UNEP

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

SUMMARY

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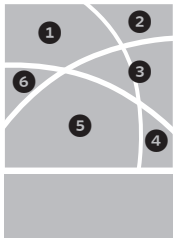

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Preface

In 1994 the Intergovernmental Panel on Climate Change published *Technical Guidelines for Assessing Climate Change Impacts and Adaptations*. These guidelines outlined a series of generic steps to be followed when designing and conducting a climate change impact and adaptation assessment. The guidelines were complemented in 1996 by the *UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. The IPCC Guidelines and the UNEP Handbook were applied in a range of country studies during the decade following their publication. They also inspired the publication of additional guidance, including the *International Guidebook for Vulnerability and Adaptation Assessments* carried out as part of the US Country Studies Program, and the *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures,* published by UNDP.

The past decade has seen a shift from centralized guidance for climate vulnerability, impact and adaptation assessment to the development of specific, often sectoral or place-based approaches. There has been a proliferation of assessment methods and tools, and it has become increasingly difficult for potential users to understand the utility, benefits, requirements and tradeoffs of those methods and tools. Stakeholders' demand for knowledge on vulnerability, impacts and adaptation needs to be matched with the supply from the research community of clear technical guidance that takes into account both the academic developments of the past 20 years as well as user needs at local, national and international levels.

The Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) has responded to this challenge by revising and improving existing guidance for assessing climate change vulnerability, impacts and adaptation, covering the range of available approaches, methods and tools. This document is the result of this effort, which has been a pleasure for me to coordinate. The PROVIA Guidance is meant to be informative rather than prescriptive; its intended users are researchers, adaptation practitioners, decision-makers and those involved in project, programme and policy formulation. The Guidance is conceived as a "living document": the current version is a consultation document that will benefit from feedback from users.

The PROVIA Guidance has been prepared by a ten-strong author team, supported by a large group of experts and reviewers (see opposite page). The conceptual basis, the decision trees and the methods and tools included in the PROVIA Guidance build on research conducted within the project MEDIATION: Methodology for Effective Decision-making on Impacts and Adaptation. MEDIATION was funded by the European Commission's 7th Framework Programme under contract number 244012. The preparation of the PROVIA Guidance was funded by UNEP, with additional support provided by the Government of Sweden.

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Harvesting carrots, India © Flickr/CGIAR-CCFAS

Summary

Climate change poses a wide range of risks – and, in some cases, opportunities – to human and natural systems around the world. In order to understand and address these risks and opportunities, stakeholders need clear technical guidance that combines robust science with explicit consideration of user needs at local, national and international levels. This document responds to that challenge by updating and improving existing guidance for assessing climate change vulnerability, impacts and adaptation, covering the range of available approaches, methods and tools.

The guidance is structured along a five-stage iterative adaptation learning cycle:

1. **Identifying adaptation needs:** What impacts may be expected under climate change? What are actors' vulnerabilities and capacities? What major decisions need to be addressed?

2. **Identifying adaptation options:** How can the specific risks and opportunities that were identified be addressed? There may be several options available to achieve the desired goals.

3. **Appraising adaptation options:** What are the pros and cons of the different options, and which best fit the adaptation actors' objectives?

4. **Planning and implementing adaptation actions:** After an option is chosen, implementation can begin. The focus here is on practical issues, such as planning, assigning responsibilities, setting up institutional frameworks, and taking action.

5. **Monitoring and evaluation of adaptation.** As measures are implemented, the process is monitored and evaluated to ensure it goes as planned, identify any problems, document the outcomes achieved, change course as needed, and draw lessons from the experience.

This is an idealized model of adapting to climate change; "real-world" adaptation processes may not be linear, and in fact, may require refinement through iteration. This guidance therefore provides multiple entry points, highlighted in boxes throughout the document, to allow readers to enter (and re-enter) at various stages or sub-stages of the process.

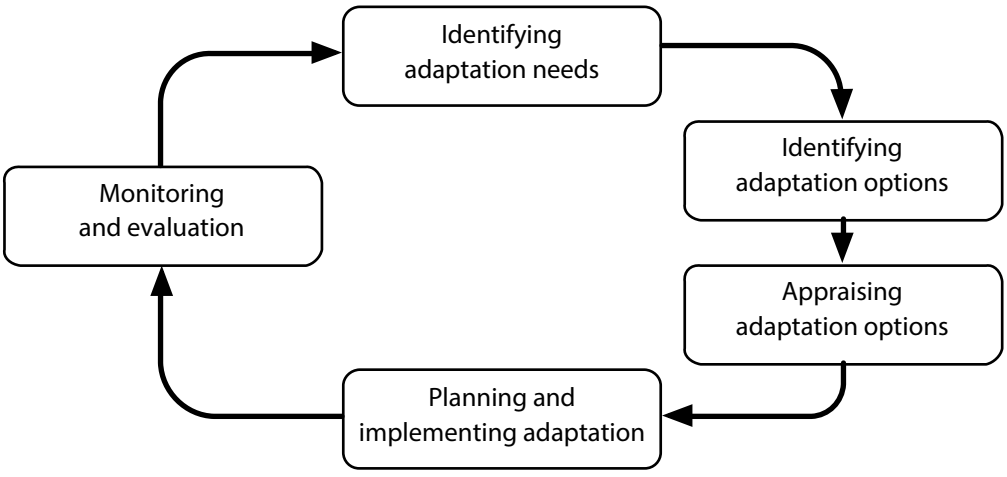
All of these tasks are complex, and many need to be carried out by experts. There is no "one size fits all" approach, and this document emphasizes the diversity of adaptation challenges and the variety of methods and tools available to address them. We use decision trees to identify key criteria that may indicate the need for a particular kind of analysis or method, but never prescribe an approach as the only valid one. The aim of the document is to provide an overview of the range of activities that make up climate risk assessment and adaptation, and a coherent and integrated structure for addressing them.

Generally, this document is targeted at professionals such as researchers, consultants, policy analysts and sectoral planners who have some prior knowledge on climate risk assessment and adaptation. Some of the material is technical and requires some relevant experience. The guidance should also be of use to those leading or initiating planned and collective adaptation, such as community-based organizations or NGOs. Below we provide brief overviews of the four sections of the document, with an emphasis on Section 2, which guides readers through the adaptation cycle and suggests approaches to different tasks. ■

Section 1: Introduction

This section introduces the basic structure and terminology used in the guidance, including how to frame the adaptation process, how to differentiate adaptation challenges based on different criteria, and how to identify the most relevant (salient) tools and approaches to address those challenges. In differentiating adaptation challenges, we emphasize two key empirical criteria: the stage in the adaptation cycle, and the type of adaptation situation: public or private, and individual or collective. Private individual situations are those in which persons act in their own interest, such coastal dwellers flood-proofing their homes. Private collective situations are those in which groups of people take action together in their own interest, and may involve interdependence and, sometimes, conflicting interests. Public situations are those in which public actors, such as governments, take action with a fiduciary duty to act in the public interest – either seeking to influence individual or collective actions, or coordinating collective actions.

The guidance also highlights three other key sets of empirical criteria: the characteristics of the climate risks (or opportunities) involved, such as whether they are already present; the characteristics of the affected actors, such as whether they are



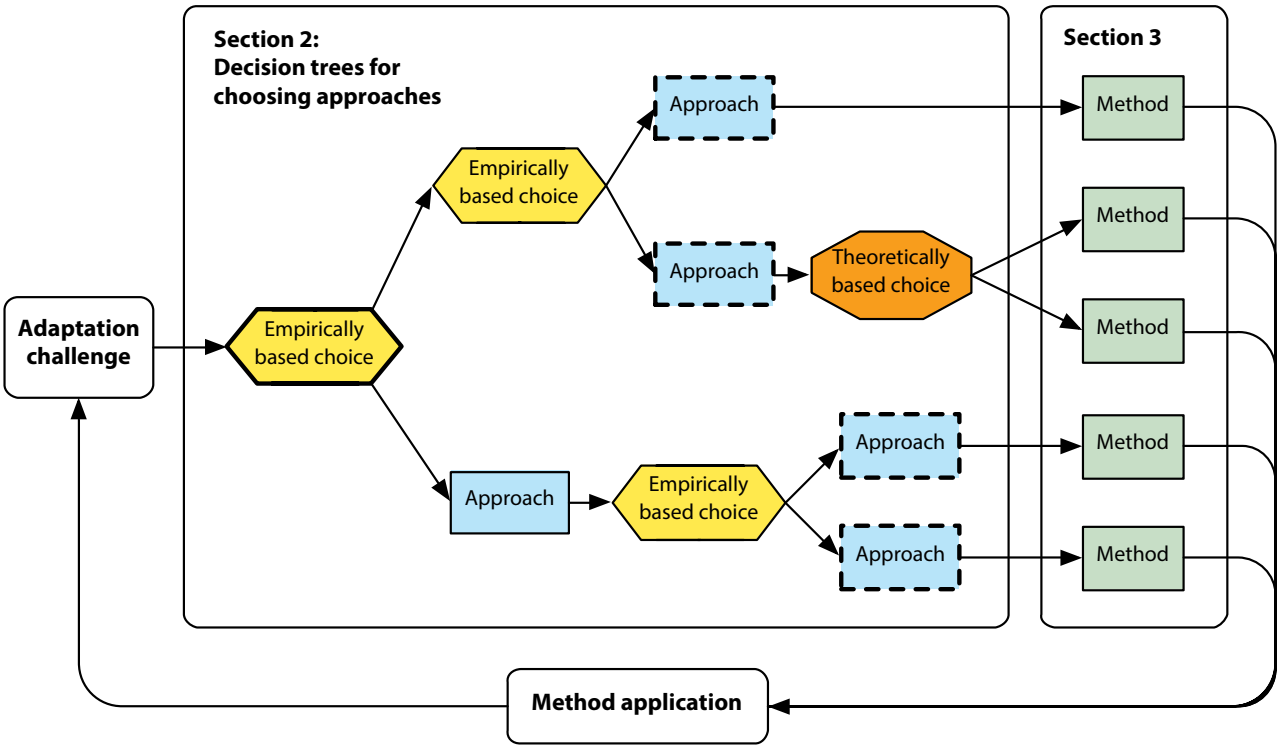
The adaptation learning cycle.

aware of the risks and have the capacity to adapt; and the characteristics of the available adaptation options, such as their relative cost and flexibility. In addition, we note other types of criteria that may inform the choice of approach, including theoretical criteria, such as whether methods from economic theory or social psychology are preferred; normative criteria, or the values and priorities that define what options are acceptable; and pragmatic criteria, such as time, skill or funding constraints.

Finally, we stress the importance of stakeholder participation at all stages of the adaptation learning cycle, which should cover the full range of affected groups, including women and marginalized populations. This is particularly the case for collective adaptation situations, to understand and take steps towards harmonizing the diverse and potentially conflicting perspectives of different actors. ■

Section 2: Choosing approaches for addressing climate change adaptation

This section goes through each stage of the adaptation cycle and identifies tasks that may arise and different approaches that may be applicable. We start by explaining how we use the term "vulnerability" here: in the most general sense, as the propensity to be adversely affected by climate change, rather than adopting any of the more specific formulations in the literature. We describe methods that model climate change impacts as "impact analysis", and methods that analyse the institutional context of vulnerability – including political, social and economic factors – as "institutional analysis". The latter include methods for assessing "social vulnerability", considering rights, entitlements and power in the analysis. Finally, we use the term "indication" to describe methods that



Exemplary decision tree and its iterative application for choosing approaches based on the current adaptation challenge. Decision nodes on empirical criteria are represented by yellow hexagons; decision nodes on theoretical criteria are represented by orange octagons. The salient approaches are represented by blue rectangles. The entry point to a decision tree is a decision node with bold borders. Exit points are approaches that lead to the next stage in the overall adaptation cycle. They are represented with dashed bold borders.

use indicators (individually or in indices) to measure climate impacts, adaptive capacity, or both.

Identifying adaptation needs

Identifying adaptation needs involves two equally important and complementary sub-tasks: 1) analysing observed or expected *impacts* of climate change (with and without adaptation); and 2) analysing the potential *capacity* to prevent, moderate or adapt to these impacts. In most adaptation situations, both types of analysis are likely to be relevant, but resource constraints and/or the characteristics of the adaptation challenge may make it necessary to prioritize one type of analysis over the other.

In choosing approaches to impact analysis, we identify several decision nodes: Are studies on future impacts available? Are the available studies comprehensive and credible? Are the results of these studies ambiguous regarding impacts? If future impacts need to be projected, are impact models available to do so? Should adaptation be included in the projection? Are monetary values involved and not known? If impact models are not available, can a trend be detected and attributed to climate change? When no impact studies or models are available and no trend can be detected and attributed to climate change, then the identification of adaptation needs and opportunities must rely on indication methods – impact indication, capacity indication, or vulnerability indication, which combines both.

Capacity analysis, meanwhile, explores the availability of a wide range of resources – such as natural, financial, cognitive, social, and institutional capital – that may be mobilized for adaptation. Several assessment methods are available, depending on the type of adaptation situation. In public situations, a public actor may wish to understand the adaptive capacity of private actors in order to influence their actions at later stages in the adaptation process. Towards this end, capacity indicators or indices are used. It is important to note that adaptive capacity indicators and indices only provide a rough and rapid assessment of actors' potential capacity to adapt. Whether this potential capacity is realized in the context of a specific climate threat depends on many contextual institutional and cognitive factors, which may need to be explored through behavioural and/or institutional analysis. In collective private adaptation situations, organizational self-assessment methods may be relevant.

Identifying adaptation options

Once specific adaptation needs have been identified, the next step is to identify ways to address them. For example, a climate impacts and vulnerability analysis might have found that due to sea-level rise and changing weather patterns, coastal communities will be exposed to major floods during storm surges. We refer to the different pathways that can be taken as *adaptation options*. For example, for a municipality, protecting the coast might involve building new infrastructure, such as a sea-wall, or working to restore natural barriers such as dunes and mangroves, or both. Individual homeowners might consider raising or fortifying their houses, or getting better insurance. The public sector might consider financial incentives to encourage individuals to pursue those measures, or if it considers retreat a better option, it might provide incentives to leave, or change zoning laws to prevent further development.

The nature of this task is different for private and public actors. Private actors act in their own interest, and can focus narrowly on the adaptation options available to them. Public actors, on the other hand, are mandated to act in the public interest, and thus need to consider a much wider array of measures and criteria, such as distributional

effects and potential conflicts that may arise. In collective situations, some options that are theoretically possible – say, choosing not to further develop a high-risk coastal zone – might not be feasible without first building consensus. At the same time, actors' awareness of the limits of their influence might lead them to not even consider measures beyond their immediate control.

In identifying public options for influencing individual action, two key factors must be considered: actors' *potential capacity* – the resources, including material resources, skills and networks or social capital available to them – and their *actual capacity* – whether they can actually go through the whole adaptation cycle. Actual capacity can be enabled or constrained by institutional and cognitive factors, which are referred to as *barriers to adaptation*. Another key consideration is whether adaptation would conflict with private interests. If so, considering the relative costs of action may help identify appropriate policy instruments to encourage adaptation. If adaptation does not conflict with private interests, behavioural analysis should be undertaken to identify the relevant cognitive and institutional barriers. Possible approaches fall into two broad categories: economic (e.g. utility maximization or bounded rationality) and social psychological (e.g. protection motivation theory, which posits that actors are motivated by the perceived severity of a threatening event, the perceived probability of the occurrence, the efficacy of the recommended preventive behaviour, and their perceived self-efficacy).

In many situations, conflicts can arise between the individual preferences of private actors and social welfare, such as when a common pool resource is over-exploited. In order to identify appropriate policy measures, one needs to understand the nature of the interdependences and conflicts between actors. This can be done through institutional analysis, looking not only at formal laws, policies and governance structures, but also at informal norms, customs and shared strategies. Different approaches can be used to identify a coordination solution, or to try to design institutions or policies to achieve the desired goal.

Appraising adaptation options

There are many methods that can be applied to appraise adaptation options, from the fields of organizational learning, decision analysis, policy analysis, and institutional and behavioural analysis. A key first choice is whether to apply a formal approach, a deliberative/participatory approach, a combination of both, or none – and make a decision based on intuition. Formal decision appraisal methods are based on formalizing the decision and then applying mathematical reasoning to indicate which options *should* be chosen. Examples of such methods are multi-criteria analysis, cost-benefit analysis or robust decision-making. In contrast, deliberative approaches appraise options by eliciting information from the actors involved and harmonizing their preferences. Intuitive decision-making relies on cognitive processes that have been developed through a great deal of experience and learning.

Formal decision-making requires a well-defined decision, with a specific set of options, known outcomes of implementing each option (computed using either risk assessment methods for present climate extreme event risks or residual impact projection methods for future climate, and one or several metrics by which to compare the options, at least one of which involves the costs of planning and implementation.

Only a limited set of adaptation decisions can be formalized due to, among other factors, the intensive time, resource and capacity requirements of formal decision-making methods. For individual decisions, there is good evidence that when

information is limited or ambiguous, some informal patterns consistently lead to better decisions than attempts to apply more formal methods. For collective decision appraisal, informal methods may be more deliberative. For example, consensus-based decision-making involves discussing options to familiarize everyone with the issues and build a shared understanding and a sense of shared control over the decision – which, in turn, can lead to more effective adaptation.

For formal appraisal of options, key factors in choosing an approach are whether the options are all short-term, or also include long-term ones; whether residual impacts can be projected; whether there are risks (or opportunities) due to current climate extremes and variability; and what the relative costs of options are. In general, short-term and lower-cost options, and options that address current risks, provide more room for experimentation and learning – that is, to take adaptation action, monitor the outcome, and make adjustments as needed. This is what is called adaptive management.

If the relative costs of an option are high, and/or if long-term options are involved, experimentation is less desirable. Instead, it would be useful to evaluate the adaptation options upfront, before implementing one, following standard approaches for decision-making under uncertainty such as cost-benefit analysis or cost-effectiveness analysis. (Cost-benefit analysis, as its name suggests, weighs the costs of implementing a measure against its expected benefits. Cost-effectiveness analysis starts from the premise that action – e.g. addressing a drought risk – is desirable, and looks for the most cost-effective, or lowest-cost, way to achieve the desired goal.) For these formal decision-making methods, having probabilistic information about the risks is crucial to calculating expected outcomes.

Farmers tend their early maturing rice varieties in Madagascar © Katherine Vincent

The farther into the future that a climate risk lies, the greater the uncertainty involved. Not only would the expected costs and benefits have to be calculated for an ever-broader range of climate scenarios, but also for different non-climate variables such as development and policy choices (e.g. how a coastal area is zoned, or whether a hydropower dam is built). Alternative methods have been developed to support decision-making under deep uncertainty. Unlike cost-benefit or cost-effectiveness analyses, which aim to find the optimal solution within a fixed set of parameters, these approaches look for solutions that are robust (don't fail) under many possible future scenarios. Such "robust" decision-making methods can appraise options using the criterion of robustness alone, or both robustness and flexibility.

Planning and implementing adaptation

Once climate impacts and vulnerabilities have been assessed, and adaptation measures to address them have been identified and evaluated to choose the best option, the next step is to make a plan to implement the chosen measures – and then do it. This is a complex and challenging process, and very often, the analytical work is not translated into concrete plans and actions. Key

constraints that can arise at this stage include lack of motivation and common purpose; concerns that the desired adaptation measures are not actually feasible; and lack of clarity around objectives or agreement on priorities.

Recognizing these common obstacles, this section focuses not only on the technical tasks of planning and implementing adaptation measures, but also on the work needed to support those efforts: communications, consensus-building, integration with non-climate initiatives (especially development), and capacity-building for key actors and institutions to ensure that they can successfully plan and implement adaptation. A key question to remember throughout the process is "*What are we adapting for?*" (the desired outcomes). For example, if a coastal area is being protected from sea-level rise and storm surges, is the priority to protect buildings, ecosystems or both? And is there a consensus about the desired outcome, or does the agreement stop at "protect the coast", but break down when it comes to specifics? The scoping phase thus sets the parameters for the work and clarifies what it is intended to achieve and who needs to be involved. Often adaptation is not the only reason for change, and measures may be implemented as part of other initiatives, such as development projects. For example, upgrading a water supply system in a coastal community which currently has no access to fresh water could provide both adaptation and development benefits.

Engagement of stakeholders in creating an adaptation plan – and well before, when identifying and assessing options – means the plan is much more likely to be accepted, especially if the stakeholders are also willing to become advocates or champions of the plan. In designing participatory processes, it is important to define the scope of the issues that stakeholders will be addressing. Stakeholder engagement approaches can vary from fairly passive interactions, where the stakeholders simply provide information, to "self-mobilization", where the stakeholders themselves initiate and design the process. Stakeholders must understand how they are being involved, how the information they provide will be used, and what opportunities they have to influence decisions. When designing the engagement, it is valuable to take into account the stage at which the engagement is occurring in terms of the policy-making process, what decisions have already occurred, and what positions are already fixed.

Adaptation decisions need to be implemented within existing governance and legislative constraints, which will inevitably influence which responses are considered to be feasible. Understanding as much as possible about the context of this wider landscape allows a balance to be struck between ensuring that actions fit within those existing structures, and creating an enabling environment to support appropriate adaptation decision-making in the future. This complexity means it is a greater challenge to ensure that adaptation in one area does not increase vulnerability in another, and that "windows of opportunity" and "win-win" opportunities are maximized. It is by no means a given that the people and institutions charged with implementing an adaptation plan will have the capacity to do so. Thus, it will also be important to identify any capacity gaps and incorporate capacity-building into the adaptation plan.

Capacity involves not only knowledge and skills, but also having the necessary tools and resources, as well as the necessary institutional framework. The best-trained adaptation experts will accomplish little if they must cram their adaptation duties into an already full workload, or they lack crucial software, or money to buy supplies, or the support of their supervisors. Agencies with competing mandates can bring one another to a standstill, and lack of enabling legislation or regulations can keep adaptation measures from being implemented. Thus, there is a broad range

of capacity-building work that may need to occur before the actual implementation process.

Monitoring and evaluation

Adaptation can involve a significant investment of resources and effort, and as discussed in previous sections, it is often planned amid uncertainty, with incomplete knowledge, and may require substantial learning, capacity-building and institutional change. All of this makes it crucial to monitor adaptation activities as they are implemented, make adjustments as needed, and evaluate the results at the end.

Monitoring of an adaptation project may have a number of purposes, such as to assess progress in the achievement of stated tasks; to determine whether the tasks are fulfilling the aims of the adaptation initiative; to assess the functioning of the team and of individuals within it; to examine engagement of other people in the process; to gather stakeholders' perspectives on the nature of that engagement (both the process and content); or to understand how well learning is occurring and informing the next steps.

Evaluation goes beyond monitoring in that it includes a value judgement on how an adaptation intervention is performing based on the monitored criteria. As funding for national, sectoral, and project-based adaptation projects has increased, so has the need to understand what makes adaptation actions effective, demonstrate value for money, protect investments, identify best practices, and judge which efforts are suitable for scaling-up. Although initiatives that focus solely on adaptation are still relatively recent, projects in which adaptation is a component have been in place for some time. In many cases, adaptation activities can be evaluated effectively by refining existing monitoring and evaluation (M&E) frameworks rather than building completely new frameworks.

Adaptation initiatives may have features that make them more challenging to evaluate, such as a longer time horizons than is usual for development projects; this means different kinds of indicators, baselines and targets may need to be set up. It is also important to get different perspectives on "success", focusing not only on funders' priorities, but also on the intended "beneficiaries" and their perspectives. Early in the planning stages of an evaluation, it is important to clarify the reasons for undertaking the evaluation and ensure that all participants are in agreement. The two fundamental questions are, "have we done things right?" (that is, the things we said we would do in the adaptation plan) and "were they the right things?" (how relevant were they? will they enable us to be less vulnerable or adapt better?). A third question might be, "how should we measure these things?"

Ideally, evaluations bring in a mixture of different types of information (scientific, political, legal, technical as well as local knowledge). It is useful to provide opportunities to compare these different perspectives – for example, through a science-policy dialogue. Indicators should also be chosen carefully, distinguishing between process and outcome indicators (e.g. number of workshops on heat stroke dangers vs. number of heat-related deaths avoided), including both quantitative and qualitative data, and disaggregating as relevant (e.g. by location, gender, income level or social group). This section also describes commonly used approaches, such as results-based management and logical frameworks – both widely used by funders – and outcome mapping and most significant change, common in development.

Finally, this section emphasizes the value of learning as part of the M&E process. Monitoring and evaluation processes can be designed to enhance learning by encouraging the use of all insights in order to adapt the current plan, improve the design of the next project, or compare with other

evaluations in an iterative cycle. Learning needs to be consciously to be built into the process if it is to be effective. This requires thinking through who needs to be learning, how people can provide insight and feedback, what kind of things can be learned (facts, skills, stories) and what level of challenge is available to move people beyond "business as usual". It also requires making "spaces" available for learning and feedback. Lastly, it is important to provide for both fast (short-term) and slow (long-term) learning. For example, it might take 10-15 years to learn that a measure meant to reduce vulnerability to increasing water scarcity (e.g. planting trees) does or does not work well. We need quick ways to check our assumptions about what needs to change and how it will change – e.g. are farmers actually adopting new practices after an intervention, and if not, why not? – while also building our knowledge over time. ■

Sand banks are used to stabilise the river bank and reduce flood risk in southern Malawi © Katherine Vincent

Section 3: Methods and tools

This section provides in-depth guidance on the approaches discussed in Section 2, as well as additional methods and tools, often with examples from the literature. Rather than try to summarize the entire chapter, which might read like a laundry list, we focus here on providing an overview, a sort of annotated table of contents to highlight materials that might not be easily found through pointers in Section 2.

Participation and engagement

This section builds on ideas introduced throughout Section 1, but goes into much greater depth, discussing the principles behind participatory processes, ethical and social-justice considerations, and the wide range of possible engagement by stakeholders: from one-shot discussions to elicit local knowledge or preferences, to sustained participation, ownership and leadership of adaptation processes. We also discuss what makes a good facilitator – from strong interpersonal skills, to a commitment to ensuring all voices are heard, to awareness of factors that might discourage people from speaking freely.

We then present several tools to help identify the stakeholders who should be engaged, analyse social networks, and understand participation (e.g. "ladders" to show different levels of engagement). Next we describe several methodologies, guidance documents, toolkits and individual tools to help readers work with stakeholders at all stages of the adaptation cycle. Although the approaches we discuss are specifically geared to adaptation, they draw from existing practices and knowledge in development, disaster risk reduction and other fields. We also present tools to help ensure participation of people who are often excluded – such as women, indigenous groups, and people who are not literate – and tools for participatory

analysis and conflict resolution, as well as a few useful generic tools (e.g. H diagrams).

Impact analysis

Building on the explanation of the first stage of the adaptation cycle in Section 2, this section describes key tasks in impact analysis and applicable methods, with examples: describing current impacts of climate change; detecting trends via statistical methods; attributing impacts; and modelling future impacts, including how to project future climate change and how to represent adaptation in models.

Next, we provide an overview of vulnerability indication, which starts from the assumption that individual or social capacities and external climate drivers are at least partly responsible for climate change impacts, but their interactions cannot be reliably simulated using computational models. The key question addressed is, which combinations of variables give the most reliable indication of how climate change may affect the study unit? The basic tasks are to select potential indicating variables, based on the literature, and to aggregate the indicating variables based on theoretical and normative arguments. We also highlight concerns that several experts have raised about vulnerability indices.

Another sub-section focuses on different ways to elicit knowledge, including community vulnerability assessments, expert judgement, participatory development, and emerging user-controlled learning tools.

Capacity analysis

This section focuses on methods and tools for assessing the capacity of individuals, communities, systems and institutions to adapt to climate change. Capacity analysis is typically done in the first stage of the adaptation process, identifying adaptation needs, but it is also relevant in appraising adaptation options and planning and implementing adaptation measures. We describe several approaches to capacity analysis, starting with the notion of "adaptation functions" and institutions to support adaptation – based on the Bellagio Framework for assessing countries' adaptive capacity, which identifies planning, management and service delivery functions needed for effective adaptation. We also describe frameworks that focus on characteristics of institutions or organizations that support adaptation, such as learning capacity, ability to understand different perspectives, and fair governance.

We also discuss the links between adaptive capacity and social vulnerability, which can be seen as the "flipside" of adaptive capacity in some respects: for example, people who can read and write may have a greater capacity to adapt than those who are illiterate – and the latter may thus be more vulnerable. Like social vulnerability, adaptive capacity is dynamic, varying across time and space, and shaped by an array of economic, social, cultural, institutional, environmental and other factors. Therefore, like vulnerability assessments, capacity analyses can only reliably tell us about capacity *here and now,* but not necessarily in the future, or under different circumstances. We stress that, although the use of indicators to measure adaptive capacity (and/or social vulnerability) can be problematic, as discussed above, this does not negate the importance of the socio-economic context in assessing adaptive capacity. Instead, we need better analyses and a recognition that adaptive capacity cannot be easily quantified and compared across countries or populations.

Scenario analysis

This section provides an overview of the extensive on the use of data and scenarios in climate impact and vulnerability assessments, focusing on the most useful resources, and highlights important issues to

consider when using scenario analysis in the context of adaptation. It also provides a list of data portals that provide global-, national- and regional-level data that can be used in scenario analyses.

We discuss how different kinds of information can be incorporated in such analyses, including climate data; quantitative data about physical, economic, social or technical aspects of the system being studied; and qualitative descriptions of past, present or future conditions (storylines). We also explain different approaches to using scenarios for future climate and for future environmental and societal conditions that may influence vulnerability, impacts and risk management in general. Lastly, we note that using common sets of scenarios can help bring consistency and comparability to climate impact and adaptation assessments.

Behavioural analysis

Behavioural research uses a variety of methods – e.g. laboratory and field experiments, econometric analysis – to try to understand how people make decisions, and how those decisions vary according to contextual factors. In climate change adaptation, impact and vulnerability analysis, behaviour analysis can be used to explain how actors (organizations or individuals) make adaptation decisions – on the assumption that such knowledge is necessary to advance adaptation. For example, understanding the factors that shape household decisions on flood protection can help improve the design of flood risk communication strategies. It can also shed light on the limits to adaptation, leading to more realistic assumptions about autonomous adaptation in climate economics models and adaptation plans.

We focus on three main approaches: one from social psychology, protection motivation theory, which assumes that individuals take action based on their perception of risks and the perceived effectiveness of acting to reduce risks; and two from economics: utility maximization, which assumes that individuals take action to maximize utility, and have complete information and the required analytical abilities; and bounded rationality, which assume that individuals want to maximize utility, but have limited information and/or limited cognitive abilities.

Institutional analysis

Assessments of vulnerability, impacts and adaptation will often seek to understand the institutional context, including political, social and economic factors that structure individual choices. Such methods are broadly categorized as institutional analysis. This section describes three main approaches: governance description, governance design and governance emergence.

Governance description approaches describe the actors and institutions relevant for adaptation, and have been done all around the world in the context of climate change. This type of approach requires no strong theoretical assumptions on the part of the analyst, and contributes to adaptation by providing a more comprehensive description of the policy context in which adaptation takes place. Governance design, meanwhile, addresses the question of how to design effective institutions, on the theoretical assumption that the link between institutions and outcomes can be understood and predicted with some confidence. One governance design approach that has been applied extensively in the adaptation literature is policy analysis, which is used to improve the design of policies, programmes or projects. Finally, governance emergence is approaches strive to understand the existing institutions, particularly addressing which contextual factors give rise to a particular institutional arrangement in a given case. Within this category, a distinction is made between those approaches that assume that it is possible to

generalize beyond a single case, and those that do not (such as ethnographic approaches).

Formal decision-making

This section describes and discusses formal decision-making methods, explaining and providing examples of six different approaches. The first is cost-benefit analysis, compares options based on a single metric (net cost or benefit), calculated as the difference between the present value of cost and present value of benefits for each, and picks the option with the highest net benefits or benefit cost ratio. Cost-effectiveness analysis, meanwhile, compares options based on both their costs and a different metric describing a desired outcome (e.g. number of endangered species saved), and picks the option with the highest cost-effectiveness ratio. Multi-criteria analysis applies multiple metrics in the comparison, computes a weighted sum for each option, and picks the one with the highest score.

We also discuss robust decision-making, which is particularly useful when making decisions amid uncertainty (see Section 2 summary), and multi-shot robust appraisal, which is useful when the set of options includes options with long investment horizons, or when a decision is considering adaptation to mid- to long-term hazards, and when the options considered are flexible. In such cases, flexible options may be favoured over non-flexible ones, and decisions are delayed to keep future options open. Adaptation "tipping points" may be identified beyond which some strategies are no longer effective, and other options need to be considered. Finally, we discuss adaptive management, another method for decision-making under uncertainty. Adaptive management allows for the updating of actions on the basis of new information as it becomes available. In this sense, adaptive management is an ex-post evaluation of options based on the preferences of the decision-maker. Adaptive management requires the availability of new information on the effectiveness of an adaptation action, and therefore is closely related to monitoring and evaluating, and to learning.

Valuation methods

This section focuses on an important task that is essential to many kinds of formal decision-making: computing a monetary value to an option on the basis of its non-monetary outcome attributes. Valuation is necessary in situations in which monetary values of outcomes are considered important, and it is also important in impact analysis, in order to identify adaptation needs.

The point of departure for valuation is those goods that people buy and sell on the market, such as bread, butter or bicycles. Their value can be established by observing the average prices that people pay for them. As prices change over time, a base year can be established, and a correction can be made

Flooding, Heidelberg, Germany © Flickr/Sylvia Wrigley

for inflation of values obtained in the past or estimated for the future. From the simple case, there are several characteristics of outcomes that can make it more difficult to assign monetary values. We discuss different approaches applicable to situations where non-market outcomes are involved, where there are indirect outcomes, where there are inter-temporal outcomes, or where outcomes are uncertain, and we note important considerations, such as the implications of different discount rates.

Finally, we discuss criticism of the valuation tasks and methods we have described, which are largely based on the neoclassical economics approaches of welfare economics. Some critics have focused on the unrealistic assumptions made about actors' choice processes, which can ignore well-known cognitive biases. Others have criticized valuation methods for enabling trade-offs to be made between outcomes should be seen as incommensurable, such as assigning a monetary value to human suffering.

Tools for adaptation planning and implementation

This section begins by highlighting the importance of understanding the context in which adaptation is to take place – societal priorities, economic interests, governance structures, etc. – and tailoring adaptation actions to that context. We also discuss different guiding principles that have been proposed for effective adaptation planning and implementation, such as the need to be participatory and inclusive, to recognize both local and scientific knowledge, and to encourage stakeholders to make their own choices and take the lead in adaptation.

We then present an array of resources and tools to support adaptation planning and implementation, including both generic, widely applicable materials, and tools designed specifically for local and regional-level planning, for specific sectors, and for businesses and organizations. We also briefly describe several techniques that have been successfully used in adaptation and other settings, such as participatory mapping, "mental model" approaches, and Soft Systems Technology.

Methods for monitoring and evaluating adaptation

This section begins with an overview of the different reasons for doing monitoring and evaluation (M&E), and the potential benefits of doing it well – from the learning opportunities, to the transparency and accountability that they can provide to both funders and intended beneficiaries. We note that although adaptation practitioners, funders and researchers have now been designing, analysing and testing M&E frameworks for several years, this is still a relatively new field for climate adaptation, and there are still many challenges to address, such as how to account for adaptation benefits that occur over a long time-scale.

We provide an overview of M&E methods, which range from fairly theoretical and technical frameworks, often developed in academia, to practical, step-by-step guides geared to people working on community-based adaptation and disaster risk reduction. And we identify several common traits of effective M&E systems, such as starting with a clear, agreed-upon understanding of what constitutes success, and how to measure it; tracking progress over the course of the project, rather than just looking at the end result; considering not just *what* is done or achieved, but *how* it is done – the quality of the process as well as the content; and recognizing that not everything can be measured, and thus including qualitative assessments as well as quantitative ones.

We describe three useful online resources, summarize an array of critical reviews of adaptation M&E

to date, discuss two frameworks that provide step-by-step guidance for adaptation M&E, and briefly list several other commonly used evaluation methods and tools.

Tools for learning and reflection

This section examines different perspectives on learning in adaptation, and emphasizes the importance of structuring adaptation activities in ways that promote learning and reflection. Learning to learn, we argue – from our own experiences, and from others' – is crucial to successful adaptation, and helping people become better learners and critical thinkers is an important aspect of building adaptive capacity. Doing this well requires understanding *what needs to be learned, by whom,* and *how*.

We also discuss emotional and relational aspects of learning, and how people can, with support, evolve as learners from depending on others to "hand down the truth" to becoming aware of multiple perspectives and having the confidence to form and express their own ideas. This kind of evolution is an important aspect of building adaptive capacity and encouraging autonomous adaptation; in the long run, the people exposed to climate hazards cannot depend entirely on others' help and expertise to avoid the worst impacts. Closely linked to this discussion is the concept of adaptation as social learning – learning on a larger scale than just individuals or groups, up to a societal scale, as a result of social interactions and processes. Through social learning, successful adaptation strategies and lessons from individual projects and actions become part of the collective knowledge base, building adaptive capacity across entire organizations, communities or sectors.

The section ends with a listing of several tools and resources to support learning and reflection, as well as cross-references to relevant resources discussed in previous sections of the guidance. ■

Section 4: Example cases

In this section, we provide three case studies of how the characteristics of an adaptation situation can be mapped to specific tasks to be addressed, and to specific approaches. Each case study begins with a narrative description of the situation, which describes the adapting actors, the climate hazards and the geographic location. Next, the key characteristics of the situation are analysed in order to identify critical tasks. Finally, a schematic diagram is presented which illustrates the sequence of questions to be addressed within a given case.

We describe two adaptation research cases: the first focused on dwindling water resources in the upper and middle Guadiana river basin, in Spain, and the second on drought impacts and neglected agricultural irrigation infrastructure in central Serbia. We also describe one policy case, examining the implications of climate change for ground-level ozone pollution in the UK, where ozone is already a public health concern, especially during heat waves. ■

The Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) is a global initiative which aims to provide direction and coherence at the international level for research on vulnerability, impacts and adaptation (VIA). Launched with the support of leading scientists and decision-makers, PROVIA responds to the urgent call by the scientific community for a more cohesive and coordinated approach, and the critical need to harmonize, mobilize, and communicate the growing knowledge-base on VIA. PROVIA also acts as a growing network of scientists, practitioners and decision-makers working towards identifying research gaps and meeting policy needs in climate change vulnerability, impact and adaptation research.

The PROVIA Secretariat is currently hosted by the United Nations Environment Programme in Nairobi, Kenya.

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PROVIA aims to meet a growing demand for knowledge on climate change vulnerability, impacts and adaptation by providing clear technical guidance that combines robust science with explicit consideration of user needs at the local, national and international levels, in both developed and developing countries. This document updates and improves existing guidance, discussing key issues at each stage of the adaptation cycle and covering the wide array of approaches, methods and tools available to address them. The resulting guidance should be useful to researchers, adaptation practitioners, planners and policy-makers alike.

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