Adaptation **C**ommittee

AC21/TP/7A

15 March 2022

Methodologies for assessing adaptation needs. Draft technical paper

Recommended action by the Adaptation Committee

The Adaptation Committee (AC), at its 21st meeting, will be invited to consider the draft technical paper contained in this document[1] and provide further guidance for its finalization.

In particular, guidance, including concrete references and rationale, is sought on:

- Possible factual errors;
- Possible conceptual errors;
- Potential new content, including figures, tables, boxes and case studies;
- Existing content that could be removed without weakening the report;
- Case studies that could potentially replace existing case studies to strengthen the report;
- General comments on the strengths and weaknesses of the existing draft and how to address weaknesses.

[1] The formatting of this revised draft technical paper deviates from the AC style guidelines for technical reasons.

Technical Paper

Methodologies for Assessing Adaptation Needs and Their Application

Executive Summary

Adaptation needs refer to the actions and resources required to complete all stages of the adaptation policy cycle, from assessment of risks and vulnerability to planning, implementation, monitoring and evaluation of adaptation measures. They also include actions and resources needed to address the underlying causes of climate vulnerability. Categorizing adaptation needs as: i) biophysical and environmental needs; ii) social needs; iii) institutional needs; and iv) information, capacity and resource needs, as described in the IPCC 5th Assessment Report, provides a framework for planning and conducting comprehensive assessments. Adaptation needs are situation-specific and dynamic, and will reflect the scale of analysis and the methods used. They will also evolve as understanding of climate risks and adaptation options increases, technologies for adaptation continue to be developed, the underlying drivers of vulnerability change, and other factors.

Assessing adaptation needs is a fundamental part of enhancing climate resilience, and links to the UNFCCC process with respect to adaptation planning and implementation (i.e. through NAPs), reporting (e.g. Nationally Determined Contributions, Adaptation Communications, biennial reports), analysis/assessments (e.g. determination of the needs of developing country Parties, technology and capacity needs assessments), and ongoing processes (e.g. global stocktake, global finance goal). Discussion of methodologies for assessing adaptation needs is challenged by the lack of a typology and 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 / modeling-based) and bottom-up (vulnerability-based) methodologies, with most recent 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.

Experience of Parties and organizations in the application of existing methodologies suggests that no single methodology, or suite of methodologies, are likely to allow for comprehensive assessment of adaptation needs in all situations. There is strong agreement that the best available information, including indigenous knowledge, about climate risks and societal vulnerabilities are starting points for assessing adaptation needs. This experience also highlights that assessment of adaptation needs is an

ongoing, continuous process that should be undertaken within a broader policy context and integrated with national development / economic planning. In many developing countries, strengthened capacity, technology and finance is needed in order to undertake more comprehensive assessments of adaptation needs.

Information contained in submissions from Parties and organizations, Parties' reports under the UNFCCC, the IPCC fifth and sixth assessment reports, and other academic and technical literature is used to identify six emerging good practices for assessing adaptation needs that could be applied to any methodology. These are:

1. Utilize participatory approaches;
2. Utilize multiple climate and socioeconomic scenarios, new technologies and benefits provided by big data;
3. Consider transboundary climate risks as well as domestic / local climate risks;
4. Employ an adaptive risk management / pathways approach;
5. Consider transformational adaptation options as well as incremental actions;
6. Conduct integrated assessment of capacity, technological and financial needs.

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. It recognizes that assessing adaptation needs at the national scale will draw upon existing knowledge and data concerning climate risks, vulnerabilities, adaptation plans and 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 will include filling key gaps and synthesizing existing information into a coherent national picture.

Recommendations highlight the need for continued sharing of experiences with assessing adaptation needs, development and testing of updated guidance on methodologies, methods and tools for assessing adaptation needs, and strengthened engagement and collaboration between constituted bodies under the UNFCCC in matters related to assessing adaptation needs.

List of acronyms

AC	Adaptation Committee
AGWA	Alliance for Global Water Adaptation
AILAC	Asociación Independiente de Latinoamérica y el Caribe (Independent Association of Latin America and the Caribbean)
AOSIS	Alliance of Small Island States
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Country
LEG	Least Developed Country Expert Group
LoCAL	Local Climate Adaptive Living Facility
NAP	National Adaptation Plan
NAPA	National Adaptation Programmes of Action
NDC	Nationally Determined Contribution
NDR	Report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement
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 Technical Advice
SCF	Standing Committee on Finance
TAP	Technology Action Plan
TEC	Technology Executive Committee
TNA	Technology Needs Assessment
UNFCCC	United Nations Framework Convention on Climate Change

88	WASP	World Adaptation Science Programme
89	WFO	World Farmers' Organization
90	WFP	World Food Programme
91	WMO	World Meteorological Organization

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A – BACKGROUND

Ai - Introduction and Mandate

Planning and implementation of adaptation measures and actions at any scale is generally preceded by an assessment of adaptation needs. While there are many methods and tools to undertake such assessments, guidance on the selection and application of these methods and tools is limited, presenting challenges to decision makers on how best to proceed (PROVIA, 2013; Stafford-Smith et al., 2022). In recognition of this challenge, the CMA, as part of Decision 11/CMA.1, requested the Adaptation Committee 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. The paper was to be prepared with the engagement, as appropriate, of IPCC Working Group II, and to draw upon the inventory of relevant methodologies for assessing adaptation needs and submissions made by Parties and observer organizations expressing their views and information on the development and application of methodologies for assessing adaptation needs, described elsewhere in decision 11/CMA.1. The decision further 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 the SBSTA at its 57th session in November 2022.

Improved understanding of the development and application of methodologies for assessing adaptation needs, including their strengths, limitations and commonalities, benefits Parties as well as a wide range of public and private sector institutions and organizations as they continue to plan and implement adaptation strategies and actions. Consideration of methodologies and their application is not an end in itself, but rather a step in enriching discussion around a range of adaptation issues. Within the UNFCCC process, assessment of adaptation needs informs the development of numerous plans and reports involving adaptation (e.g. NAPs, NDCs, BURs, BTRs, Adaptation Communications). The findings of this paper may be relevant to discussions by Parties on those topics, as well as discussions on adaptation technology, finance and capacity building, the global stocktake, the global goal on adaptation, and the global finance goal.

Assessment of adaptation needs is relevant on a wide range of spatial scales, from site/project specific through national, regional and global perspectives. This paper focuses on methodologies that contribute to understanding adaptation needs at the national scale. It is informed by, and builds upon, the findings of the first NDR (Box 1; SCF, 2021), and hopefully contributes to strengthening future NDRs.

Methodologies for, and challenges of, assessing adaptation needs at regional and global scales are discussed elsewhere, including Africa's Adaptation Gap Technical Report (Schaeffer et al., 2013) and the Adaptation Gap Reports of the United Nations Environment Programme (e.g. UNEP, 2017 and 2021).

Box 1 – First NDR (SCF, 2021)

Decision 4/CP.24 requests the Standing Committee on Finance 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 provides an overview of information, both qualitative and quantitative, on mitigation and adaptation needs identified by developing countries based on review of 563 documents, including NDCs, ACs, NAPs and NAPAs, TNAs and TAPs. 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 between countries. It also acknowledges the challenges of assessing needs, and that some countries are dealing with significant gaps in available data, tools and capacity. It notes the lack of a common framework and methodologies, particularly for assessing adaptation needs, and a need to enhance existing methodologies.

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Aii – Sources of Information

This technical paper draws upon a wide range of information sources. In establishing the context for this work, emphasis is placed on findings of the IPCC fifth and sixth assessment reports (AR5 and AR6, respectively), other peer-reviewed literature from academic and technical institutions, other United Nations bodies (e.g. UNEP, 2021), and existing technical guidance for the use of relevant methods and tools (e.g. PROVIA, 2013). This information is complemented by knowledge and practical experiences with the application of methodologies contained in submissions by Parties and observer organizations in response to the call in decision 11/CMA.1, documents submitted to the UNFCCC by Parties, as well as information contained in the first NDR (SCF, 2021). It builds upon previous work undertaken by various UNFCCC bodies, including the AC, LEG, SCF, and CTCN, 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. Sources of knowledge are referenced throughout the paper.

Aiii – Organization of this Paper

Following this introductory section (Section A), the technical paper starts with consideration of the terms "adaptation needs" and "methodologies", fundamental to the mandate of this paper, as well as the concepts of risk and uncertainty (Section B). In addition, Box 2 presents definitions of key terms used in the paper, including emerging concepts that are only beginning to be part of adaptation policy discussions.

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

Section D represents the analytical core of the paper. Building on the challenges, opportunities, and gaps identified in the first NDR (SCF, 2021), it presents lessons learned, good practices (illustrated through case studies) and gaps identified through application of existing assessment methods. As a final synthesis, it presents a five-step, general process for assessing adaptation needs reflecting the key concepts and experiential evidence presented previously.

The final section of the paper (Section E) presents brief conclusions and recommendations for possible future actions both within and outside of the UNFCCC process that could help further develop understanding of methodologies for assessing adaptation needs and their application.

B - Key Concepts and Definitions

The volume of literature concerning climate change adaptation, including methods and tools, has increased enormously over the past decade. This explosive growth has led to the development of new (or newly defined) terms of relevance to this paper (Box 2). In addition, there are at least three concepts of fundamental importance to understanding the scope of this paper.

Box 2: Key technical terms used in this paper

Adaptation limits - The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions (IPCC, 2014a)

Soft limit - when additional adaptation may be possible if constraints are able to be

overcome.

Hard limit - when no additional adaptation is possible (IPCC, 2022a).

Adaptation needs - The circumstances requiring action to ensure safety of populations and security of assets in response to climate impacts (IPCC, 2014a).

Incremental adaptation - Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale (IPCC, 2014a).

Pathways - The temporal evolution of natural and/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, and/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-term 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).

Adaptive management - A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables (IPCC, 2014a).

Climate resilient pathways - Iterative processes for managing change within complex systems in order to reduce disruptions and enhance opportunities associated with climate change (IPCC, 2014a).

Climate-resilient development pathways - Trajectories that strengthen sustainable development and efforts to eradicate poverty and reduce inequalities while promoting fair and cross-scalar adaptation to and resilience in a changing climate. They raise the ethics, equity, and feasibility aspects of the deep societal transformation needed to drastically reduce emissions to limit global warming (e.g., to well below 2°C) and achieve desirable and liveable futures and wellbeing for all (IPCC, 2022a).

Risk - the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard (IPCC, 2014a).

Risk assessment - The qualitative and/or quantitative scientific estimation of risks (IPCC, 2014a).

Transboundary climate risks – climate risks that cross national borders. They are 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 (submission from the Stockholm Environment Institute)

Transformational adaptation - Adaptation that changes the fundamental attributes of a system in response to climate and its effects (IPCC, 2014a).

Uncertainty - A state of incomplete knowledge that can result from a lack of information sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts) (IPCC, 2014a)

<End Box>

Bi – Adaptation Needs

While the concept of adaptation needs is integral to UNFCCC, the term has not been formally defined under that process and does not appear in the Convention text. However, the concept is 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". It is also clear from Article 4 that the scope includes both technical and financial needs. The term "adaptation needs" does appear in the 2010 Cancun Adaptation Framework (Decision 1/CP.16) as well as in Article 7 (paragraphs 4 and 7) of the Paris Agreement, but remains undefined.

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 (Figure 1), possibly a response of the research community to policy direction provided by the UNFCCC.

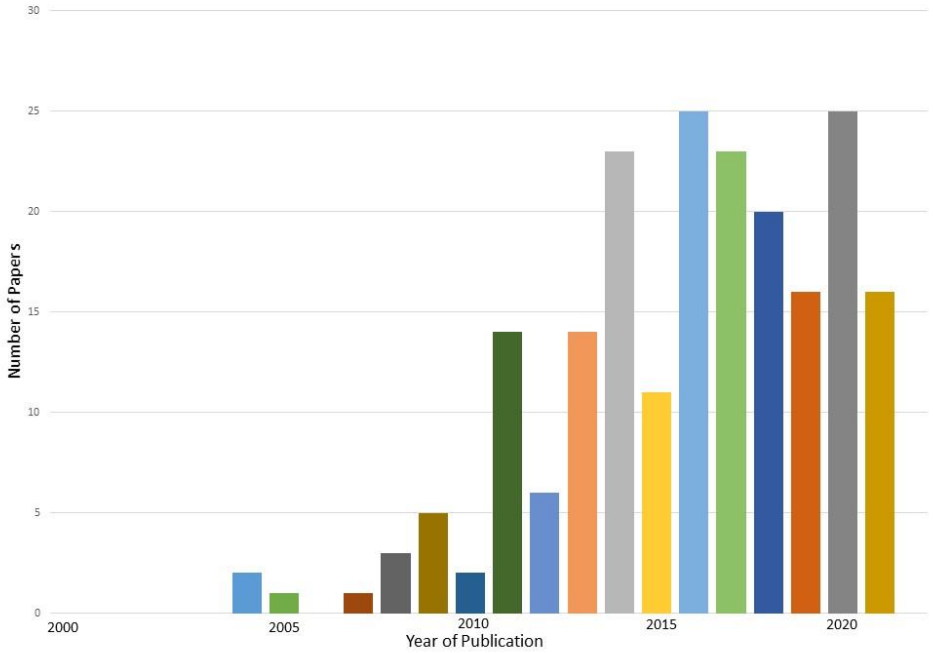


Figure 1: Number of academic publications per year using the terms "climate" and "adaptation needs" in the title, abstract or key words since the year 2000, as determined from a search using Scopus on November 4, 2021.

The IPCC first included "adaptation needs" in the glossary of the WGII AR5 (Box 2), and the concept is discussed in detail in Chapter 14 of that report (Noble et al., 2014). Expanding on the formal definition, adaptation needs are "the gap between what might happen as the climate changes and what we would desire to happen" (Noble et al. 2014, p. 836), including the actions and resources needed address that gap. This definition implies adaptation needs encompasses both actions taken to address the risks presented by climate change and actions taken to benefit from any opportunities that may be presented. The scope of the term has expanded over the past decades. In early discussions the term was used primarily to refer to immediate and near-term needs, and focused almost exclusively on biophysical impacts (the example of NAPAs is discussed by Noble et al., 2014). It was recognized that assessing adaptation needs required analysis of WHAT adaptation was addressing (observed and projected climate change impacts and non-climate drivers) and HOW adaptation would occur (the capacity and resources needed to undertake actions) (GEF, 2002; PROVIA, 2013). The past 15 years has seen this scope of capacity analysis expand to include analysis of the underlying causes of vulnerability to climate change (Füssel, 2007).

Of significance for the scope of this paper, adaptation needs are no longer considered to simply be 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 (Figure 2). This point was highlighted in several of the submissions from Parties (e.g. submission by Paraguay on behalf of the AILAC Group of countries; submission by Malta and the European Commission on behalf of the European Union and its Member States).

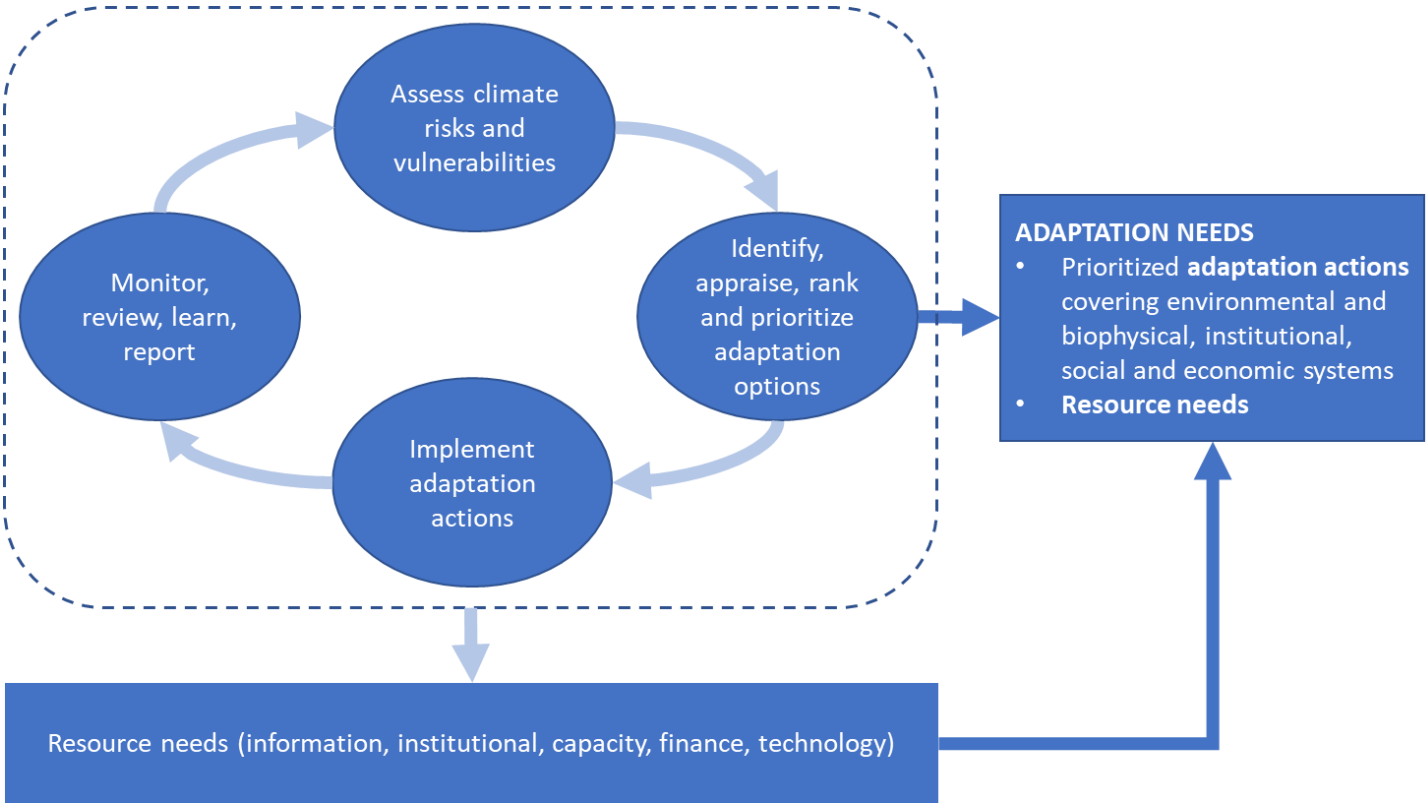


Figure 2: The Adaptation Policy Cycle and associated adaptation needs. This concept appears frequently in the adaptation literature, often using slightly different terminology (e.g. adaptation learning cycle).

Building on the work of Burton et al. (2006), Noble et al. (2014) identified five categories of adaptation needs, four[1] of which are highlighted here (see original source for additional references):

Biophysical and environmental needs – ecosystem services critical for the maintenance / 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. 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.

Social needs – the 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 at scales from local to global, with profound inequities resulting in vulnerable populations with little capacity to undertake adaptation actions. The scope includes emotional and psychological needs which can be seriously affected by climate change. Shared learning, including education and improved access to information, is important as fundamentally, adaptation is a social learning process (Mimura et al., 2015).

Institutional needs – the critical role played by formal and informal institutions in building adaptive capacity and implementing and incentivizing adaptation action. Emphasis is often placed on the role of governments at all scales (national to local) as well as international / 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 policy-making, 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

[1] The fifth category of needs highlighted by Noble at el. (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, contributing to public sector initiatives, and responding to opportunities presented by climate change, as well as serving as a source of direct financing for adaptation actions (complementing the responsibilities of the public sector) and for providing 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 is looked at in terms of the role it can play in addressing the four broad categories of adaptation needs identified in Section Bi.

institutions, all have important roles in adaptation and also benefit from cross-institutional coordination mechanisms.

Information, capacity and resource needs – all stages of the adaptation policy cycle (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 (scientific, Indigenous and practitioner / local knowledge) greatly enhances the utility of such information. Specific initiatives under the UNFCCC have been established to help address capacity and technology needs (e.g. the PCCB and CTCN). 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. UNEP, 2021; SCF, 2021; New et al., 2022). 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[2] (SCF, 2021, also see Section D).

Several Parties made note of these, or similar, categories in their submissions on this topic. For example, the submission by Portugal and the European Commission on behalf of the European Union and its Member States provide examples of five factors of importance in identifying adaptation needs: i) biophysical and environment-related factors; ii) social, cultural or economic factors; iii) inequalities within a society; iv) institutional factors, rules and regulations; and v) access to information, capacity and resources. Parties also highlighted that adaptation needs are location / context specific and dynamic.

Bii – Methodologies

The terms methodologies, methods and tools are frequently used interchangeably, even in technical literature. A dictionary definition of methodology is "a body of methods, rules and postulates employed by a discipline" (merriam-webster.com, 2022), while a more academic definition is "a coherent and logical scheme based on views, beliefs, and values, that guides the choices made" (Kara et al., 2015). Broadly speaking, a methodology provides the conceptual framework for analysis, methods are the

[2] This topic will be expanded upon in a synthesis report on "Efforts of developing countries in assessing and meeting the costs of adaptation, which is being prepared in 2022 in response to decision 19/CMA.1.

systematic procedure of conducting the analysis, and tools are the vehicles used for collecting and analyzing 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), implying that each method and tool could have a unique methodology.

In the climate change adaptation literature, emphasis is generally placed on description of methods and tools with relatively less attention given to characterizing methodologies (the same is true for the submissions provided by both 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 by Paraguay, on behalf of the AILAC group of countries, states that "many AILAC countries have not so far established a process to collect, categorize or systematize methodologies that have been used in the various processes" to assess adaptation needs. The same is generally true at the global scale. Establishing a systematic typology may assist in further understanding the range of methodologies being employed, as well as their relative strengths and weaknesses.

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 which would need to be adapted to, whereas bottom-up methodologies use understanding of current vulnerability to climate as the starting point for determining adaptation needs. The former is dominated by quantitative, modelling methods while the latter generally involves more qualitative, participatory research methods. While there is utility in this distinction, assessments have evolved such that most recent assessments employ hybrid approaches that allow analysis to benefit from the strengths of both approaches (Dessai et al., 2005; McKenzie Hedger et al., 2006; PROVIA, 2013; Noble et al., 2014). Note also that the terms "top-down" and "bottom-up" are used in a slightly different sense when discussing costing (see Section Cii). Africa's Adaptation Gap Report notes that top-down approaches, using Integrated Assessment Models, may be particularly useful for assessing long-term adaptation costs (Schaeffer et al., 2013).

Characterizing analysis as an "adaptation needs assessment" is rare in the literature. For example, an operational framing of adaptation assessments by Fünfgeld and McEvoy (2011) distinguishes between impacts, risk, and vulnerability assessments. Similarly, the first NDR differentiates between impacts-, adaptation-, vulnerability-, and risk-based approaches as the basis of current national estimates of

adaptation needs in developing countries (SCF, 2021). Several submissions from Parties and observer organizations use similar distinctions (see Section C).

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 existing (previously published) knowledge. This general methodology has been adopted by many countries for undertaking national assessments, some of which incorporate new analysis and/or broader inclusion of Indigenous and practitioner/local knowledge. For example, Japan's national assessment examines the probability and magnitude of climate change impacts, the timing when impacts will be evident and when adaptation measures need to be in place, and documents the level of confidence for all (submission by Japan). Such approaches have proven extremely useful for identifying adaptation 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.

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 (Section C). Among a large number of recent publications, 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 (Decision-making options for managing risk) of the IPCC AR6 WGII report (New et al., 2022). There is a lack of empirical evidence on the relative utility of different analytical methods for managing climate risks based on their application by decision makers (New et al., 2022)

Biii – Risk and uncertainty

Adaptation is fundamentally a process of managing risk, a concept central to IPCC assessments, particularly since the AR5 (e.g. IPCC, 2014b, 2022b). Uncertain outcomes are a fundamental aspect of understanding risk (see definition in Box 2), 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 (Box 3; see French, 2020 for overview and bibliography).

Box 3 – Dealing with uncertainty through adaptation pathways

Most decision-making related to climate change adaptation is done 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; and/or 2 – the probability distributions of uncertainty about key variables; and/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, measures that deliver benefits over a wide range of climate and socioeconomic scenarios (Adler et al., 2022). However, such responses are likely of limited scope in addressing adaptation needs, particularly in the long term. The IPCC AR6 emphasizes that focussing on near-term risk reduction reduces the opportunity for transformational adaptation (IPCC, 2022b).

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, involving a series of choices and trade-offs between short-term and near-term goals (Figure 3; Denton et al., 2014; Adler et al., 2022). It is recognized that there is not a single, correct pathway to reach desired goals, rather that 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., 2022). The IPCC AR6 provides definitions for adaptation pathways, climate-resilient development pathways, climate-resilient pathways, development pathways, and sustainable development pathways (IPCC, 2022a, also see Box 2), placing different relative emphasis on adaptation, mitigation and sustainable development.

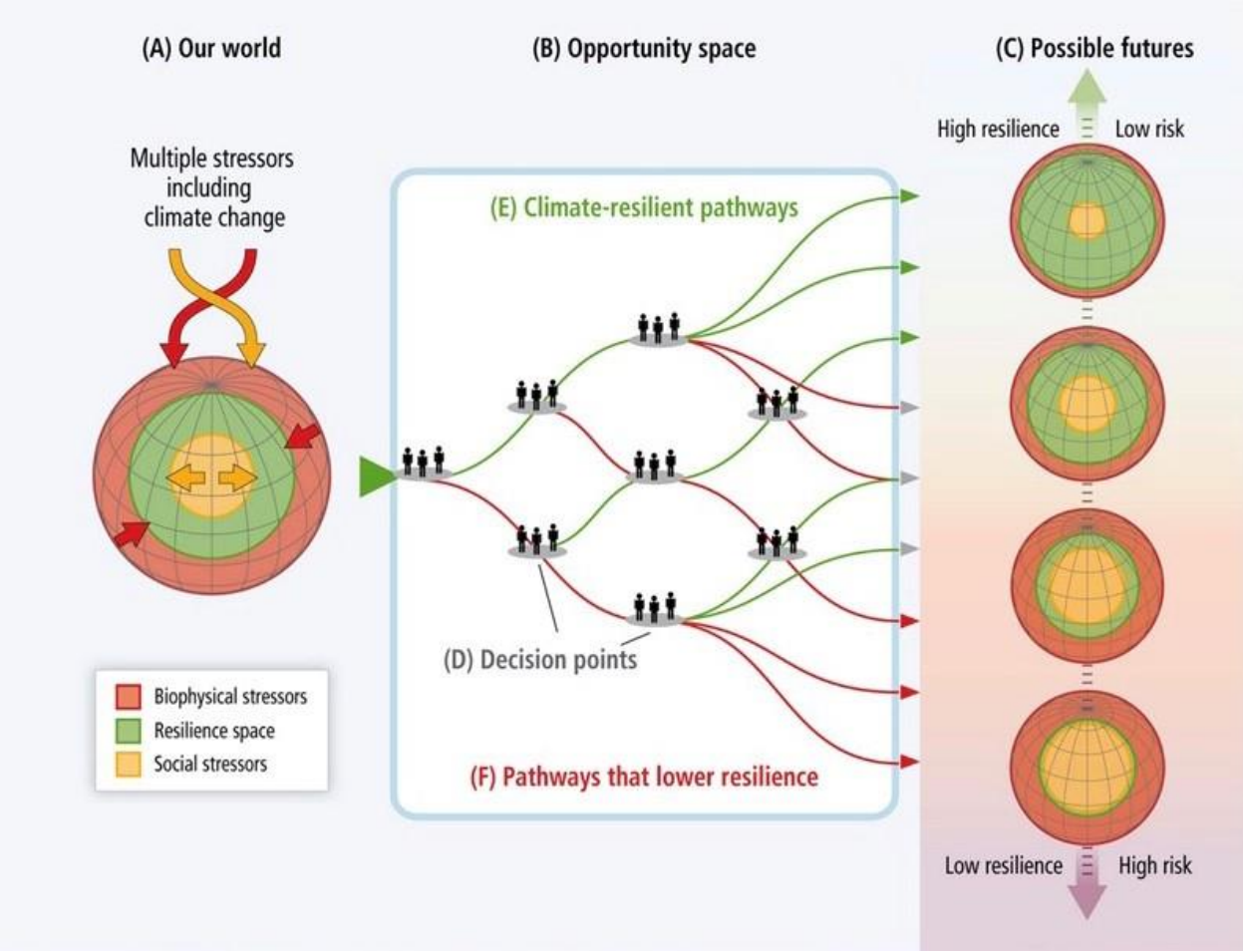


Figure 3 – Adaptation pathways (IPCC, 2014c).

A pathways approach stresses that choices made when assessing adaptation options represent one decision point in an ongoing process to achieve climate resilience. Initial steps may involve low-regrets options that enhance flexibility rather than limiting future options (New et al., 2022). It is anticipated that many pathways will involve both incremental and transformational actions (Denton et al., 2014).

<End Box>

Temporal scale

Assessing adaptation needs is undertaken knowing that risks will change with time, and that uncertainty regarding both climate and non-climate factors increases with time. Considerations of multiple scenarios is a primary way to address this uncertainty. The range of emission scenarios used by the IPCC captures the likely range of climate futures, although risk management dictates that consideration of low

probability (extreme) scenarios is appropriate when the consequences of impacts are potentially catastrophic (see Section Dii).

Spatial scale

The complexity of assessing adaptation needs increases markedly as one moves from site/situation specific to national and global scales. Most analysis of needs undertaken to date has happened at the project scale, 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 / 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 country will necessitate adaptation action within the country (see Section D).

C – Overview of existing methodologies and experiences

This section examines information on the experiences 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 the terms methodologies, methods and tools. This information is synthesized in Section D.

Ci – Inventory of methodologies submitted by Parties and organizations to the UNFCCC

The call for submissions to support development of this technical paper elicited input from eight Parties and groups of Parties, and from eleven 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 commonalties among them. The submissions from organizations highlight sectoral perspectives, linkages with disaster risk reduction, sustainable development and other agendas, as well as emerging issues.

Overview

Most submissions acknowledge the broad scope of adaptation needs, encompassing all stages of the adaptation policy cycle (section Bi). Recognizing the context / situation-specific nature of adaptation needs, the submissions acknowledge that assessment of such needs should, to the extent possible, be undertaken within a broader policy context, integrated with national development / economic planning

and recognizing linkages with other international agendas (including the 2030 Agenda for Sustainable Development, the Convention on Biodiversity, the Sendai Framework for Disaster Risk Reduction, and the Ramsar Convention on Wetlands of International importance (Argentina, European Union and its Member States, IIED).

The submissions also make clear that virtually 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 have highlighted the need for methodologies to be simple, practical and deployable (LDCs, LoCAL). Furthermore, since the methodology applied influences the outcome of the analysis, and associated adaptation response, using more than one methodology will likely lead to more rigorous results.

Current experience of Parties assessing their adaptation needs has developed through a "learning by doing" process (AILAC). General guidance provided by the UNFCCC or other international entities often provides a starting point, with individual countries / organizations developing detailed methodologies determined by their specific circumstances. These methodologies are often sector-specific (AOSIS). Interestingly, 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.

Parties generally advocate for a step-wise approach to assessing adaptation needs, with each step likely involving different methodologies. Many submissions highlight that the starting point is the best available scientific information and knowledge (Cuba, Argentina, Japan, IIED), including understanding the current and projected impacts of climate change and the underlying causes of vulnerability. The importance of transparency and participatory methodologies, stressing gender and social inclusion, are commonly highlighted (Nigeria, LDCs, AOSIS, IIED). Bottom-up approaches received most attention, noting need for consultations from multiple levels of government, the private sector, non-government organizations and civil society broadly. It is also noted that such approaches require significant time and human resources (AGWA).

Most submissions drew attention to the importance of assessing capacity, technological and financial needs. Where methodologies have been developed or endorsed by the UNFCCC, for example the

methodology for technology needs assessments (Box 4, UNEP DTU), they tend to see broad application. Recent development of a toolbox by the PCCB may lead to greater rigour in analyzing capacity needs (Box 5). That said, 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). Established methods and tools for economic analysis, as well as newer multi-metric techniques, are beginning to see greater application with respect to climate change (Box 6). For example, the submission by Argentina notes their intent to use multi-criteria analysis for prioritizing adaptation options and cost-benefit or cost-effectiveness analysis to guide implementation decisions (Argentina). Nonetheless, application of these methods for assessing adaptation is not widespread, particularly at the national scale.

Box 4: Technology Needs Assessments (TNAs)

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 understanding other needs. Since its start, more than 90 developing countries have completed TNAs. Efforts increased since 2010, with UNEP DTU Partnership providing technical and methodological support to undertake assessments, and the Global Environment Facility providing financial support for TNA projects (UNFCCC, 2022a). The methodology is sector-focussed, with agriculture, water and infrastructure the most frequently prioritized sectors for adaptation needs (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 (Figure 4). The first step, identification and prioritization, emphasized stakeholder engagement and multicriteria analysis. The second step, barrier analysis and enabling framework, includes market assessments and analysis of institutional capacity (see Section Dii, Case Study 6). The final step involves the development of a TAP, 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 prioritising 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).

Figure 4 – The Technology Needs Assessment process (Haselip et al., 2019).

The TNA process may provide lessons learned regarding methodologies and guidance for broader assessments of adaptation needs. Short-comings of the process have been identified, including limitations related to spatial scale (SCF, 2021). Perhaps the most important next step is moving technology needs assessment 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). It is felt that 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).

<End Box>

Box 5: Assessing capacity needs

Capacity building is a critical dimension of the Convention and the Paris Agreement, with capacity-building frameworks adopted in 2001 (decisions 2/CP.7 and 3/CP.7). The concept of adaptive capacity is well established in the adaptation literature (e.g. Smith et al., 2003; Brooks and Adger, 2005; Smit and Wandel, 2006; IPCC, 2007). 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 the national scale should consider needs at three different levels – individual, institutional and systemic (Figure 5; UNFCCC, 2022b). They should also be viewed as an iterative, on-going process rather than a one-off initiative (PCCB, 2020), consistent with the broader nature of assessing adaptation needs 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 countries (GEF, 2001).

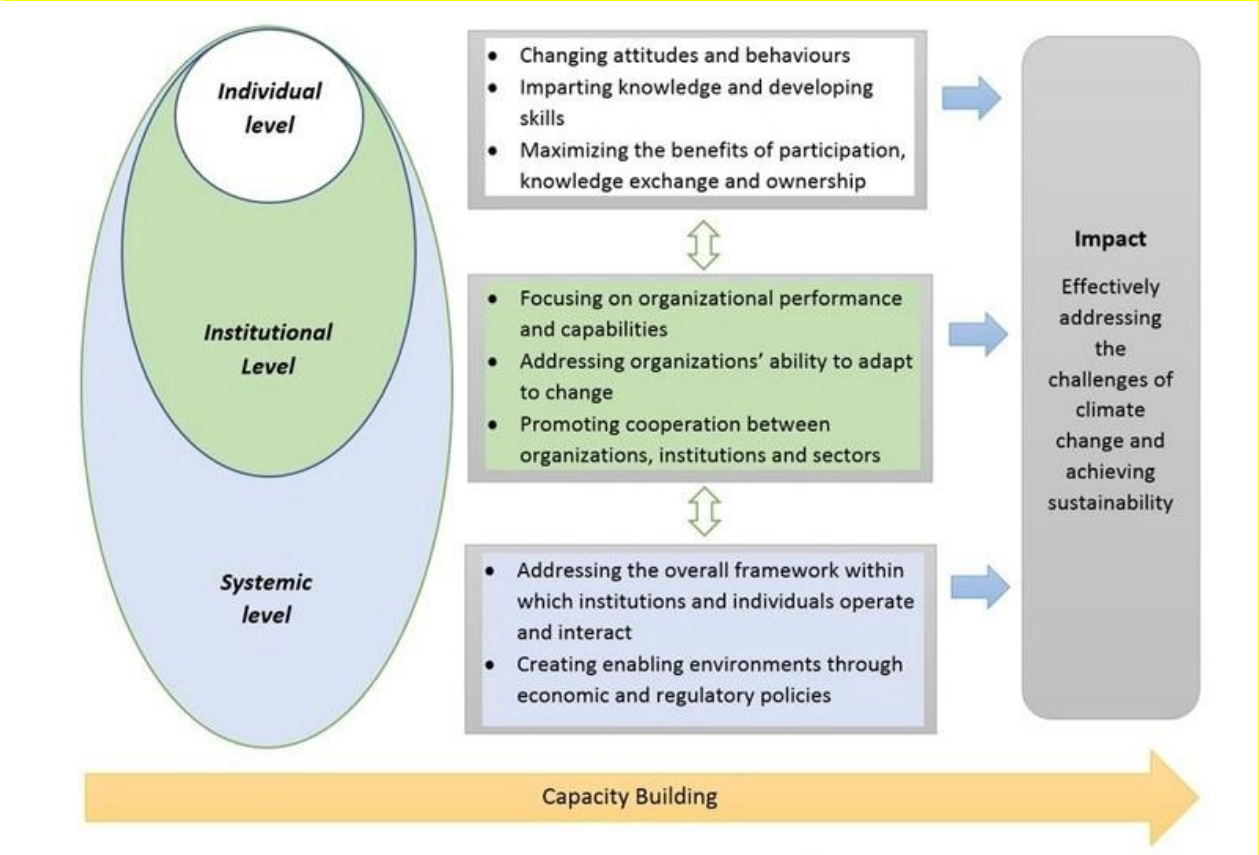


Figure 5 – Scope of capacity building in the UNFCCC process (UNFCCC, 2022b).

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 stresses the importance of participatory assessment methods (e.g. UNDP, 2008; Bizikova, 2012). Specific tools are available for the assessment of institutional capacity (e.g. Gupta et al., 2010; Dixit et al., 2012; USAID, 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).

<End Box>

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 behavioral biases, 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 / local level, rather than part of national-scale 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).

564 **Table 1 - Economic appraisal methods for adaptation decision support** (modified from Boyd and
565 Markandya, 2021)

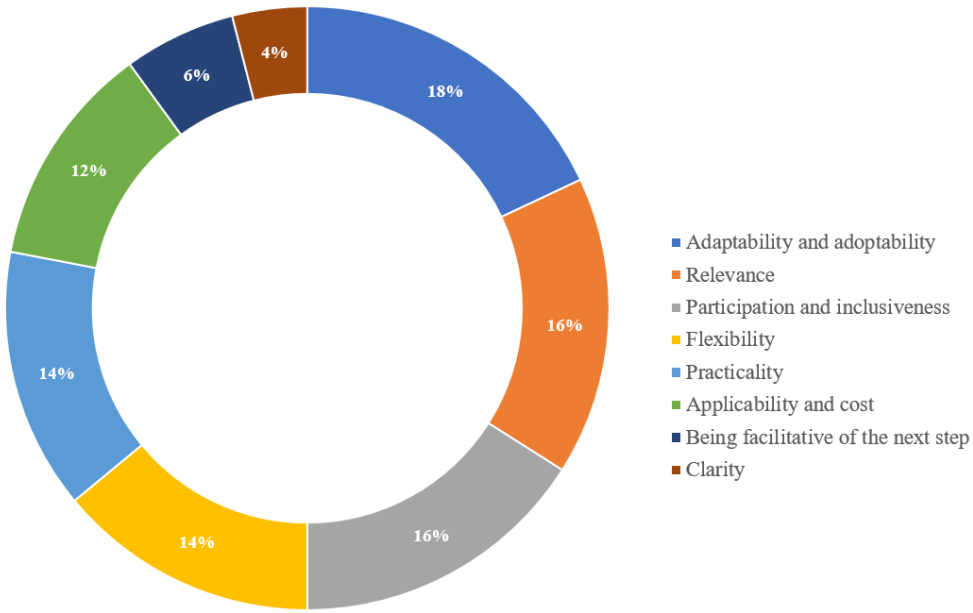
566

Method	Description	Level of Complexity
Cost-Benefit Analysis	Appraises options in terms of their monetary value, weighing the lifecycle 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. Approach is 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 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 judgement of experts or stakeholders.	Low to Medium
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). It explicitly incorporates uncertainties and risk, and is particularly useful when future uncertainties are poorly characterized and probabilistic information is not available.	Medium to High
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. It 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. It is useful when there are many adaptation options available to achieve a goal and when good data is available.	High
Real options analysis	Explicitly assesses the level of flexibility in the timing for implementing one or more adaptation options. It is also used to assess the flexibility for adjusting an adaptation option over time, once it has been implemented. Evaluates whether it is better to	High

	invest in options that offer greater flexibility in the future. It is 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.	
Adaptation pathways	Operationalizes the criterion of flexibility by characterizing 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 or may not actually 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

<End Box>

Of the guiding principles for assessing adaptation needs identified by the Adaptation Committee (Figure 6), 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.



576

577 **Figure 6: Relative importance of the principles for assessing adaptation needs** formulated by the
578 Adaptation Committee, as highlighted in Party submissions. Note that not all submissions explicitly
579 responded to question about principles.

580

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

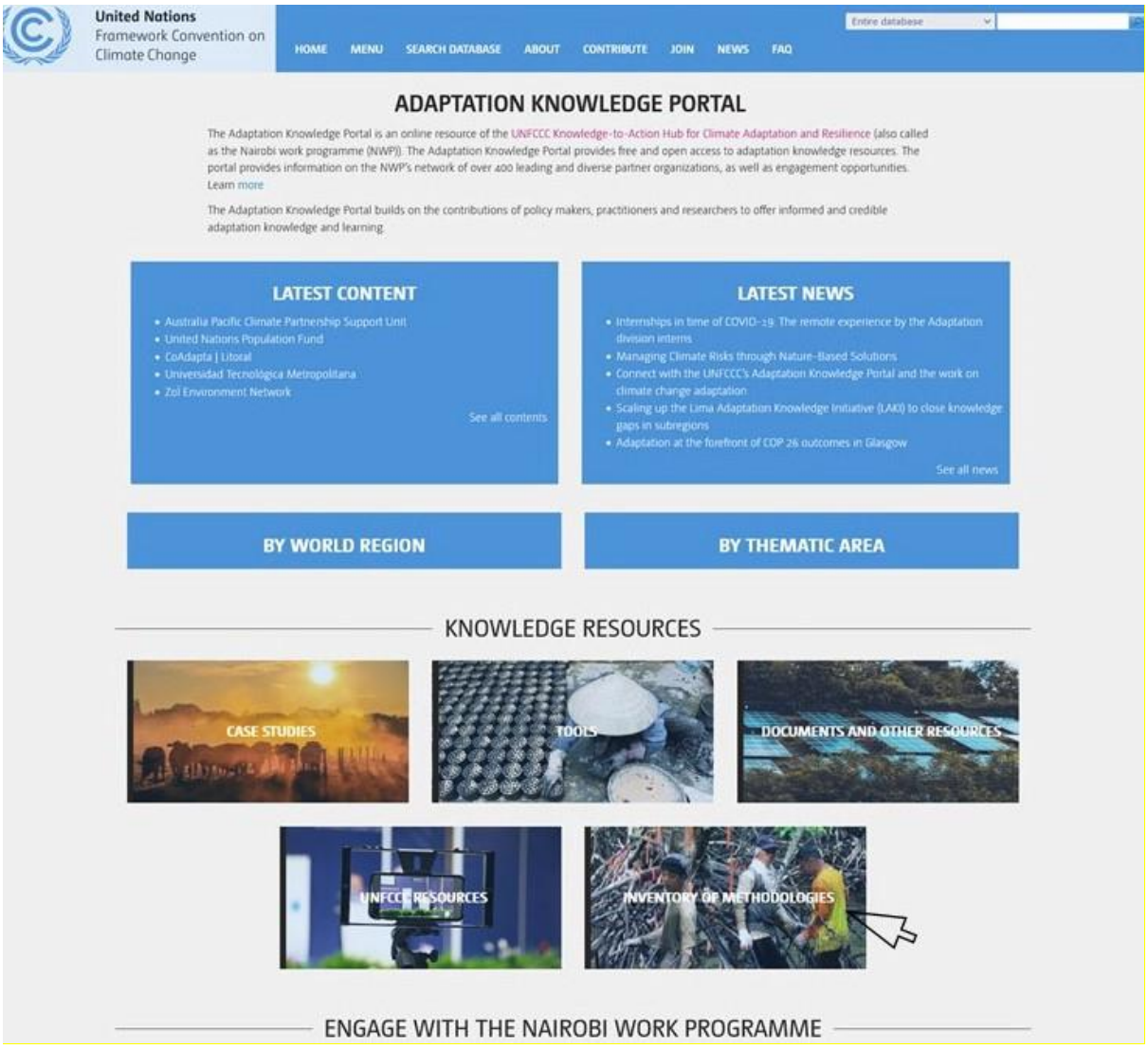
588 *Methods and Tools*

589 Most submissions made in support of this paper included examples of methods and tools, as well as
590 case studies of assessing adaptation needs. This input, as well as relevant content received through
591 other submissions, can be found on the Adaptation Knowledge Portal (Box 7) under Methodologies for
592 Assessing Adaptation Needs. As of January, 2022 this inventory included 128 tools and 118 case studies.
593 Descriptions generally include an overview of methods used in applying tools, but rarely address the
594 overarching methodology. Methodological insights can be gained from many of the case studies,

595 although the lack of an analytical framework makes it difficult to draw conclusions about the relative
596 value of various approaches.

597 **Box 7: Using the Adaptation Knowledge Portal**

598 The Adaptation Knowledge Portal (Figure 7) is an online resource of the UNFCCC Knowledge-to-Action
599 Hub for Climate Adaptation and Resilience providing free and open access to adaptation knowledge
600 resources. As of February, 2022 the portal included more than 1750 entries, predominantly tools and
601 case studies.



602

603 **Figure 7 – Adaptation Knowledge Portal home screen.** The cursor is pointing to inventory of
604 methodologies.

The Adaptation Knowledge 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 document/reports, online portals, and educational/training materials. As with the rest of the portal, the search bar allows the user to type in a query, and use tags from the drop-down bar above the search line to filter search results by: 1) region; 2) geographic scales; 3) adaptation sector/themes; 4) adaptation elements; 5) climate hazards; and 6) target group (Figure 8).

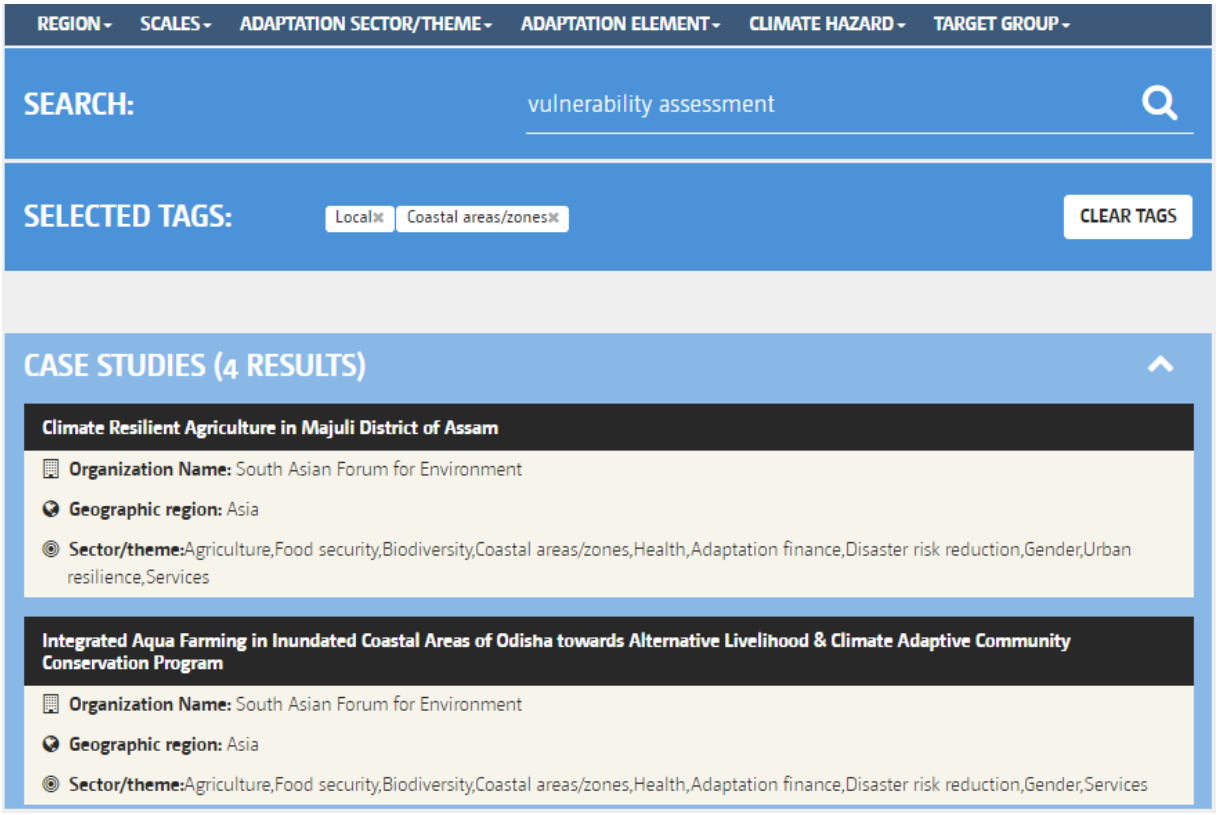


Figure 8 - Example of search function. This example uses the query "vulnerability assessment" with tags "local" (selected from “SCALES” dropdown menu) and "coastal areas/zones" (selected from “ADAPTATION SECTOR/THEME” dropdown menu).

<End Box>

Analysis of input received to August 2021 shows that the inventory includes tools developed in all regions of the world, with North America (specifically in the United States of America) contributing the most (Figure 9A). Many of the tools have a sectoral focus, with agriculture and water resources being dominant, recognizing that most tools can be used to address multiple sectors (Figure 9B). Consistent with the emphasis placed on bottom-up approaches, the majority of tools analyzed are designed to

address adaptation needs at the local scale (Figure 9C). It is noteworthy that less than 25% of the tools included in this inventory focus on the national level. Finally, it is not surprising to see the majority of tools relate to impact / vulnerability / risk assessment, with only a few encompassing the complete adaptation policy cycle (Figure 9D).

Additional work could increase the utility of the inventory. For example, it would be helpful to differentiate between methods and tools that yield quantitative analysis from those with 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 informed section D of this paper.

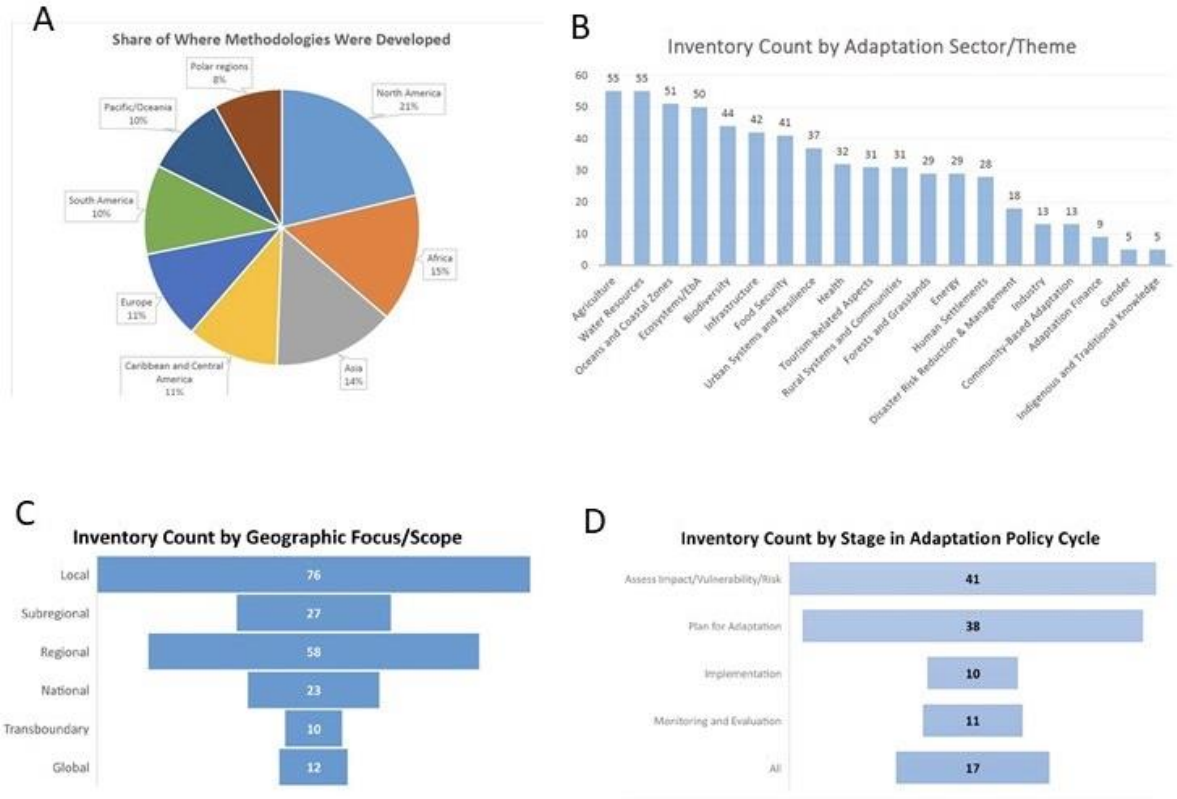


Figure 9: Characteristics of tools contained in the inventory of methodologies for assessing adaptation needs, as of August 2021. Source - AC20/INFO/5C.

Cii – First NDR

Overview

A comprehensive overview of developing country Parties experience in assessing their needs, as documented in various types of reports submitted to the UNFCCC, is contained in the first NDR (Box 1; SCF, 2021). It includes both qualitative and quantitative information, the former referred to as "needs", 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 modeling. 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.

The report 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 modeling 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 the 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.

While most countries have assessed their mitigation and adaptation needs separately, using different methods and tools, there are examples of countries that 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.

Analysis and recommendations

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-based, risk-based and adaptation-based approaches, as well as multi-criteria decision analysis (see Box 4). 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. The Coordinated Regional Climate Downscaling Experiment CORDEX145 Model).

The approaches that have been undertaken to date vary depending upon 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 section Ci, 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.

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

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 can not 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.

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

- encouraging developing country Parties to provide, where possible, information on needs related to … methodologies employed in the determination of the needs in their national reports to the UNFCCC;
- encouraging developing country Parties to consider the insights on methodologies identified in the first NDR when costing and determining needs;

- encouraging Parties, multilateral and financial institutions, academia, methodology developers, research institutions and other relevant actors to continue to develop methodologies for the determination of adaptation and resilience enhancement needs.

Ciii – Experience with existing guidance

The need for improved guidance for assessing adaptation needs was identified in many submissions. Requests had many dimensions, ranging from general guidance on appropriate use (WFO) to detailed guidance on how to address uncertainties in climate and vulnerability data (Commonwealth Secretariat). It is noted 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, Box 6) among the most complete, but somewhat dated.

Box 6 - PROVIA Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change

The guidance document developed by PROVIA (subsequently renamed the World Adaptation Science Program) (PROVIA, 2013) provides an overview of information to that date on key concepts, approaches to analysis, and methods and tools for participation and engagement, impacts analysis, capacity analysis, scenario analysis, behavioural analysis, institutional analysis, formal decision-making, and valuation. The scope covers the entirety of the adaptation policy cycle (termed adaptation learning cycle in that document), including implementation and monitoring and evaluation, and hence aligns well with the scope of adaptation needs as 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 the guidance is noted in some submissions, there has not been systematic analysis of its application and utility.

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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 is available through the UNFCCC website NAP Central and is complemented by an evolving collection of supplementary material. Additional resources are available through the NAP Global Network, the NAP Global Support Programme, and regional / national

adaptation centres. While not developed as a means to comprehensively assess adaptation needs, many countries have utilized the process to formulate and implement NAPs as the basis for their current estimates (SCF, 2021).

One of the most applied methodologies relates to technology needs assessments and associated technology adaptation plans, a process that has evolved over the past two decades (see Box 4). Despite the success of this process, it is noted that it does not include specific provisions on how to assess adaptation needs at the local level (SCF, 2021).

D – Analysis

Di – Lessons learned

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

- Adaptation needs encompass all stages of the adaptation policy cycles, from assessment of risks and vulnerability to planning, implementation, monitoring and evaluation of adaptation measures.
- Adaptation needs include actions to address the underlying causes of vulnerability to climate change, as well the resources to undertake those actions.
- The categorization of adaptation needs as presented in the IPCC AR5 (Noble et al., 2014), particularly biophysical and environmental needs, social needs, institutional needs, and information, capacity and resource needs, provides a useful framework for planning and conducting a comprehensive assessment.
- Adaptation needs are both situation-specific and dynamic – they will change with time, with the scale of analysis, and with the methods used for the analysis.
- Assessing adaptation needs should be an ongoing process where findings will reflect improved understanding of climate risks and adaptation options, technology development, changes in underlying drivers of vulnerability, and other factors.
- Assessing adaptation needs should be undertaken within a broader policy context, integrated with national development / economic planning and recognizing linkages with other international agendas.
- In many developing countries, strengthened capacity, technology and finance is needed in order to undertake more comprehensive assessments of adaptation needs.

Lessons learned with respect to methodologies include:

- No single methodology or suite of methodologies allows for comprehensive assessment of adaptation needs in all situations.
- Broadly embraced principles for methodologies for assessing adaptation needs include participation and inclusiveness, relevance, and adaptability and adoptability.
- The best available scientific information about climate risks and societal vulnerabilities, usually arising from risk / vulnerability assessments, are starting points for assessing adaptation needs.
- Top-down and bottom-up methodologies have different strengths for assessing adaptation needs, and most recent approaches have incorporated elements of both.
- 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).
- Pathways approaches (adaptation / climate-resilient development pathways) are emerging as a powerful concept for understanding adaptation needs at a range of scales.
- More progress has been made in assessing the needs for action in adaptation relative to the estimation of financial or technological needs.

Dii – Emerging good practices

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

Utilize participatory approaches

All submissions, and indeed virtually 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, it is noted that “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" (highlighting added; New et al., 2022, p. 17-5). 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. They 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. An abundance of methods and tools are available to undertake participatory processes, including facilitation toolkits and conflict resolution techniques (see PROVIA, 2013 for a comprehensive summary).

There are many examples of effective use of participatory approaches in assessing adaptation needs. Case Study 1 presents an example from Nepal.

Case Study 1 – Nepal's National Adaptation Plan (NAP) process

The recently completed National Adaptation Plan for Nepal includes 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 a commitment to an inclusive process that would "leave no one behind" (Figure 10; Nepal Ministry of Forests and Environment, 2018). The process was led by the national government with stakeholders treated as key members of the institutional arrangements. Thematic and crosscutting working groups were established that brought together multiple levels of governments, civil society organization, research institutions, private sector associations and a wide range of other stakeholders. Actors within each working group were initially characterized as service providers, policy stakeholders, beneficiaries, enablers and advocates (Figure 10), although most have important roles in all of these dimensions. The diverse perspectives brought to the working group enabled a thorough discussion of the opportunities and gaps associated 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 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, 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 a standalone theme in the NAP process, with the goal of integrating climate change adaptation into investments that promote inclusive economic development and livelihood opportunities.

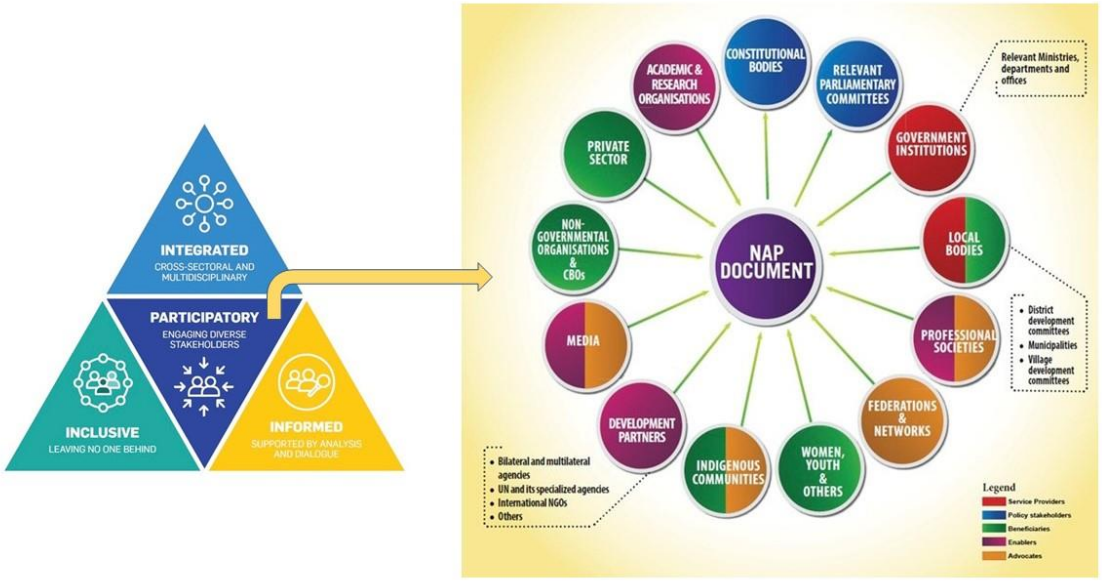

Figure 10 – Unique features of Nepal's NAP process (left), with participation of a wide range of stakeholders (right) a key principle. Sources: Left - Nepal Ministry of Forests and Environment (2018); right – Nepal Ministry of Population and Environment (2016).

The working group process required significant investments in both time and resources, and still faced challenges in addressing the 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 sub-national actors were needed to ensure broad and inclusive participation (Nepal Ministry of Forests and Environment, 2018).

Utilize multiple climate and socioeconomic scenarios, new technologies and benefits provided by big data

As adaptation is about managing climate risks, it is essential to consider a range of possible futures when assessing adaptation needs. Understanding of adaptation needs under multiple climate scenarios illustrates the benefits of accelerated mitigation action, highlighting 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 scenarios approach also provides a foundation for adaptive management strategies, defining climate-resilient pathways, and insights on adaptation limits.

The scenarios profiled in the IPCC assessment reports (Representative Concentration Pathways (RCPs) of the AR5 (IPCC, 2013), Shared Socioeconomic Pathways (SSPs) of the AR6 (IPCC, 2021)) 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. From a risk management perspective, it is important to consider high and very high emission scenarios (Case Study 2) along with those compatible with the global temperature goal to capture the range of possible adaptation needs and identify thresholds associated with hard adaptation limits. It is noted that projections based on extrapolation of current energy policies show that global warming of 4°C or more by 2100 is within the range of outcomes (Betts, 2020). The socioeconomic pathways and assumptions that underlie the SSP-based scenarios provide a foundation for development of socio-economic scenarios at the regional and national level. While there are benefits of 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 datasets on factors affecting vulnerability that are otherwise unavailable or outdated, especially in developing countries (Ford et al., 2016).

Case Study 2 – Extreme scenarios of sea level rise

The projected mean global sea level rise for the end of this century under a high emissions scenario (SSP5-8.5) is 0.77m (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 likely range was not defined for that purpose (Seigert et al., 2020). Research on the physical processes associated with global sea level rise reveal that an extreme scenario of a 2.3m increase by 2100 is possible (Fox-Kemper et al., 2021). The reasons for this

large difference between the likely range and extreme scenarios of sea level rise primarily relate to uncertainties regarding stability of the Antarctic Ice Sheet (Seigert et al., 2020; Fox-Kemper et al., 2021).

When assessing adaptation needs to reduce coastal risks, the sea level rise scenarios used should depend upon the risk tolerance of stakeholders (Oppenheimer et al., 2019; Fox-Kemper et al., 2021). In many cases the likely ranges for SSP2-2.6 and SSP5-8.5 will be adequate. 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 not a question of if, but a question of when (Fox-Kemper, 2021). Aggressive global measures to reduce greenhouse gas emissions would ensure these upper limits are not exceeded for many centuries.

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

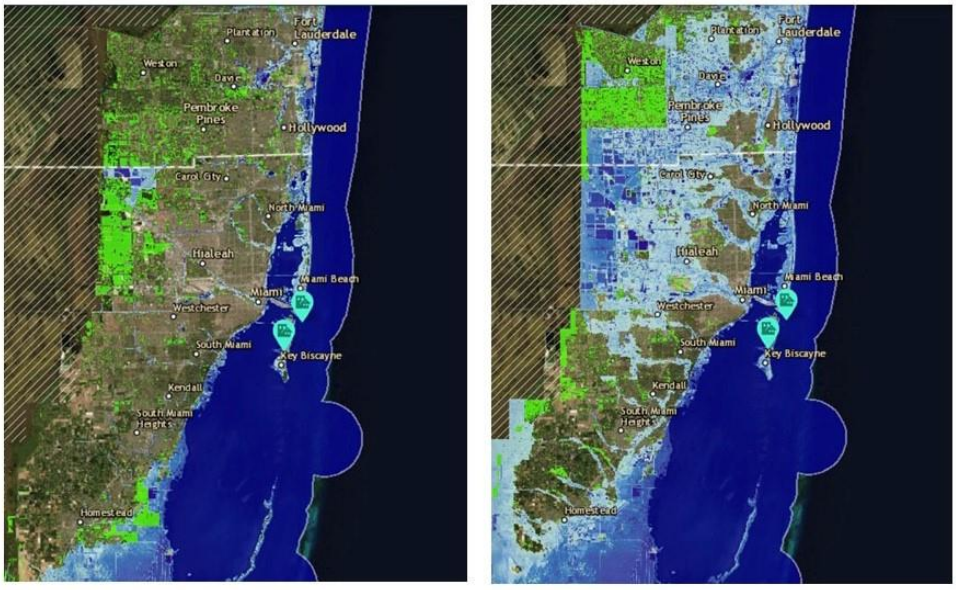

Figure 11 – Inundation of coastal water in southern Florida (Miami area), USA contrasting intermediate (left, 0.90m) and high (right, 1.74m) of sea level rise in 2090. Images captured from sea level rise viewer (https://coast.noaa.gov/digitalcoast/tools/slr.html), part of Digital Coast (NOAA Office for Coastal Management, 2022).

Consider transboundary climate risks as well as domestic / local climate risks

Assessment of adaptation needs at the national scale has largely focused on climate risks and vulnerabilities arising from climate impacts within that country, frequently based on sectoral analysis. While the importance of cross-border and regional climate risks, particularly associated with shared drainage basins, have been identified by many countries in their NAPs, associated adaptation solutions tend to be complex. The concept of transboundary climate risks expands the concept 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 have consequences on 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).

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 (Case Study 3). In the case of the UK, transboundary climate risks were found to be as much as ten times greater than those arising from domestic 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 (submission from the Stockholm Environment Institute). With respect to institutional adaptation needs, it has been highlighted that 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).

Case Study 3 – Transboundary climate risk analysis in Germany (Peter et al., 2021[3])

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. Qualitative analysis 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.

The project focussed on foreign trade (Figure 12), only one dimension of transboundary climate impacts, examining Germany's ten major trading partners. Key risks were associated with: i) severe storms, flooding and extreme heat impacting production facilities and warehouses in climate-vulnerable countries; ii) prolonged drought, extreme heat and rainfall impacting agricultural production; and iii) 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 impacted by climate change much more than exports, and supply chains within the Europe 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.

[3] Document is an abridged English version "Folgen des globalen Klimawandels für Deutschland – Abschlussbericht". The original is available at https://www.umweltbundesamt.de/publikationen/folgen-des-globalenklimawandels-fuer-deutschland-0

Figure 12 – Overview of how climate change affects foreign trade (modified from Peter et al., 2021)

Employ an adaptive risk management / pathways approach

A large number of the lessons learned highlighted above, including that assessing adaptation needs is a continual process that should be undertaken in the context of national development / economic planning, are integral to adaptive risk management (e.g. Lempert et al., 2018) and climate-resilient development pathways (Box 3) (e.g. Schipper et al., 2022). Uncertainties related to future climate change impacts and adaptation actions are continually identified, assessed, prioritized, managed and revised based on monitoring, new information, experience and stakeholder input (Lempert et al., 2018). It 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, co-benefits and co-impacts (Boyd and Markandya, 2021).

Such approaches stress that choices made when assessing adaptation options represent one decision point in an ongoing process to achieve climate resilience (Case Study 5). It shifts 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. It also fits well with the short-, medium- and long-term perspectives included in some NAPs (e.g. Kuwait), recognizing that the lead-up time for implementation of some adaptation measures can be decades (Adler et al., 2022).

Case Study 5 – Bangladesh Delta Plan 2100 (BDP 2100)

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 the 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 Netherlands to benefit from the best practices of Dutch Delta management (Zevenbergen et al., 2018).

Adaptive risk management and the concept of adaptation pathways to address uncertainties are integral to the plan. The rationale and approach is succinctly described (Government of the People's Republic of Bangladesh, 2018, p. 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.*

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

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

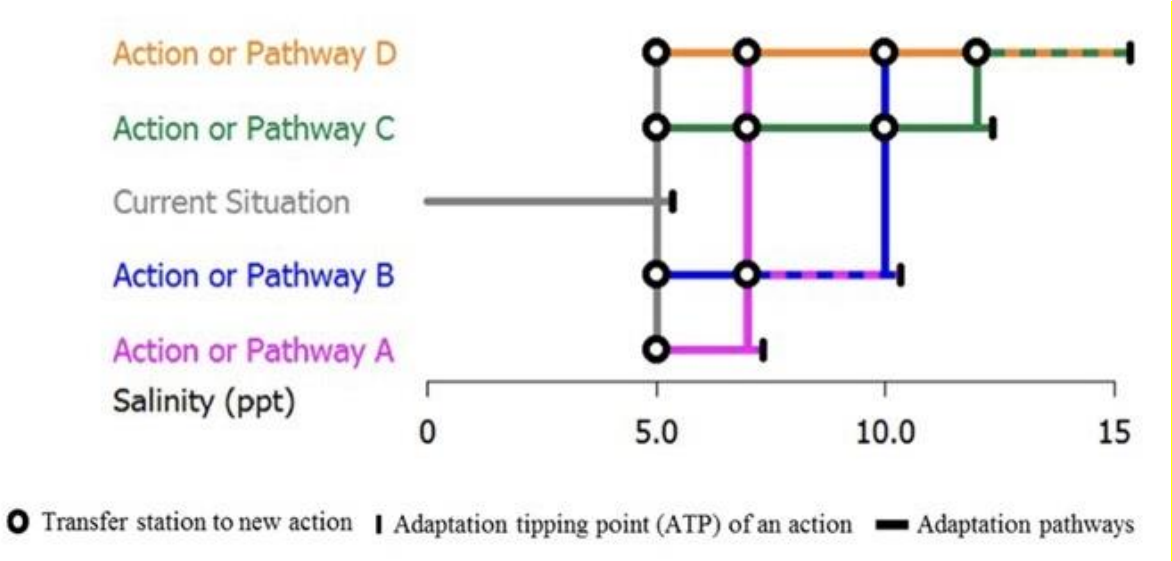

Figure 13 – Conceptual model of adaptation pathways approach to adapting to increasing salinization in Bangladesh. Action or pathway A can sustain up to salinity level 7 ppt, action or pathway B in combination with A will be sustainable up to a salinity level of 10 ppt, at which point action or pathway C is suitable until salinity exceeds 12 ppt, while action or pathway D combined with action C are expected to sustain up to 15 ppt of salinity (Hossain et al., 2018).

Consider transformational adaptation options as well as incremental actions

The majority of adaptation measures currently being planned and implemented are incremental (New et al, 2022), actions designed to maintain the essential features of an existing system (see Box 2). This is despite growing recognition that, in many situations, climate change impacts may exceed adaptation limits and threaten the viability / sustainability of those systems. In such situations, incremental actions

are of limited effectiveness and transformational actions, ones 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). This 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., 2022).

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, submission by IIED). 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 adaption measures and provides further options once a system reaches a soft adaptation limit (O'Neill et al., 2022). Migration, spatial planning, governance cooperation, universal access to healthcare and changing food systems have been identified as measures with high transformative potential (New et al., 2022). 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 5 – Managed retreat in coastal communities

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 of a soft adaptation limit for the individuals involved. The 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 particularlty great on indigenous peoples (Pérez and Tomaselli, 2021).

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 advanced planning for voluntary managed retreat is the island state of São Tomé and Príncipe, 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 (GFDRR, 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, ensuringe access to livelihoods and services in relocation areas, planning for manpower requirements, and preventing return while ensuring coastal access (GFDRR, 2016).

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 (Table 2, O'Neill et al., 2022). These incremental changes could involve any one of a suite of management, infrastructure and policy adaptation options (e.g. Major and Juhola, 2021)

Table 2 – Example of possible incremental (immediate to medium term) and transformational (medium- to long-term) adaptation responses to addess impacts of sea level in a small coastal community with minimal infrastructure (modified from Major and Juhola, 2021).

Time period	Actions	Notes
Immediate	Improve evacuation plans	Based on local knowledge; inexpensive
Short-term (<5 years)	Locally-constructed adjustments, join any availabel early warning systems, review retreat and temporary refuge options	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 / vulnerable buildings and roads	Moderate costs; some local, institutional and property issues; access to projected climate impacts data
Long-term (>15 years)	Plan and implement full retreat	High cost; complex institutional and property issues

Conduct integrated assessment of capacity, technological and financial needs

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 inter-related, and hence should be assessed together in an integrated manner (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.

Within the UNFCCC process, capacity, technology and finance are addressed under multiple agenda items and by separate constituted bodies (the Paris Committee on Capacity Building, the Technology Executive Committee, and the Standing Committee on Finance). Guidance developed by these bodies recognizes the linkages between capacity, technology and finance. For example, a key step in developing a Technology Needs Assessment is undertaking a barrier analysis and establishing an enabling framework that looks at capacity, financial and other needs (Case Study 6, 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 6 – Barrier Analysis as part of Technology Needs Assessments

As of February 2022, the UNFCCC TNA database includes 66 Barrier Analysis and Enabling Framework (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:

- Economic and financial barriers
- Legal and regulatory barriers
- Network barriers
- Institutional and organisational capacity barriers
- Human skills barriers
- Social, cultural and behavioural barriers
- Information and awareness barriers
- Technical barriers

Individual BAEF reports are strongly focused 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 (Table 3). Some, such as the report submitted by Jamaica, include cost-benefit analysis of measures to address major barriers (Gordon et al., 2021). Virtually 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 water sector of Pakistan, with examples of financial and capacity needs. Source: Table 2.1 in Government of Pakistan (2016)

Barrier category	Barriers
Economic & Financial	High capital and maintenance cost
	Limited financial allocation to local governments
	Inadequate loan and donor funding
Policy, legal and regulatory	Lack of sound comprehensive cross-sectoral policies for resource protection, development and management
Information & awareness	Limited information and awareness about the existence and usefulness of the technology
Institutional & organizational capacity	Limited institutional capacities specially at local level in integrating climate change risks in development planning
	Limited human skills and maintenance specially at local level

Diii - Gaps

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 report, and through development of this paper.

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:

- The lack of financial and institutional support necessary for the effective application of any methodology, particularly within developing countries (IIED). LDCs note the need for strengthened institutions / institutional arrangements for climate change planning, financing and climate information services, including support for non-state actors (LDCs).
- Limited access to data and data analysis tools (AILAC). Climate data continues to be a gap for many countries (AOSIS), despite major advances in climate services (WMO).
- A lack of information on the economic impacts of slow onset changes, relative to that available for damages associated with extreme climate events (LDCs).
- Understanding of the strengths and weaknesses of existing institutions to support adaptation (WFP, WFO Climakers).

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

With respect to methodologies, examples include:

- A lack of detailed documentation on the methodologies that have been used by countries in assessing adaptation needs (SCF, 2021).
- Practical methodologies for quantitative assessments, which tend to be more complex and data/resource intensive, while recognizing that qualitative / semi-quantitative analysis of adaptation needs can be extremely useful (Argentina, IFAD).
- Practical methods for the assessment of financial or technological needs (Cuba), whose submission states that greater progress has been made in assessing the needs for action.
- Methodologies for valuation of non-market costs and benefits, and monetizing adaptation actions and the benefits derived from them, particularly for countries with limited capacity (LDCs).
- Methodologies that can identify needs and opportunities for transformative adaptation (IIED).
- Methodologies for integrating multiple sectoral assessments (Commonwealth Secretariat).
- Methodologies for prioritization of adaptation options (AOSIS).

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

- The lack of a typology or analytical framework that would enable a systematic analysis of existing methodologies.
- The lack of empirical data that would allow for analysis of the relative utility of different methods and tools.

Div - Synthesis

Information in the assessment reports of the IPCC, other academic literature and reports submitted to the UNFCCC by Parties and observer organizations fail 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. That 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 over-

arching 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.

Building on that experience, this paper proposes a 5-step process for assessing adaptation needs at the national scale, with a variety of methods and tools being applicable at each stage of the process (Table 4). The stages are:

- framing the assessment;
- assessing climate risks and vulnerabilities;
- identifying desired adaptation options;
- assessing resource needs; and
- compiling adaptation needs.

The scope of each stage is detailed in Table 4.

Table 4 – Process for assessing adaptation needs. See text for additional explanation and caveats. * Indicative methods include examples mentioned in this paper, and is far from comprehensive. Additional methods, as well as specific tools, can be found in the UNFCCC Adaptation Knowledge Portal, through global, regional and national adaptation centres, and other sources noted in this paper. Acronyms used in Table: NAPs – National Adaptation Plans, BURs – Biennial Update Reports, BTRs – Biennial Transparency Reports, NDCs – Nationally Determined Contributions, UNFCCC – United Nations Framework Convention on Climate Change.

Stage	Scope	Indicative methods (broad categories)*
1. Frame the assessment	• Setting of the objectives of the needs assessment • Identification of resources and capacity needed and available • Compilation and/or collection of required data and information	• Participatory multi-stakeholder engagement • Stocktaking of available information, resources, capacity • Data collection
2. Assess climate risks and vulnerabilities	• Identification of underlying causes of vulnerability • Assessment of projected climate impacts • Analysis of projected changes in climate risks and vulnerabilities (environmental, social, economic, institutional) • Assessment of existing capacity to adapt • Identification of risks and opportunities	• Climate and socioeconomic scenario analysis • Impact, vulnerability and risk assessment approaches including, inter alia: o risk-based o community-based o ecosystem-based o sector-based approaches
3. Identify desired adaptation actions	• Identification of adaptation options • Appraisal of suitability of the adaptation options (environmental, social, economic, institutional) • Costing adaptation options • Ranking and prioritization of the adaptation options to identify desired adaptation actions	• Adaptation / climate resilient development pathways • 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: o Resources for addressing underlying vulnerabilities o Resources for planning and implementation of adaptation actions o Resources for monitoring and evaluation of adaptation actions	• Capacity needs analysis • Technology needs assessment • Costing adaptation actions • Economic analysis
5. Compile adaptation needs (adaptation actions and resource needs)	• Compilation of adaptation actions • Compilation of resource needs – capacity, technology, information, financial	• Guidelines for different end uses including for: o NAPs – to facilitate implementation o Mobilizing/accessing support o National Communications, BURs, BTRs, NDCs, Adaptation Communication – to facilitate reporting under the UNFCCC o Other national processes – such as subnational and sectoral planning and implementation

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The first stage, framing the assessment, is critical as decisions made will affect the outcome of the process and help direct methods and approaches. Beyond that stage, it is unlikely any national-scale assessment would be starting from scratch. Rather, it would incorporate and build upon existing knowledge and data concerning climate risks, vulnerabilities, adaptation plans and 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/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.

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 of the resource needs associated with various adaptation options, as well as the associated benefits, will be a key factor in ranking and prioritizing adaptation options. It should also be stressed that there are a number of methods and tools that 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.

While depicted as a linear process in Table 4, it needs to be remembered that assessing adaptation needs is an ongoing and continuous process that aligns with the adaptation policy cycle (Figure 2). Knowledge and data concerning vulnerabilities, climate risks, 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 as reason why the process must be ongoing. Results of successive assessments provide important insights into successes, failures and gaps in adaptation responses.

E – Conclusions and recommendations

Assessing adaptation needs is a critical step in enhancing climate resilience. It is challenging, in part because it encompasses all stages of the adaptation policy cycle, including monitoring and evaluation of implemented actions. Assessment of adaptation needs is happening from project to global scales, with information at the national scale particularly relevant under the UNFCCC.

Submissions by Parties highlight a multitude of different methods and tools that are being utilized 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, based on generic guidance provided for development of NAPs or similar initiatives and customized to address the specific circumstances where they are being applied. National scale needs assessment draw upon analyses conducted at different scales, at different points in time, and using different methods and tools.

Comparing the practical experience of Parties with information contained in the academic literature highlights a significant gap between theory / 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 / 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 paper is intended to serve as a starting point for more detailed work on methodologies, methods and tools for assessing adaptation needs as part of the UNFCCC process. It identifies emerging good practices for needs assessments, recognizing the importance of incorporating new ideas as our understanding of adaptation process increases. It presents a 5-step approach to assessing adaptation needs broadly, while recognizing that it is part of an ongoing, continuous assessment process necessitated by the fact that knowledge of climate vulnerability, risks, adaptation solutions and priorities continue to evolve.

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

- Continued sharing of experiences on assessing adaptation needs, including on the utility of the emerging good practices identified in this paper. Key players: Parties, organizations, facilitation role for UNFCCC (AC, LEG, NWP through AKP).
- Continued development of methodologies, methods and tools for assessing adaptation needs, recognizing the need for a range of tools that can applied in differing circumstances, including in countries with limited capacities. Key players: academia, methodology developers, and adaptation-focusses institutions.

- Consideration, and if appropriate, development, of a typology or analytical framework for methodologies to assess adaptation needs to allow more rigorous examination of strengths, weaknesses and utility. Key players: academia
- Develop 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: World Adaptation Science Programme (formerly known as PROVIA), other relevant and interested adaptation institutions like the NAP Global Network and the NAP Global Support Programme.
- Develop guidance for Parties on framing assessments of adaptation needs (stage 1 of the 5-part process presented in Table 4). Key players: AC, LEG
- 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: SCF, AC, LEG, PCCB, TEC.
- Consideration of the value of, and practical limitations of, developing and promoting a general methodology for assessing adaptation needs that could be employed by all countries, recognizing capacity limitations, in order to produce more comparable estimates of adaptation needs. Key players: SBSTA, AC, LEG, SCF, GCF.

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