decision point in an ongoing process to achieve climate resilience (see case study 5). They shift thinking away from one-time, one-off responses to address short-term issues (such as identified in NAPAs) and places the focus on the timing and sequencing of a series of adaptation actions as part of a long-term vision that can and should be adjusted as circumstances change. They also fit well with the short-, medium- and long-term perspectives included in some NAPs (e.g. Kuwait; Kuwait Environment Public Authority, 2019), recognizing that the lead-up time for implementing some adaptation measures can be decades (Adler et al., 2022).

Case study 5 – Bangladesh Delta Plan (BDP) 2100

79. The confluence of the Ganges, Brahmaputra and Meghna rivers in Bangladesh forms the world's largest delta. About 110 million people live within the delta and depend on it for their livelihoods (Roome, 2021). Climate change impacts, including sea level rise and salinization, represent a major threat to the region. To address these and a wide range of other issues, the national government developed BDP 2100, a comprehensive development plan focused on economic growth, environmental conservation and enhanced climate resilience. It describes holistic, cross-sectoral actions that will improve productivity and minimize disaster risks (Government of the People's Republic of Bangladesh, 2018). Technical assistance was provided by the Government of the Netherlands to benefit from the best practices of Dutch delta management (Zevenbergen et al., 2018).

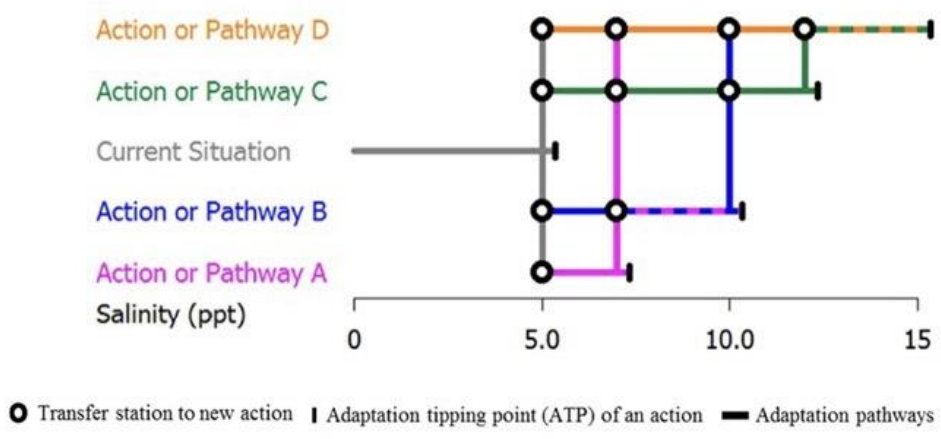
80. Adaptive risk management and the concept of adaptation pathways to address uncertainties are integral to the plan. The rationale and approach are succinctly described as follows (Government of the People's Republic of Bangladesh, 2018, pp.5–6):

> "Due to the large uncertainties with respect to climate change and socio-economic development, planning is being enriched with adaptive strategy making in several deltas in the world. Rather than providing linear recipes, robust and flexible strategies and measures have been taken, with strong institutions and a good knowledge base that allows policy makers and stakeholders to anticipate and decide on the most appropriate investments. Learning from these international experiences, BDP 2100 has been developed in light of the many possible future paths that are possible and is designed to be changed over time as new information becomes available or policy priorities change. So, instead of only focusing on short term 'trial and error' actions and projects, the idea is to keep the long-term vision in mind while prioritizing short term 'no regret' actions."

81. With respect to assessing adaptation needs, it is noteworthy that implementation of BDP 2100 requires a series of institutional and policy reforms that are already under way, with a Delta Governance Council and an interministerial forum having been established to provide strategic direction (Roome, 2021).

82. An issue-specific illustration of an adaptive risk management approach examines adaptation to increasing salinization in the delta (Hossain et al., 2018). Analysis used input from households and key informants, multi-criteria analysis and 'adaptation turning points' (thresholds beyond which a particular adaptation response is no longer effective) to develop three sets of adaptation pathways that allow adaptation to proceed in a stepwise manner as salinity increases from current levels of about 5.5 ppt to more than 15 ppt (see figure 13) without exceeding hard adaptation limits.

Figure 13
Conceptual model of adaptation pathways approach



Source: Hossain et al. (2018).
Notes: Approach to adapting to increasing salinization in Bangladesh. Action or pathway A can sustain up to salinity level 7 ppt, action or pathway B in combination with A will be sustainable up to a salinity level of 10 ppt, at which point action or pathway C is suitable until salinity exceeds 12 ppt, while action or pathway D combined with action C is expected to sustain up to 15 ppt salinity.

5. Consider transformational adaptation options in addition to incremental actions

83. The majority of adaptation measures currently being planned and implemented are incremental actions designed to maintain the essential features of an existing system (New et al., 2022a). This is despite growing recognition that, in many situations, climate change impacts may exceed adaptation limits and threaten the viability or sustainability of those systems. In such situations, incremental actions are of limited effectiveness and transformational actions that change the fundamental attributes of a system at a scale and ambition greater than incremental actions are necessary (Noble et al., 2014; O'Neill et al., 2022). The AR6 also stresses the distinction between actions that are incremental and those that are transformational may not always be clear, in that some incremental actions may serve to expand the potential for future, more transformational solutions (Begum et al., 2022).

84. Transformational adaptation may involve radical restructuring, replacement or abandonment of systems, processes and practices that are no longer viable under new climatic conditions (Brooks et al., 2019). Because transformational adaptation is system-wide, it is often (but not necessarily) associated with large-scale policy shifts developed through top-down, formal decision-making processes (Noble et al., 2014). It has also been noted that, where transformational adaptation is left to autonomous processes and market institutions alone, it can lead to significant economic inequities (de Koning and Filatova, 2020). Successful transformational planning requires integration of climate-resilient pathways and sustainable development (New et al., 2022a).

85. Current methodologies for assessing adaptation options appear to be biased towards near-term, incremental actions. These approaches need to be complemented by methodologies that can identify needs and opportunities for transformational adaptation (Brooks et al., 2019; IIED submission). While work on such methodologies is ongoing, this should not preclude the consideration of transformational actions when assessing adaptation needs. Indeed, consideration of both incremental and transformational adaptation expands the scope of adaptation measures and provides further options once a system reaches a soft adaptation limit (O'Neill et al., 2022; case study 6). Migration, spatial planning, governance cooperation, universal access to health care and changing food systems have been identified as measures with high transformative potential (New et al., 2022a). Expert assessment, within a broadly

inclusive process, will be important. Examples of transformational adaptation occurring in response to drivers other than climate change (Brooks, 2017) may also provide methodological insights.

Case study 6 – Managed retreat in coastal communities

86. Relocation of people, communities, and critical infrastructure to sites beyond the reach of specific existing and projected climate hazards has been the subject of considerable research and analysis, and in many cases would represent a transformational change (e.g. Mach and Siders, 2021). This is certainly the case for migration but moving even relatively short distances likely represents crossing a soft adaptation limit for the individuals involved. A case has been made for the importance of distinguishing between climate migration and managed retreat within adaptation policies and plans (Ajibade et al., 2020). The negative impacts of relocation may be particularly high on indigenous peoples (Pérez and Tomaselli, 2021).

87. The NDCs of several countries identify managed retreat in coastal settings as a necessary response to sea level rise, coastal erosion and flooding. One example of advance planning for voluntary managed retreat is the island State of Sao Tome and Principe, where vulnerability has been mapped at the household level and spatial planning has identified new areas for urban development adjacent to the old coastal community, but with greatly reduced risks from storms and coastal flooding (Global Facility for Disaster Reduction and Recovery, 2016). Key lessons learned with respect to successful managed retreat include ensuring community engagement and leadership at each stage of the relocation process, provision of compensation where necessary, ensuring access to livelihoods and services in relocation areas, planning for manpower requirements and preventing return while ensuring coastal access (Global Facility for Disaster Reduction and Recovery, 2016).

88. Managed coastal retreat is a complex process with significant social and institutional dimensions. Its planning will inevitably raise questions about adaptation limits, acceptable losses and societal aspects that need to be maintained (Mach and Siders, 2021). In advance of such a transformational solution, incremental adaptation options can serve to reduce risks and buy the time necessary for managed retreat to be planned effectively (see table 2; O'Neill et al., 2022). These incremental changes could involve any of a suite of management, infrastructure and policy adaptation options (e.g. Major and Juhola, 2021).

Table 2
Possible incremental and transformational adaptation responses to address impacts of sea level rise in a small coastal community with minimal infrastructure

Time period	*Actions*	*Type of change*	*Notes*
Immediate	Improve evacuation plans	Incremental	Based on local knowledge; inexpensive
Short term (<5 years)	Locally constructed adjustments, join any available early warning systems, review retreat and temporary refuge options	Incremental	Some outside assistance needed for temporary refuge options
Medium term (5–15 years)	Moderate protection for some building and roads, retreat and relocation of most critical or vulnerable buildings and roads	Incremental	Moderate costs; some local, institutional and property issues; access to projected climate impact data

Long term (>15 years)	Plan and implement full retreat	Transformational	High cost; complex institutional and property issues

Source: Modified from Major and Juhola (2021).

6. Conduct integrated assessments of capacity, technological and financial needs

89. Every stage of the adaptation cycle, from vulnerability and risk assessment through analysis of adaptation options, to the planning, implementation, monitoring and evaluation of adaptation actions, requires human, technological and financial resources. All three are clearly interrelated and hence should be assessed together (European Union and its member States). The coherence resulting from such an approach should reduce inefficiencies associated with separate analysis of each type of resource and ultimately reduce the analytical workload associated with the assessment.

90. Within the UNFCCC process, capacity, technology and finance are addressed under multiple agenda items and by separate constituted bodies (the PCCB, the Technology Executive Committee and the SCF). Guidance developed by these bodies recognizes the linkages between capacity, technology and finance. For example, a key step in developing a TNA is undertaking a barrier analysis and establishing an enabling framework that looks at capacity, financial and other needs (case study 7; Haselip et al., 2019). Likewise, case studies on Indonesia and Trinidad and Tobago included on the PCCB toolkit highlight the importance of technology needs in informing capacity assessments (PCCB, 2020).

Case study 7 – Barrier analysis as part of technology needs assessments

91. As at February 2022, the UNFCCC TNA database[17] included 66 BAEF reports addressing technologies for adaptation. Guidance for these reports provided by Nygaard and Hansen (2015) identifies several categories of barriers, many of which are relevant for assessing adaptation needs broadly. These include:

(a) Economic and financial barriers;

(b) Legal and regulatory barriers;

(c) Network barriers;

(d) Institutional and organizational capacity barriers;

(e) Human skills barriers;

(f) Social, cultural and behavioural barriers;

(g) Information and awareness barriers;

(h) Technical barriers.

92. Individual BAEF reports focus on technology solutions to address priority climate impacts within economic sectors. They differ in terms of level of detail and presentation, but all consider the range of barriers listed above (see table 3 for an example). Some, such as the report submitted by Jamaica, include cost–benefit analysis of measures to address major barriers (Gordon et al., 2021). Almost all BAEF reports place high priority on capacity-building at the institutional and individual levels, and the financing required to build that capacity.

Table 3
Barriers to implementing prioritized technologies in the water sector in Pakistan

Barrier category	*Barriers*
Economic and financial	High capital and maintenance cost
	Limited financial allocation to local governments

[17] https://tech-action.unepccc.org/tna-database/.

Barrier category	*Barriers*
	Inadequate loan and donor funding
Policy, legal and regulatory	Lack of sound, comprehensive, cross-sectoral policies for resources protection, development and management
Information and awareness	Limited information and awareness about the existence and usefulness of the technology
Institutional and organizational capacity	Limited institutional capacities, especially at the local level, in integrating climate change risks in development planning
	Limited human skills and maintenance, especially at the local level

Source: Government of Pakistan (2016, table 2.1).

C. Gaps

93. A number of gaps related to assessing adaptation needs have been identified by Parties and organizations in their submissions, in the broader academic literature including the IPCC assessment reports and in this paper.

94. The gaps most frequently cited in submissions relate to the lack of resources needed to undertake assessments of adaptation needs, rather than gaps in methodologies. Specific examples include:

(a) The lack of financial and institutional support necessary for the effective application of any methodology, particularly within developing countries (IIED submission). LDCs note the need for strengthened institutions and institutional arrangements for climate change planning, financing and climate information services, including support for non-state actors;

(b) Limited access to data and data analysis tools (AILAC submission). Climate data continue to be a gap for many countries (AOSIS submission), despite major advances in climate services (World Meteorological Organization submission);

(c) A lack of information on the economic impacts of slow onset changes, relative to that available for damages associated with extreme climate events (LDCs submission);

(d) A lack of understanding of the strengths and weaknesses of existing institutions to support adaptation (WFO Climakers and World Food Programme submissions);

(e) The lack of engagement by the private sector and a lack of documentation about private sector adaptation needs and actions (Argentina submission; also highlighted by Noble et al., 2014).

95. With respect to methodologies, examples include:

(a) A lack of detailed documentation on the methodologies that have been used by countries in assessing adaptation needs (SCF, 2021);

(b) Practical methodologies for quantitative assessments, which tend to be complex and data and resource intensive, while recognizing that qualitative and semi-quantitative analyses of adaptation needs can be extremely useful (Argentina and IFAD submissions);

(c) Practical methods for the assessment of financial or technological needs (Cuba submission);

(d) Methodologies for valuating non-market costs and benefits, such as ecosystem services, and monetizing adaptation actions and the benefits derived from them, particularly for countries with limited capacity (LDCs);

(e) Methodologies for assessing adaptation needs related to monitoring and evaluation;

(f) Methodologies that can identify needs and opportunities for transformative adaptation (IIED submission);

(g) Methodologies for integrating multiple sectoral assessments (Commonwealth Secretariat submission);

(h) Methodologies for prioritization of adaptation options (AOSIS submission).

96. With respect to analysis of existing methodologies for assessing adaptation needs, gaps include:

(a) The lack of an analytical framework that would enable a systematic analysis of existing methodologies;

(b) The lack of empirical data that would allow for analysis of the relative utility of different methods and tools.

D. Synthesis

97. Information in the IPCC assessment reports, other academic literature and reports submitted to the UNFCCC by Parties and observer organizations fails to show convergence on a single methodology, or suite of methodologies, for assessing adaptation needs that would be applicable across a wide range of national circumstances. Lack of convergence relates, in part, to the inconsistent use of the term "methodologies" as differentiated from methods and tools. Furthermore, experience within the UNFCCC process on assessing specific dimensions of adaptation needs (e.g. technology and capacity) reveals that overarching methodologies can remain quite simple, with the key to success being the availability of detailed guidance material that allows analysis to be undertaken in a systematic manner.

98. Building on that experience, this paper proposes a five-step process for assessing adaptation needs at the national level, with a variety of methods and tools being applicable at each stage of the process (see table 4). The stages are:

(a) Framing the assessment;

(b) Assessing climate risks and vulnerabilities;

(c) Identifying desired adaptation actions;

(d) Assessing resource needs (including for monitoring and evaluation);

(e) Compiling adaptation needs.

99. The scope of each stage is detailed in table 4.

Table 4
Process for assessing adaptation needs

Stage	*Scope*	*Indicative methods (broad categories)*
1. Frame the assessment	Setting goals and objectives of the needs assessment	Participatory multi-stakeholder engagement
	Establishing desired level of detail and complexity	Stocktaking of available information, resources, capacity
	Identification of resources and capacity needed and available	Data collection
	Compilation and collection of required data and information	
2. Assess climate risks and vulnerabilities	Identification of differential vulnerabilities and their underlying causes	Climate and socioeconomic scenario analysis

	Assessment of projected climate impacts, including cascading impacts Analysis of projected changes in climate risks and vulnerabilities (environmental, social, economic, institutional) Assessment of existing capacity to adapt Identification of climate risks (including transboundary risks) and opportunities	Impact, vulnerability and risk assessment approaches, including: a. Risk-based; b. Community-based; c. Ecosystem-based; d. Sector-based
3. Identify desired adaptation actions	Identification of adaptation pathways and options, including timescale for feasible and effective implementation Appraisal of potential effectiveness, feasibility and justice and equity of the adaptation pathways and options Consideration of trade-offs and ability to balance across perspectives and values Costing adaptation options Ranking and prioritization of the adaptation pathways and options to identify desired adaptation actions and timing of implementation	Adaptation and climate-resilient development pathways Equity analysis Multi-criteria decision analysis Cost–benefit analysis Real options analysis Portfolio analysis
4. Assess resource needs (capacity, technology, information, finance)	Identification of resources required considering environmental, social, economic and institutional needs: a. Resources for addressing underlying vulnerabilities b. Resources for planning and implementation of adaptation actions c. Resources for monitoring and evaluation of adaptation actions	Capacity needs analysis Technology needs assessment Costing adaptation actions Framework for monitoring and evaluation Economic analysis Analysis of responsibilities
5. Compile adaptation needs (adaptation actions, resource needs)	Compilation of adaptation actions Compilation of resource needs – capacity, technology, information, financial	Guidelines for different end uses, including for: a. NAPs – to facilitate implementation b. Mobilizing and accessing support c. National communications, BURs, BTRs, NDCs, adaptation communications – to facilitate reporting under the UNFCCC d. Other national processes, such as subnational and sectoral planning and implementation

100. The first stage, framing the assessment, is critical, as decisions made will affect the outcome of the process and help direct methods and approaches. The stage starts with defining the goals of the adaptation needs assessment, which will likely relate to adaptation goals broadly. As noted in the AR6, defining specific adaptation goals is challenging because climate change affects different groups and populations in different ways, such that their adaptation priorities and solutions will also differ (Begum et al., 2022). Pragmatic goals generally involve the reduction and management of climate risks, rather than the elimination of risks. Another important dimension of the first stage is to define the level of analytical detail necessary or desired to complete the assessment. Needs assessments can be multi-layered, and often high level analysis may adequate to achieve the goals of the adaptation needs assessment without placing a heavy burden on limited capacity and resources.

101. Beyond that first stage, it is unlikely any national assessment would start from scratch. Rather, it would incorporate and build on existing knowledge and data concerning climate risks, vulnerabilities, adaptation plans and adaptation actions. This information will be unequal with respect to scope, detail and geographic scale, having been collected at different points in time using different methods and tools. New activities would involve filling key gaps in available information concerning biophysical and environmental needs, social needs, institutional needs, and information, capacity and resource needs, while synthesizing existing information into a coherent national picture. This approach may be less than ideal from a technical perspective but is the most practical approach in terms of time and resources.

102. A critical analytical component of assessing adaptation needs relates to the consideration of trade-offs between various adaptation options or pathways (stage 3). Because different groups and populations have different adaptation priorities and goals, decisions to pursue one particular adaptation solution will result in an uneven distribution of benefits and burdens. Choices may preclude addressing other priorities or even have unintended negative consequences for certain groups or populations (maladaptation). This highlights the importance of understanding the equity and justice implications of choices made in pursuit of effective and adequate adaptation solutions (see figure 3).

103. There may be overlap between the various stages in the process, particularly between identifying desired adaptation options (stage 3) and assessing resource needs (stage 4). Understanding the resource needs associated with various adaptation options, the associated benefits and the distribution of those costs and benefits will be a key factor in ranking and prioritizing adaptation options. It should also be stressed that a number of methods and tools could be applied at each phase (see table 4). In the absence of stronger empirical evidence on the utility of different methods, the approaches applied in any setting should be dictated by specific circumstances, including capacity and time.

104. While depicted as a linear process in table 4, it needs to be remembered that assessing adaptation needs is an ongoing and continuous process (see figure 2). Knowledge and data concerning vulnerabilities, climate risks and adaptation solutions are continuously evolving, as are policy priorities and hence adaptation needs. An assessment of adaptation needs will unavoidably present an incomplete picture at one point in time and be, to some extent, outdated by the time it is completed. This is true of most assessments, including those of the IPCC. It should not be viewed as a limitation, but rather highlights the critical importance of monitoring and evaluation and the reason why the process must be ongoing. Results of successive assessments provide important insights into successes, failures and gaps in adaptation responses.

VI. Conclusion and recommendations

105. Assessing adaptation needs is a critical step in enhancing climate resilience. It is challenging in part because it encompasses all stages of the adaptation cycle, including monitoring and evaluation of implemented actions. Assessment of adaptation needs is

happening from project to global levels, with information at the national level particularly relevant under the UNFCCC.

106. Submissions by Parties and organizations highlight a multitude of different methods and tools that are being used to assess adaptation needs. There are important commonalities between approaches, including an emphasis on participatory approaches to ensure understanding of existing vulnerability and capacities. In many cases, methodologies are developed in an ad hoc manner, on the basis of generic guidance provided for developing NAPs or similar initiatives and customized to address the specific circumstances where they are being applied. National-level needs assessment draws on analyses conducted at different levels, at different points in time and using different methods and tools.

107. Comparing the practical experience of Parties with information contained in the academic literature highlights a significant gap between theory and concepts associated with assessing adaptation needs and current application of methodologies. This is to be expected and in no way diminishes the value of existing assessments of adaptation needs. It does, however, highlight the importance of continued development of methodologies, methods and tools that incorporate new concepts, particularly adaptation pathways and climate-resilient development pathways. Methodological work must also stress the importance of providing approaches suitable for countries with limited capacity to undertake such assessments, recognizing that these are also the countries most in need of support. This may require not different methodologies but rather the ability to apply the same methodology at differing levels of detail and complexity.

108. To facilitate further work on methodologies, methods and tools for assessing adaptation needs, this paper identifies emerging good practices for needs assessments, recognizing the importance of incorporating new ideas as understanding of the adaptation process increases. It also presents a five-step process for assessing adaptation needs broadly, recognizing that it is part of a continuous assessment process necessitated by the fact that knowledge of climate vulnerability, risks, adaptation solutions and priorities continues to evolve.

109. Recommendations for possible future work within and outside of the UNFCCC process include:

(a) Continued sharing of experiences on assessing adaptation needs, including on the utility of the emerging good practices, such as those identified in this paper. Key players are Parties, organizations and the UNFCCC (e.g. AC, LEG, NWP through the adaptation knowledge portal);

(b) Continued development of methodologies, methods and tools for assessing adaptation needs, recognizing the need for methodologies that can be adapted for application in differing circumstances, including in countries with limited capacities. Key players are practitioners, academia, and adaptation-focused institutions;

(c) Consideration and, if appropriate, development of an analytical framework for methodologies to assess adaptation needs to allow a more rigorous examination of strengths, weaknesses and utility. The key player is academia;

(d) Development and testing of updated guidance on methodologies, methods and tools for assessing adaptation needs, similar in scope to the guidance provided in PROVIA (2013). Key players are the World Adaptation Science Programme and other relevant and interested adaptation institutions such as the NAP Global Network and the National Adaptation Plan Global Support Programme;

(e) Development of guidance for Parties on framing assessments of adaptation needs (stage 1 of the five-part process presented in table 4). Key players are the AC and the LEG;

(f) Strengthened engagement and collaboration between the constituted bodies under the UNFCCC in matters related to assessing adaptation needs, including

in strengthening guidance for integrated assessment of capacity, technology and financial needs. Key players are the AC, the LEG, the PCCB, the SCF and the Technology Executive Committee;

(g) Consideration of the value and practical limitations of developing and promoting a general methodology for assessing adaptation needs that could be employed by all countries, recognizing capacity limitations and the context-specific nature of assessments, to produce more comparable estimates of adaptation needs. Key players are the SBSTA, as well as the AC, the Green Climate Fund, the LEG and the SCF;

(h) Encouragement for the continuous and enhanced provision of international support to developing country Parties for assessing their adaptation needs in accordance with Article 7.13 of the Paris Agreement.

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Document information

Version	*Date*	*Description*
01.0	26 August 2022	AC 22 The AC will be invited to take note of this technical paper and made it available as an annex to its annual report to the COP.
N/A	15 March 2022	AC 21 The AC was invited to consider this draft paper and provide further guidance for its finalization.
01.0	30 August 2021	AC 20 The AC was invited to take note of the analysis and provide further guidance as needed.

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