

ADAPTATION METRICS

CURRENT LANDSCAPE AND EVOLVING PRACTICES

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Executive Summary

Effective adaptation assessment frameworks and metrics are essential for tracking and assessing climate change adaptation actions and progress. If used properly, adaptation metrics can enhance our understanding of what works and what does not work, why, and under which circumstances. Adaptation metrics are central to the learning process, as well as in guiding future adaptation efforts.

Although frameworks and metrics to track adaptation are still at the early stages of development and application, there is already sufficient knowledge to help guide future efforts. This paper highlights the following emerging lessons:

Start with the purpose, not the metrics. There is a tendency for the international debate to address adaptation metrics generically. However, the choice of metrics depends on the purpose and requires careful consideration of what one intends to measure or achieve, the types of decisions the metric will be used for (e.g., allocation of funding

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versus learning), its meaningfulness to its audience, and the scale at which it will be communicated.

Abandon the search for a single adaptation metric or index and focus instead on enhancing the comparability, consistency and continuity of sets of indicators that meaningfully capture adaptation. Adaptation processes are similar to and often inseparable from development and require similar approaches to selecting and using metrics. There is great potential for creating sets of adaptation metrics that allow a certain degree of comparability and standardization, thus complementing context-specific metrics.

Induce collaboration between key actors in various sectors and thematic areas to create more systematic and transparent approaches to generating and selecting effective adaptation metrics. Available adaptation assessment frameworks are not designed with inter-comparison or synthesis in mind, limiting our ability to track and assess adaptation progress across contexts and scales, including our understanding of the factors that explain differences in performance across programs, sectors, regions, and countries. This paper highlights current practices in a few

important areas: agriculture, cities, and finance and investment. These and similar collaborative efforts to establish more systematic and comparable adaptation frameworks and metrics could be advanced and incentivized further.

Explore new technologies and options to utilize existing frameworks, indicators and data sources, and develop them further. Key barriers to advancing the use of adaptation metrics include a lack of data and a lack of resources. New technologies such as data gathering through earth observation and mobile phones provide cost-effective alternatives. Mobile phones and social media also allow direct interaction with the target audience. Drawing more broadly on existing frameworks and data sources, including the indicators of the Sustainable Development Goals and their relevance for tracking adaptation, should be explored further as a means to overcome the challenges of data availability and collection.

Finally, this paper illustrates the importance of building flexibility and learning into adaptation assessment frameworks and of including quantitative as well as qualitative indicators to ensure comprehensive understanding of adaptation and to allow contributions to be assessed.

1 Introduction

Adaptation metrics are essential for tracking and assessing adaptation needs, actions, and progress. If used properly, they can enhance our understanding of what works and what does not work, why, and under what circumstances. Adaptation metrics are central to the learning process, as well as in guiding future adaptation efforts. The demand for enhanced adaptation tracking and assessment is growing steadily, in tandem with the mounting scientific and empirical evidence of the magnitude of the adaptation challenge, the growth in political attention, and the increasing volume of resources flowing into adaptation.

Given the multiple purposes, dimensions, contexts, and scales at which adaptation tracking and assessment have become relevant, it is hardly surprising that there is no 'one-size-fits-all' solution to adaptation metrics. However, there has been a tendency for the international debate to address adaptation metrics generically, without giving sufficient attention to the variety of purposes and contexts involved. Put differently, adaptation metrics are often proposed as the answer, without clarity on the question being asked.

In this paper, we aim to provide an overview of the landscape of adaptation metrics and highlight emerging cross-cutting findings from evolving practices in key areas that can help guide future efforts in respect of adaptation metrics. The paper examines two main questions from an adaptation metrics perspective: Where do we stand, and what are the promising ways forward?

Our focus is on adaptation frameworks and metrics that enable comparison and assessment across contexts and scales, as well as over time. Making progress with such frameworks and metrics is essential to enhancing adaptation tracking and assessment. This is an evolving field, one in which the literature is still scarce.

As the paper shows, most available frameworks and metrics for adaptation assessment do not permit consistent comparison and assessment. Existing frameworks are primarily designed for Monitoring and Evaluation (M&E) at the community, project, program, or sector level, rather than at national and global levels.¹ Furthermore, present frameworks primarily adopt context-specific approaches and indicators, which largely prevents comparison of different experiences across contexts. As a result, our current understanding and ability to track and assess adaptation

across contexts, as well as nationally and globally, including our understanding of the factors that explain differences across programs, sectors, regions, and countries, is partial and fragmented.²

There is still a debate about whether it is meaningful and plausible to track and assess adaptation across contexts, particularly at a global level, through 'universal' indicators (see later sections). A primary argument here is that adaptation is local and context-specific, but it is sometimes overlooked that metrics can be qualitative as well as quantitative. Our paper builds on an approach that understands adaptation (and thus adaptation metrics) as largely similar to and often inseparable from development, which is well documented in the scientific and practice literature. Drawing an analogy, no one contests the context-specificity of development, yet the usefulness of tracking development progress across contexts and scales and over time is equally universally acknowledged, as showcased by the 2030 Agenda for Sustainable Development. While some questions can only be answered in a meaningful way in certain contexts and at certain scales, others lend themselves to higher levels of aggregation. The key is to ensure consistency between the purpose of the assessment and the chosen framework and metrics, and to be aware of the limitations of aggregation.

For the purposes of this paper, the term 'adaptation metrics' covers both individual indicators and composite indicators or indices. Individual indicators essentially express just one variable, but they can build on a combination of data: for example, agricultural productivity data together with information about climate variability and extreme events. Indices combine multiple variables into a single number. Metrics can be quantitative as well as qualitative and, as the paper shows, for many types of assessments both are needed. Finally, while we mostly use the term 'adaptation metrics', there are often overlaps or links with risk, vulnerability, and resilience metrics. In simplified terms, adaptation can be seen as a process by which one seeks to minimize current and future risks, lower vulnerability, and enhance resilience (with the latter two relating to states or outcomes, rather than processes). In turn, this implies that metrics for outcomes of adaptation are often expressed in terms of changes in resilience and/or vulnerability. To the extent possible, we distinguish between these different types of metrics.

The rest of the paper is structured into three main parts. The first part (Section 2) provides an overview of the landscape of adaptation metrics and frameworks. It explores the purposes, types, and limitations of adaptation metrics before turning to findings related to frameworks for adaptation tracking and assessment that comprise sets of metrics. The second part (Sections 3 and 4) focuses on current and evolving practices and lessons in five key contexts in which adaptation tracking and assessment is attracting a great deal of attention: at the global, national, city, and sectoral levels (agriculture), and with respect to finance and investment, focusing on efforts by Multilateral Development Banks (MDBs). The third part summarizes the emerging findings and provides recommendations for enhancing our ability to track and assess adaptation through the use of metrics (Section 5).

2 The landscape of adaptation metrics and frameworks

2.1 Main purposes of adaptation metrics

Adaptation metrics are usually intended to fulfil a particular purpose. However, the international debate on adaptation metrics often discusses metrics in the abstract without defining what metrics are meant to be used for. This can cause confusion, since different purposes typically require different metrics. For example, an evaluation of the effectiveness of a specific adaptation intervention at the community level will need to choose metrics based on the characteristics of the community, the nature of the intervention, and the local factors that are driving climate and non-climatic risks. In contrast, climate funds might be interested in metrics with a wide applicability across the portfolio. Accordingly, it is essential to clarify what adaptation metrics are supposed to be used for in order to develop metrics that can best support that purpose. This is partly due to the nature of adaptation, which defies a single 'natural' all-purpose adaptation metric with universal applicability.³

The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) mentions three uses of adaptation metrics: to identify adaptation needs (usually by assessing climate vulnerability or risk), to track the implementation of adaptation, and to assess its effectiveness.⁴ Based on the Adaptation Monitoring and Evaluation

(M&E) Navigator, which has been designed to identify suitable M&E approaches for adaptation, Table 1 provides an extended list of common purposes or uses for adaptation metrics.⁵ Each purpose is classified according to its temporal and spatial dimension:

- **Temporal:** are metrics meant to estimate future conditions (ex-ante) or to measure what has already occurred (ex-post)?
- **Spatial:** do metrics refer to a particular geographical level (e.g., the local, sub-national, national, regional or global level), or are they applicable across levels?

In some cases, the same metrics can be used irrespective of the temporal or spatial dimension. For example, climate change impacts, whether observed (ex-post) or projected into the future (ex-ante), can be expressed in identical metrics: 'number of days with extreme heat', for example. Likewise, the realized and expected benefits of adaptation projects can use common metrics, for example, regarding health benefits and avoided negative economic impacts.⁶ In these cases the difference in the temporal dimension does not require different metrics, but different methods of data collection, namely observations (ex-post) or the modelling of climate impacts and expected health benefits (ex-ante).

In many cases, however, the context-specific nature of adaptation does require metrics to be tailored to the particular context. This applies, for example, to climate risk or vulnerability assessments for particular regions or communities, to the monitoring of interventions for management and learning purposes, and to evaluations of the effectiveness of specific adaptation actions. Table 1 lists a range of different applications for adaptation metrics. It emphasizes that metrics need to be 'fit for purpose' and that the search for a small set of generic, all-encompassing adaptation metrics would not be the most helpful way of promoting adaptation.⁷

2.2 Types of adaptation metrics

Adaptation metrics come in different forms and with different degrees of complexity. A common distinction is made between indicators and indices:

- **Indicators** usually consist of a single factor or variable that is meant to provide an indication about the question of interest.

TABLE 1 Purposes for the use of adaptation metrics

Purpose for the use of metrics	Temporal	Spatial	Limitations of using metrics for this purpose
Assessing climate vulnerability, adaptive capacity, risk, resilience or climate impacts	Present or ex-ante	Any level	Indicators are a common feature of these assessments (for an example, see European Environmental Agency (EEA)), ⁸ but they are limited in their ability to examine causal relationships and in-depth social dynamics, which can be better examined through participatory vulnerability assessments or resilience frameworks. ⁹ Fekete provides a review of the usefulness of metrics for social vulnerability assessments. ¹⁰
Allocation of funding	Ex-ante	National or global, but also sub-national	Metrics for the allocation of funding often refer to attempts to determine which countries are particularly vulnerable. Both Klein and Hinkel point out that vulnerability is a normative concept and that its measurement cannot be objectively solved. ¹¹ Instead there is always a political judgement involved. The results of indices also strongly depend on the chosen methodology (see 2.3.2). ¹²
Determining the potential benefits of adaptation investments	Ex-ante	Any level	Metrics can help guide the selection of adaptation interventions. To do so, methodologies on how to calculate the metrics are equally important. Care needs to be taken that indicators do not provoke unintended behaviour, e.g., to prioritize the achievement of narrow performance indicators over the achievement of the action's overarching objective. ¹³
Tracking the process of implementation of an adaptation intervention, plan or strategy	Ex-post	Any level	Indicators are generally suitable for measuring milestones and progress with implementation, provided they have been appropriately formulated. They can indicate deviations from targets, but do not explain what went wrong. To compensate for this, indicators might be complemented by qualitative or participatory methods. ¹⁴
Assessing the effectiveness of an adaptation intervention, plan or strategy	Ex-post	Any level	The validity of indicators, i.e., their ability to measure what they are supposed to measure, determines their usefulness for assessing effectiveness. Even if validity is high, indicators on their own do not explain how or why changes took place, what worked and what did not. This often requires complementary qualitative inquiry.
Assessing the effectiveness of a portfolio of adaptation interventions	Ex-post	National, global or sub-national	To maintain the applicability of indicators across a very diverse portfolio of adaptation projects, organizations often end up with simple counting indicators at the output level (compare Table 3). While such indicators can be useful for communication purposes, "if confined to adding up simple, quantitative numbers, aggregation cannot account for important insights about progress being made." ¹⁵
Assessing adaptation progress in a certain sector, theme or geographical area	Ex-post	Sub-national or higher	On their own, metrics cannot provide causal explanations about progress. In other words, they indicate whether change has taken place, but they don't provide information as to how or why the change took place. Also, they might fail to account for the complexities and dynamics that influence adaptation progress.

Source: Purposes adapted from Leiter (2017a).

- **Indices** are made up of multiple indicators and combine them into a single number.

Table 2 gives examples of adaptation indicators and indices. This raises the question of what distinguishes an adaptation indicator from any other indicator. In principle, any indicator that can plausibly be argued to capture aspects of adaptation could be an adaptation indicator. This implies that adaptation indicators do not necessarily need to be created from scratch, but their adaptation relevance needs to be made explicit. That is, it needs to be explained to what extent the indicator is indicating something directly about reductions to climate risks. This is important because the same indicator could be considered an adaptation indicator in one context, but not in another. For example, an indicator of water savings in an area where water availability is impacted by climate change could be an adaptation indicator, while applying the same indicator in another region lacking noticeable impacts of climate change on water resources would not be an adaptation indicator, but merely an indicator of resource efficiency. This means that, without knowing the context in which an indicator is being applied, it is not always possible to judge whether it is an adaptation indicator or not. Indicators from first-generation national adaptation M&E systems like “number of people with diversified income” or “increase in agricultural productivity through irrigation” also illustrate this point (for a list of further indicators, including their adaptation relevance and application context, see Hammill et al.).¹⁶

The IPCC defines adaptation as an adjustment, that is, as a process of change.¹⁷ Indicators are commonly classified according to the stage in the change process that they refer to, in other words, whether they indicate the *potential* for adaptation (process or output indicators) or the *realization* of adaptation (outcome indicators). These categories (input, output, outcome, impact) follow the standard terminology used in development cooperation.¹⁸ They point out that an ‘adaptation indicator’ might not actually measure adaptation as such, but just steps on the way towards adaptation, like improvements in adaptive capacity. Furthermore, climate risk or vulnerability assessments often have to use indirect measures (so called ‘proxy measures’) if the subject of interest cannot be directly observed. For instance, ‘percentage of households with internet access’ might be one of several proxy indicators that are assumed to represent adaptive capacity, but on its

own it would rarely be considered an adaptation indicator. Hence, it is not always clear cut whether an indicator is an adaptation indicator or not. Adaptation metrics should therefore be scrutinized for their ability to actually measure adaptation to climate change.

Resilience indicators are similarly diffuse, possibly even more so than adaptation indicators, since resilience can apply to a large variety of different shocks; for example, non-climate related natural disasters, economic downturns, or conflicts. In their review of resilience measurement frameworks, aptly titled “Resilience and indicators: two contested ideas combined”, Schipper & Langston write:

“What counts as an indicator of resilience has been defined and redefined in semi-chaotic fashion according to different interpretations of what the concept means, as well as how best to go about measuring it. Due to the need to be context-specific to be accurate and also rely on available data, universal indicators cannot exist (...)”.¹⁹

Compared to resilience, adaptation to climate change has not seen a similar level of contestation concerning its scope, but the nature of adaptation has likewise been found to impede universal indicators.²⁰ The concepts of adaptation and resilience partly overlap, and their exact relationship is understood differently by different disciplines and organizations (see Bahadur et al.; Nelson et al.).²¹ Accordingly, whether an adaptation indicator could also be a resilience indicator and vice versa depends on the definitions of the terms and their relationship to one another. It is also not uncommon for the terms to be simply used as synonyms, so what some sources may refer to as ‘adaptation metrics’ might be what others call ‘resilience metrics’.

The term ‘metric’ is commonly associated with quantitative data, but indicators can also be based on qualitative data. For example, IIED’s Tracking Adaptation and Measuring Development (TAMD) approach proposes the use of expert judgement and scorecards to assess, for instance, the level of integration of adaptation into planning. The scorecard first defines different levels of integration before participatory workshops determine the current level which a country, organization or community is at.²² Qualitative information can also complement quantitative indicators, this being an important way of compensating for some of the limitations

TABLE 2 Types and examples of adaptation metrics

Type of adaptation metric	Description	Examples of applications
Indicators of climate exposure, vulnerability, risk or resilience	Indicators representing factors that determine climate exposure, vulnerability, resilience, adaptive capacity or risk.	Indicators vary widely depending on the exact focus, the circumstances and the assessment methodology (on methodologies, see PROVIA; Deutsche Gesellschaft für Internationale Zusammenarbeit GIZ and EURAC. ²³ Countless assessments of climate exposure, vulnerability, risk and resilience have been undertaken, most of which make use of indicators. Vulnerability indicators used by projects financed by the Inter-American Development Bank are reviewed in Ludena et al. ²⁴ Examples of national-level vulnerability and risk indicators can be found in climate change impact, vulnerability and risk assessments by the EEA, the UK Committee on Climate Change's Climate Change Risk Assessment Evidence Report, and Brooks et al., ²⁵ as well as in National Communications submitted to the United Nations Framework Convention on Climate Change (UNFCCC). Resilience indicators, which can be overlapping or identical with vulnerability or adaptive capacity indicators, are discussed in Birkmann et al. ²⁶
Context-specific indicators of adaptation interventions	Indicators used for M&E purposes, i.e., to assess whether interventions are being implemented and have achieved their intended objectives.	Context-specific adaptation indicators may refer to any geographical area or sector. Examples can be found in project documents on the websites of international and national implementing agencies, NGOs, and climate funds. A review of the indicators used in UK-funded adaptation projects is available in Brooks et al., ²⁷ while examples from other development cooperation organisations can be found in Lamhauge et al. and in Leiter. ²⁸
Standard adaptation indicators of portfolios	Standard indicators used to measure performance across adaptation interventions for aggregation purposes.	Most global and national climate funds have indicators that are applied across the portfolio. They are linked to the objectives and results frameworks of the funds. Examples are provided in Table 3.
Comparative global indices	These indices use multiple variables to calculate an index value which is typically used to rank countries (see 2.3.2).	Numerous global vulnerability and risk indices exist (see reviews by Füssel and Leiter et al.). ²⁹ Brooks et al., for example, find 11 indicators to be strongly linked to mortality associated with climate-related disasters, and have used them to create an index to rank countries' vulnerability. ³⁰

Source: Produced by authors

of indicators. A common misconception is that quantitative data is objective and qualitative data is subjective. In fact, qualitative data, like a person's feelings can easily be transformed into quantitative data by asking people to answer on a scale from 1-10 (with, e.g., 1 representing a depressed mood and 10 happiness). In this example, the quantitative data is based entirely on subjective feelings.

Regardless of whether data is recorded in a quantitative or qualitative way, subjective sources can add further insights, for example, when people are being asked about their perceived levels of resilience. People's views and perceptions can provide more immediate and valid accounts than are possible to obtain through generic proxy indicators like level of education or income.³¹ While it has traditionally

TABLE 3 Adaptation portfolio indicators currently used by international climate funds (selection)

Indicator	Results category
Adaptation Fund	
Number of beneficiaries (direct and indirect)	Output
Number of people trained in climate resilience measures	Output
Early warning systems: number of systems supported and type of support, geographical coverage, and number of municipalities included	Output or use of output (if operational)
Assets Produced, Developed, Improved, or Strengthened: absolute number and, where applicable, degree of improvement on a 1–5 scale	Output
Meters of coastline protected	Outcome
Hectares of natural habitat restored/preserved	Outcome
Increased income, or avoided decrease in income	Outcome
International Climate Initiative (German Federal Ministry of the Environment (BMU))	
Number of people directly supported by the project to adapt to climate change (disaggregated by gender)	Output
Number of new or improved policy frameworks developed to address climate change	Output
Number of new or improved institutionalized structures or processes to address climate change	Output
Number of new or improved methodological tools developed to address climate change and conserve biodiversity	Output
Area of ecosystems improved or protected (if adaptation-related)	Outcome
Pilot Program for Climate Resilience (PPCR) (part of the Climate Investment Funds)	
Number of people supported	Output
Number of households, communities, public entities, and businesses using PPCR-supported tools	Use of outputs
Number of development plans or strategies to have integrated climate change (disaggregated by local, sectoral, and national levels)	Output
Number of knowledge products, systems, and studies supported	Output
Number of government officials having received climate resilience training	Output
UK International Climate Fund: key performance indicators (adaptation-related)	
Number of people supported to cope with climate change	Output ⁱ
Public/private finance mobilized for climate change purposes	Input

Sources: Adaptation Fund. (2014); Adaptation Fund. (2019). *Adaptation Fund Results Infographic*; Climate Investment Funds. (2019). Roehrer, C., & Kouadio, K. E. (2015). *Monitoring, Reporting, and Evidence-Based Learning in the Climate Investment Funds' Pilot Program for Climate Resilience: Monitoring, Reporting and Evidence-based Learning*. *New Directions for Evaluation*, 2015(147), 129–145; Programme Office of the International Climate Initiative. (2016). *Guidelines on results-based project planning and monitoring in the International Climate Initiative (IKI), as of December*; and UK International Climate Fund (2018).

been expensive to conduct surveys with large numbers of people, mobile phone-based surveys enable large sample sizes at relatively low cost.³² Overall, adaptation indicators might draw upon a combination of quantitative and qualitative as well as social and environmental data to understand and express progress with adaptation better.

2.3 Limitations of adaptation metrics

2.3.1 LIMITATIONS OF ADAPTATION INDICATORS

This section outlines the main limitations of adaptation indicators as ways of measuring progress, while the following section focusses on indices. It is not meant to discour-

ⁱ The outcome equivalent would be: 'People demonstrated that they are better able to cope with climate change as a results of adaptation support'.

age their use, but to invite reflection on how they can be used most effectively and whether what they are expected to do matches their ability to measure change.

Indicators and indices, collectively referred to as metrics,ⁱⁱ are meant to provide an indication, usually in a quantitative form, about a question of interest. They essentially define what is being measured, and hence their formulation is as important as that of the targets or objectives whose state they are supposed to capture. Indicators have become so commonplace that their utility seems to be taken for granted, while their limitations often go unnoticed or are ignored. For example, Hinkel examined six types of problems that vulnerability indicators were meant to address but found that in five of them either vulnerability was not the appropriate concept or that indicators were not the appropriate methodology.³³ Even if indicators provide an accurate reflection of their subject, they do not explain why and how changes in the indicator value took place. However, such information is essential in order to facilitate learning and understanding, which in turn lie at the heart of evidence-based decision-making. Hence, indicators on their own are not always sufficient, for example, when information on cause-and-effect is required. Critical reflection is therefore needed regarding what indicators can do and where alternative or complementary ways of assessment might be required.

Indicators define what is being measured, and conversely also what is being left out. In a review of resilience measurement frameworks, Levine remarked critically “that the arguments for indicators are implicitly imposing a very particular understanding of what resilience entails”, with the result that, “when we try to measure what is important, we make important what it is that we measure”.³⁴ This way, indicators can be harmful if they create the wrong incentives, for example, designing a project in such a way that an indicator value is maximized rather than actually performing well.³⁵ Moreover, logical models like theories of change, which present the theoretical framework to which indicators are connected, can be socially exclusionary, meaning that beneficiaries might not have a say about how success is being measured.³⁶ These studies stress that formulating resilience or adaptation indicators is not a mere technical problem, it is also shaped by different framings, social

norms, and power constellations that determine what is to be measured and who is allowed to define it.

A feature commonly ascribed to indicators is that they simplify complexity. This can be useful in communicating with target groups that might not need further details, but it does not resolve the complexity itself. Hence, metrics cannot simply overcome the trade-off between simplification and meaningful information. In fact, another review of resilience measurement frameworks, this time by Lavelle et al., found “considerable difficulty in balancing simplicity and accuracy”.³⁷ The type of information that indicators generate is suitable for some decision-making purposes, but not sufficient for those that require a more nuanced understanding of the mechanisms of change and the social dynamics. The limitations involved in employing metrics for the different purposes introduced in section 2.1 are outlined in the last column of Table 1.

The international discussion on adaptation metrics often neglects the fact that indicators do not just consist of a title, they also require details of calculation and data sources. For example, it would probably be easy to agree on the adaptation indicator “avoided economic damage from climate change”, but this indicator can be calculated in many different ways producing very different figures. Hence, even if a seemingly identical indicator is being used, its values are not necessarily comparable unless the underlying methodologies are identical or at least comparable and the respective data sources are of similar quality. Even indicators which seem straightforward to measure, like ‘number of beneficiaries’, can lead to unreliable results if there is no guidance on whom to consider as a beneficiary.³⁸ Therefore, adaptation indicators should be accompanied by details about their operationalization, including their rationale, guidance on interpretation, calculation, and data sources. This could take the form of indicator factsheets as used by the Adaptation Fund, the UK’s International Climate Fund,ⁱⁱⁱ or Germany’s national adaptation monitoring system.³⁹ Hence, to ensure a reliable use of adaptation metrics, it is not just the title of the metric that matters, but also an agreement on its calculation and data sources. This important aspect seems to be partly absent from the international debate on adaptation metrics.

ii The terms metric, indicator, and index are not applied consistently in the literature and in practice often appear as synonyms. In this background paper, “metric” is used as umbrella term covering both indicators and indices.

iii The UK ICF indicator factsheets are available at <https://www.gov.uk/government/publications/2017-uk-climate-finance-results>

2.3.2 Limitations of adaptation indices

Indices, also called composite indicators, combine multiple factors or variables into a single number. Their rationale is that multidimensional concepts like sustainability or globalization cannot be captured by an individual indicator.⁴⁰ Index scores are often used to visualize differences on maps (e.g., vulnerability maps) or to compare countries, communities or entities. In adaptation literature and practice, indices are often employed as part of vulnerability or risk assessments.

The design of indices requires multiple normative choices, ranging from composition and weighting to the method of calculation and data needs. The design choices and their challenges are described in Table 4. Each of the choices influences the results of the index, so even indices that claim to be measuring the same subject can lead to very different results. This is shown in Table 5, which compares the country rankings of four global climate risk and vulnerability indices for 2015. The top 20 list of countries shows marked variations across the four indices, with no country appearing on more than two lists, and each index putting another country at the top. This comparison demonstrates a core limitation of indices: their results are very sensitive

to the chosen methodology, and it is in principle possible to tamper with the design to favour certain outcomes. Furthermore, when comparing rankings year by year, it is not apparent what has caused any changes in the ranking. This illustrates another limitation of indices, namely that the aggregated index score hides the underlying factors which caused the change. Paradoxically, indices are regularly hailed as enabling easier interpretation of complex phenomena, although they actually disguise the information required to interpret the changes adequately. Accordingly, studies have shown that practitioners find it more useful to examine the sub-components of an index rather than its aggregate score.⁴¹

The shortcomings of indices are well-documented in the literature on adaptation, international development, sustainability, and in the many other disciplines where indices have been proposed (see, for example, Morse, Brooks et al., Böhringer and Jochem, Füssel, Gutiérrez et al., Michener, and Leiter et al.).⁴² Despite that, attempts are made regularly to develop indices to inform decision-making. For example, the European Commission's Joint Research Centre developed a vulnerability index to inform funding decisions under the Global Climate Change Alliance Plus

TABLE 4 Index design choices and challenges

Index design choices	Challenges
Conceptualization	The subject of the index needs to be conceptualized, i.e., defined in terms of what it consists of and how its components relate to each other. Vulnerability and resilience can be operationalized in numerous ways. For instance, the IPCC changed its conceptualization of climate vulnerability in favour of a climate risk approach in its Fifth Assessment Report. ⁴³
Composition	Once a conceptualization has been agreed upon, the next step is to define how to measure it. Indicators are one possibility, but they need to be valid representatives of the conceptualization.
Weighting	A decision needs to be taken regarding how to weight the different components and its indicators. Should they all be given equal weight, or should some carry more weight than others?
Normalization	The chosen indicators might have very different measurement scales, for example, head counts, degrees Celsius, or calories. To combine them into a single number, each scale needs to be transformed into a comparable scale.
Aggregation	Aggregation describes how, once translated into a comparable scale, the various indicator values are merged into a single number.
Compensation	If some indicators in the index perform very well, they can push up the index value, despite the possibility of other crucial indicators performing at lower levels. In this way, rising numbers of, for instance, enrolment in primary schools could 'compensate' for a decline in maternal health. The index design needs to consider such effects and possible ways to counter them.
Data requirements	The choice of indicators implies certain data needs. In practice, limited data availability can restrict the choice of indicators.

Source: Produced by the authors

TABLE 5 Comparison of the top 20 countries on four vulnerability and risk indices for 2015

	ND-GAIN Country index	Global Climate Risk Index	INFORM – Index for Risk Management	World Risk Index
1	Central African Republic	Mozambique	Somalia	Vanuatu
2	Chad	Dominica	Central African Republic	Tonga
3	Eritrea	Malawi	Afghanistan	Philippines
4	Burundi	India	South Sudan	Guatemala
5	Sudan	Vanuatu	Sudan	Solomon Islands
6	Yemen	Myanmar	Yemen	Bangladesh
7	Afghanistan	Bahamas	Iraq	Costa Rica
8	DR Congo	Ghana	DR Congo	Cambodia
9	Papua New Guinea	Madagascar	Chad	Papua New Guinea
10	Mauritania	Chile	Myanmar	El Salvador
11	Uganda	Pakistan	Mali	Timor-Leste
12	Haiti	Micronesia	Syria	Brunei Darussalam
13	Guinea-Bissau	Philippines	Nigeria	Mauritius
14	Niger	Zimbabwe	Uganda	Nicaragua
15	Congo	Burundi	Ethiopia	Guinea-Bissau
16	Liberia	France	Pakistan	Fiji
17	Madagascar	Oman	Kenya	Japan
18	Angola	FYR Macedonia	Haiti	Vietnam
19	Zimbabwe	Italy	Bangladesh	Gambia
20	Lesotho	Australia	Niger	Jamaica
Total	181	134	191	171

Source: Leiter et al. (2017)

Note: The final row lists the number of countries included by the respective index. Countries in **bold** appear twice among the top 20, countries in **bold** and italics appear twice even among the top 10.

Initiative.⁴⁴ However, funding decisions have never been based primarily on this vulnerability index, because it does not take into account political relations between the European Union and the respective country. In addition, country-level vulnerability, however measured, does not say anything about the quality of project proposals. This example illustrates the gap between what indices are often expected to do, namely to provide seemingly objective solutions to complex decision-making problems, and what they can actually do well, namely to raise awareness and stimulate public debate. For instance, despite consisting of just three indicators that can hardly capture the full range of human development, the Human Development Index has become widely known and has successfully drawn attention to dimensions of development beyond Gross Domestic

Product.⁴⁵ Accordingly, the Organisation for Economic Co-operation and Development (OECD) states that indices “must be seen as a means of initiating discussion and stimulating public interest”,⁴⁶ while their usefulness for other purposes remains contentious.

2.4 Adaptation frameworks comprising sets of indicators

The previous sections have shown that the problem is not to identify adaptation metrics *per se* – as we will see in the subsequent sections, there is already an abundance of indicators – but rather to clarify and agree on the purpose, which has implications for the approach and selection of the most appropriate indicators. In this section, we focus

TABLE 6 Examples of challenges of the M&E of adaptation and of possible strategies to address them

Challenge	Examples of possible strategies
Adaptation is not an end point, but a process, making it harder to measure	<ul style="list-style-type: none"> • Pay close attention to what indicators measure vis-à-vis what adaptation is about • Ensure the M&E approach assesses the overall strategy • Ensure that M&E considerations are integrated from the start, and that they are resourced appropriately
Significant time lags can exist between interventions and measurable benefits	<ul style="list-style-type: none"> • View adaptation as an iterative, formative process, and use M&E to check progress against changing conditions • Use process indicators to determine whether implementation is on track • Consider flexibility as a measure of success
Uncertainties are inherent	<ul style="list-style-type: none"> • Establish counterfactuals to determine changes • Ensure the evaluation process examines the assumptions that underpin a program, as well as any emerging conditions that may call for adjustments • Use flexibility as an important measure of the success of the intervention
Measuring avoided impacts is difficult	<ul style="list-style-type: none"> • Consider whether it is appropriate to establish a counterfactual, or whether it is better to consider the intervention as one of many 'adaptation pathways' and assess progress along it • Reflect on the objectives of the intervention; maintaining the status quo may itself be the goal
Diversity of key concepts and definitions	<ul style="list-style-type: none"> • Define concepts clearly at the outset and use them consistently and correctly to avoid confusion about what exactly is being measured or assessed
Tracking a 'moving target' complicates baselines	<ul style="list-style-type: none"> • The program and its underlying assumptions – not just its metrics – will need flexibility if it is to adapt to an evolving climatic context • Be clear about the purpose of the evaluation at the outset
Adaptation spans multiple scales and sectors. While often a local process, progress towards it is often examined at higher levels and across portfolios	<ul style="list-style-type: none"> • The diversity and complexity of adaptation presents challenges for standardization • Quantifiable indicators alone cannot be expected to provide a nuanced picture of adaptation progress • Be specific about adaptation: by whom and for whom?
Assessing attribution versus contribution	<ul style="list-style-type: none"> • Ensure an evaluation framework that illustrates contributory factors and the relationships between them. Such an approach also facilitates evaluations that document lessons learned.
No one set of indicators or M&E approaches	<ul style="list-style-type: none"> • Consider the inclusion of proxy indicators, as 'vulnerability' and 'resilience' are not easily measured • Strategies must be nested in the specifics at hand, as well as being grounded in socio-economic, governance, and natural environment contexts • Global metrics can be useful for comparative purposes, but cannot replace or substitute for those that are tailored to specific M&E frameworks at other scales
Causing harm: 'maladaptation' – when interventions have unintended negative consequences	<ul style="list-style-type: none"> • The risk of maladaptation can be reduced by using M&E for learning, reflection, and course corrections • Engage a wide range of stakeholders in the M&E process

Source: Based on Bours, McGinn and Pringle (2014b)

on methodological and empirical issues related to establishing adaptation frameworks that use sets of adaptation metrics. Studies show that for this purpose information – quantitative as well as qualitative – needs to be collected at regular intervals in a systematic, comprehensive, comparable, and consistent manner.⁴⁷

2.4.1 EXPERIENCE AND LESSONS LEARNT

Much of our current understanding comes from experience with the M&E of adaptation at the community, project, program, or sector levels, as well as with emerging experiences of M&E systems at the national level (see section 3.2). Numerous overviews, comparisons, and reviews of M&E frameworks have been conducted.⁴⁸ They provide a good understanding of the inherent challenges of the M&E of adaptation and highlight possible strategies to address them; see Bours et al., for example.⁴⁹ These challenges and response strategies are commonly found across the M&E literature and are summarized in Table 6.

Table 6 reiterates the importance of establishing conceptual clarity and transparency up front about the purpose of conducting M&E, as well as clarity and consistency regarding definitions and use of key concepts. It also highlights the desirability of building flexibility and learning into the frameworks (see also the advisory document provided by the Scientific and Technical Advisory Panel of the Global Environment Facility).⁵⁰ Finally, Table 6 underscores some of the specific challenges, including the context-specific nature of adaptation, problems with standardization, and the lack of universal indicators. These are all confronting efforts to establish frameworks to capture adaptation actions and assess progress across scales (involving aggregation from, for example, the local to national or national to global levels), as well as across individual frameworks and issues (involving, for example, assessments at the sectoral level across countries).

At the national or global level, assessments require frameworks and metrics that are applicable across sectors (or issues), across scales, and over time. Aiming to distil lessons for the ways forward for establishing global adaptation frameworks,^{iv} the 2017 edition of UN Environment's (UNEP) Adaptation Gap Report provided a detailed assessment of 216 existing adaptation frameworks and tools cov-

ered in reviews by the Adaptation Committee, UKCIP, OECD, and GIZ.⁵¹ The report found most available frameworks to be designed “explicitly and exclusively for M&E at the community, project, program, or sector level, not the national to global level”, with approaches being tailored to each unique context. Similarly, national-level adaptation M&E systems are based on national contexts and indicators and are not designed with international syntheses in mind (see 3.2).

The Adaptation Gap Report 2017 also highlighted the fact that the available frameworks designed for aggregation, such as the Adaptation Fund's Strategic Results Framework, the UNDP's Climate Change Adaptation M&E framework, and the Global Environment Facility's Adaptation Monitoring and Assessment Tool, are rarely suitable for the national and global scales. These frameworks use standard indicators for outputs and outcomes that are designed to document tangible results using comparable data and aggregation across projects at the programmatic level (see Table 3). They often use proxy indicators for adaptation outcomes that may be plausible and measurable at the project level but are unsuited to scaling up to the national level.

2.4.2 POSSIBLE WAYS FORWARD

So what are the possible ways forward in generating frameworks for assessing and tracking adaptation at the global level? The UN Environment Adaptation Gap Report put forward six desirable criteria for a global framework, listed in Table 7.⁵² While the report focused on the synthesis and aggregation of data from the national level to the global level, the criteria are also relevant for other types of aggregation and cross-context assessments.

The criteria of aggregation, transparency, coherence, and sensitivity to specific contexts all relate to the question of addressing the challenges commonly identified through M&E experience at other scales (Table 6). Two additional aspects are highlighted in Table 7: feasibility and longitudinal aspects. The generation and compilation of high-quality data collected at regular intervals requires considerable efforts and resources, especially for comprehensive assessments of adaptation progress at the sectoral, national, and global scales. Yet if substantial progress on adaptation assessment is to be made, it is essential that such data becomes available; to which new technologies, big data, and social media provide promising opportunities to do this (see section 5). Existing studies demonstrate a

iv The focus of the UN Environment Adaptation Gap Report (UNEP, 2017) is on frameworks for global assessments of adaptation. However, the term 'global' should be understood as generically applicable as well as in terms of aggregation to the global level.

TABLE 7 Desirable criteria for a global framework for assessing progress on adaptation

Criteria	Description
Aggregable	Does the measure reflect a consistent definition of adaptation that is comparable at the national level, and is available for a comprehensive number of countries globally, such that data could be systematically aggregated (qualitatively or quantitatively)?
Transparent	Are definitions, assumptions, and methods transparent and consistent between countries?
Longitudinal	Can the measure be tracked over time to monitor and evaluate progress?
Feasible	For global synthesis/aggregation of national assessments submitted to UNFCCC: does the measure avoid placing undue additional reporting burden on countries? For global tracking of adaptation using publically available data: is the measure reasonably available or can it be collected for all countries?
Coherent	Does the measure reflect a concept of construct that is coherent with a general understanding of what constitutes meaningful adaptation? Are assumptions underpinning the use of proxies empirically validated or theoretically sound?
Sensitive to national context	Is the measure sensitive to diverse national contexts (for example, different political, economic, and socio-cultural priorities and resources)? Does the measure avoid unjustified, poorly evidenced or generalized assumptions – implicit or explicit – regarding what is ‘good’, ‘appropriate’, or ‘sufficient’ adaptation?

Source: Based on UNEP (2017)

significant trade-off between the depth of information that the adaptation assessment can deliver and the amount of resources required.⁵³

To sum up, given the increasing attention towards the need for providing assessments that can help guide adaptation efforts across issues and scales, as well as over time, new frameworks need to be developed that are designed for this purpose. In doing so, it will be important to be mindful of the limitations in terms of the purposes or the types of questions that can be meaningfully explored at various scales (see Table 1). Typically, there is a trade-off between the level of aggregation and the context-sensitivity of adaptation metrics. This implies that, while global assessments can be suitable for tracking the implementation of adaptation processes, as well as adaptation progress overall, they cannot provide causal information that explains trends and differences between countries and over time.

3 Current and evolving practices: adaptation metrics at the global and national scales

Global and national frameworks for tracking and measuring progress on adaptation are receiving increasing attention, and the call for systematic, coherent, consistent, and comparable insights and metrics to guide adaptation at the national and global scales is growing.⁵⁴ This section provides an overview of current and evolving practices and highlights some of the potential ways forward.

3.1 Adaptation metrics in global agreements and frameworks

Three major global agreements and frameworks, all agreed in 2015, are central to current efforts and ways forward for tracking and assessing adaptation progress at a global level, including through metrics:

1. **The Paris Agreement under the UNFCCC.** The Paris Agreement has been pivotal in cementing the burgeoning push for a global recognition of adaptation. The Agreement establishes a global goal on adaptation consisting of “enhancing adaptive capacity, strength-

ening resilience and reducing vulnerability to climate change”.⁵⁵ Furthermore, it sets up a five-year cycle of global stocktakes, which includes an assessment of the collective progress towards the global goal on adaptation.

2. **The 2030 Agenda for Sustainable Development** (hereafter referred to as the SDGs). The SDGs is a transformative plan of action for the period 2016–2030 to achieve global sustainability which is comprised of 17 Sustainable Development Goals (SDGs), 169 targets, and 232 indicators, many of which are directly or indirectly linked to adaptation, resilience and vulnerability.⁵⁶ One of the goals, SDG 13, specifically targets urgent action to combat climate change and its impacts.
3. **The Sendai Framework for Disaster Risk Reduction 2015–2030** (hereafter referred to as the Sendai Framework). The Sendai Framework is a voluntary, non-binding agreement aimed at “the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of person, businesses, communities and countries”.⁵⁷ It includes seven global targets with 38 associated indicators and sets out four priority areas for action: 1) understanding disaster risk; 2) strengthening disaster risk governance to manage disaster risk; 3) investing in disaster risk reduction for resilience; and 4) enhancing disaster preparedness as an effective response to “build back better” in recovery, rehabilitation and reconstruction.

The three frameworks are related through climate change, with adaptation being one of the primary foci of the Paris Agreement, Goal 13 of the SDGs focuses on climate action, while the Sendai Framework concerns disaster risk reduction, including climate-related disasters. Table 8 illustrates the differences and similarities between the three agreements in terms of their objectives, purposes, targets, metrics, and processes.

As Table 8 shows, the SDGs and the Sendai Framework have global targets, quantitative indicators, and monitoring systems, in contrast to the Paris Agreement. Referring to the desirable criteria of a global framework for assessing progress on adaptation introduced in Table 7, it is possible to examine these criteria in the context of the focus areas of the SDGs and the Sendai Framework, rather than in the context of adaptation. The SDGs and the Sendai

Framework are explicitly designed to allow for **aggregation**, reflecting consistent definitions that are comparable at a national level and available for a comprehensive number of countries globally. Their definitions, assumptions, and methods are **transparent** and consistent between countries, and they are **longitudinal**. While not all of the required data is available for all countries as of yet, measures are being put in place to ensure their **feasibility**. They are also widely accepted as **coherent**, with a general understanding of what constitutes meaningful sustainable development and disaster risk reduction respectively. Both the SDGs and the Sendai Framework avoid normative indicators; they are based on joint principles for data collection, and data can be considered at a national level to allow understanding of the specific **national context**. For example, the Sendai Framework includes minimum standards and meta-data for reporting, and a technical report with methods for measuring each target and indicator has been made available.⁵⁸ The SDGs include two targets specifically targeting enhanced capacity-building support to developing countries 'to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts' (target 17.18), and to support statistical capacity-building in developing countries (target 17.19).

The Paris Agreement's global stocktake is substantially different from the two other frameworks. It is important to recognize that the global stocktake was not created in order to design a comprehensive global framework for assessing progress on adaptation. However, the objective and purposes of the Paris Agreement and the global stocktakes are intrinsically linked to assessments of global progress, and it is therefore relevant to consider the extent to which the stocktakes are likely to be aligned with the desirable criteria for global assessments. During the 24th Conference of the Parties to the UNFCCC in December 2018, countries adopted the Katowice Climate Package,^v which sets out essential procedures and mechanisms to make the Paris Agreement operational. Communications that document progress in national adaptation will form an important source of information for the adaptation elements of the global stocktake. While the Katowice Climate Package comprises a list of elements that an adaptation communication should contain, as well as topics for

v Available at: <https://unfccc.int/process-and-meetings/the-paris-agreement/katowice-climate-package>

TABLE 8
Overview of objectives, purposes, metrics, and processes of the SDGs, the Sendai Framework, and the Paris Agreement

	Sustainable Development Goals	Sendai Framework	Paris Agreement (adaptation-specific elements only)
Objective of the agreement	<ul style="list-style-type: none"> To achieve sustainable development, and serve as a driver for implementation and mainstreaming. 	<ul style="list-style-type: none"> A substantial reduction of disaster risk and losses in lives, livelihoods, and health and in economic, physical, social, cultural, and environmental assets. 	<ul style="list-style-type: none"> Enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal (art. 7).
Purpose of tracking progress	<ul style="list-style-type: none"> Measure global progress towards the achievement of the SDG goals and targets. 	<ul style="list-style-type: none"> Measure global progress in implementing the seven Sendai targets. 	<ul style="list-style-type: none"> “Assess the collective progress towards achieving the purpose of this Agreement” (Art. 14). “Recognize adaptation efforts of developing country Parties”; “Enhance the implementation of adaptation action”; “Review the adequacy and effectiveness of adaptation and support provided for adaptation”; “Review the overall progress made in achieving the global goal on adaptation” (Art.7). “Clarity and tracking of progress towards achieving Parties’ individual Nationally Determined Contributions (NDCs) and Parties’ adaptation actions” (Art. 13).
Quantitative goals, targets, and indicators at the global level	<ul style="list-style-type: none"> Yes, 17 goals, 169 targets, and 232 indicators. Countries may define additional national targets. Progress is benchmarked towards articulated targets within each goal. 	<ul style="list-style-type: none"> Yes, 7 targets and 38 indicators. Countries may define additional national targets and indicators. Targets are outcome-based. 	<ul style="list-style-type: none"> No, the global goal on adaptation is qualitative, and no global targets and indicators are defined. Countries may define their own national goals, targets, and indicators.
Development process	<ul style="list-style-type: none"> By an ‘Inter-Agency and Expert Group on Sustainable Development Goal Indicators’, adopted by the United Nations (UN) General Assembly. 	<ul style="list-style-type: none"> By an ‘open-ended intergovernmental expert working group’ comprising experts nominated by states and supported by the United Nations International Strategy for Disaster Reduction (UNISDR); adopted by the UN General Assembly. 	<ul style="list-style-type: none"> By the UNFCCC and adopted at the COPs. National reporting formats are flexible under the Adaptation Communications (Art. 7) and the Transparency framework (Art. 13, ‘Modalities, procedures and guidelines’), and feed into the Global Stocktake (Art. 14).

Source: Based on Leiter and Olivier (2017), updated and expanded on by authors.

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.

2.3.1 Volume of production per labor unit by classes of farming/pastoral/forestry enterprise size.

2.3.2 Average income of small-scale food producers, by sex and indigenous status.

2.4.1 Proportion of agricultural area under productive and sustainable agriculture.

2.5.1 Number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities.

2.5.2 Proportion of local breeds classified as being at risk, not at risk or at unknown level of risk of extinction.

2.a.1 The agriculture orientation index for government expenditures.

2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector.

Source: Based on United Nations (2015)

adaptation as part of the Biennial Transparency Reports, it leaves the specific content and format flexible and up to each country.⁵⁹

As it stands, this implies that the global stocktake on adaptation under the Paris Agreement would face significant challenges if it were to comply with the desirable criteria for a global framework for assessing progress on adaptation, as identified in the Adaptation GAP Report.⁶⁰ This is with the exception of the last criterion, namely national sensitivity, and possibly the feasibility criterion (avoiding an undue burden on countries). Currently no transparent, consistent, comprehensive, coherent, or comparable definitions,

assumptions, methods or metrics (qualitative or quantitative) have been established, and while the global stocktakes will take place at five-year intervals, it is not clear that the reporting will be longitudinal at the country level (countries may choose to include different content and information under the various stocktakes). However, information at the country level provided under the transparency framework or as an Adaptation Communication will form the basis of a synthesis report on the state of adaptation efforts, experience, and priorities that the UNFCCC Secretariat has been requested to prepare for the global stocktake.

A possible way forward could be to explore how global and national monitoring efforts under the overarching SDG framework could be expanded to provide meaningful coverage of adaptation across all relevant SDGs and associated targets. The SDGs, while not specific to climate change adaptation overall, already include a number of goals and targets that specifically relate to adaptation, while several of the Sendai Framework targets are already reflected in the SDGs on 'no poverty', 'sustainable cities and communities', and 'climate action' (see Table 9). Table 9 provides an overview of the seven SDG targets that specifically mention climate change adaptation or resilience and their associated indicators. However, as discussed in section 2.2, what distinguishes an adaptation indicator from any other indicator is that its adaptation relevance can be made explicit. If long-term adaptation relevance and dependence are considered, a majority of the SDGs and associated targets are relevant to take into account in relation to potential adaptation indicators. One example is SDG 2, focused on ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture. As Table 9 shows, one target under goal 2 specifically refers to adaptation and resilience. However, as illustrated in Box 1, three additional targets and associated indicators under SDG 2 are also adaptation-relevant.

As we will see in section 4.1, the Food and Agriculture Organization, the UN custodian agency that monitors a number of the SDG indicators under different goals, including Goal 2, aims to use and apply the existing SDG indicators to track progress with adaptation and resilience and its adaptation co-benefits. There is a large potential to do the same for other goals and indicators, which could be key to making progress on adaptation tracking at a global level.

3.2 National adaptation M&E systems

All countries that signed or ratified the Paris Agreement have adopted at least one law addressing climate change or the transition to a low-carbon economy.⁶¹ Many countries also have national adaptation strategies and programs or have embarked on the National Adaptation Plan process (NAP).⁶² It is therefore increasingly necessary for governments to understand not only the level of climate risk facing their country, but also how well they are adapting. Approximately 50 countries have started designing national systems to monitor or evaluate their adaptation efforts, although only few are as yet fully operational.⁶³

These national adaptation M&E systems can be characterized according to several dimensions, including their mandate, purpose, content, scope, methodologies, institutional arrangements, and types of output and reporting.⁶⁴ A particular challenge is how to measure progress with adaptation and what metrics to use, if any. Most national adaptation M&E systems employ some sort of indicators, often based on existing data sources, while some other countries deliberately avoided using them.⁶⁵ Norway, for example, has chosen an approach without any formal metrics, focusing instead on consultation and joint reflection among stakeholders to stimulate learning. Meanwhile, South Africa has formulated national 'desired adaptation outcomes' to be assessed without narrow indicators, instead assessing progress based on all available information and communicating it in an annual climate change report.⁶⁶ An inventory of first-generation national adaptation indicators however, shows that many are focusing on the output level and that their adaptation relevance may need further specification.⁶⁷

Difficulties in formulating adaptation metrics at a national level are partly due to the fact that responsibility for relevant sectors may lie with different ministries, meaning that many actors need to get on board and already existing M&E efforts need to be aligned. Aggregation across government levels is also impacted by different mandates, for instance, in federally organized countries, where the national level cannot monitor certain actions made by other levels of government.⁶⁸ Experience shows it has been a rather complex process in many countries to even define the purpose of the M&E system, to design an operational methodology, or to secure buy-in for its operation. While some developing countries have received financial support to develop their M&E systems, the human and financial resources to sustain them remain limited in the Least Developed Countries. Synergies also need to be found with the monitoring of national development plans and other national processes, as well as with international agendas, most notably the SDGs and the Sendai Framework for Disaster Risk Reduction.⁶⁹

National adaptation M&E systems can produce multiple types of information (see Table 10), especially in concert with national vulnerability or risk assessments. Country-specific adaptation M&E systems have the potential to inform national policy processes and to provide the basis for reporting under the Paris Agreement as defined in the outcomes of COP24.

TABLE 9

Sustainable Development Goal targets specifically referring to climate change adaptation or resilience and associated indicator

Goals and targets	Indicators		Notes
1. No poverty			
Target 1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.	1.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.	From Sendai Framework.
	1.5.2	Direct economic loss attributed to disasters in relation to global gross domestic product (GDP).	The indicators should be confined to climate-related disasters for adaptation purposes.
	1.5.3	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework.	
	1.5.4	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies.	
2. Zero hunger			
Target 2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.	2.4.1	Proportion of agricultural area under productive and sustainable agriculture.	Requires an objectively verifiable definition of 'productive and sustainable' from a climate risk perspective.
3. Good health and well-being			
Target 3.d Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.	3.d.1	International Health Regulations capacity and health emergency preparedness.	Requires further specification
9. Industry, innovation and infrastructure			
Target 9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.	9.1.1	Proportion of the rural population who live within 2 km of an all-season road (i.e., a road that is reliably passable year-round).	Limited coverage of infrastructure
Target 9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.	9.a.1	Total official international support (official development assistance plus other official flows) to infrastructure.	Input indicator. Assumes the official international support to infrastructure translates into sustainable and resilient infrastructure.

11. Sustainable cities and communities			
Target 11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.	11.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.	Based on Sendai Framework. The same four indicators are used for Target 1.5. The indicators should be confined to climate-related disasters for adaptation purposes. Indicators 11.b.1 and 11.b.2 do not appear to reflect all dimensions of target 11.b.
	11.5.2	Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters.	
Target 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework, holistic disaster risk management at all levels.	11.b.1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030.	
	11.b.2	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies.	
Target 11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.	11.c.1	Proportion of financial support to the least developed countries that is allocated to the construction and retrofitting of sustainable, resilient and resource-efficient buildings utilizing local materials.	Requires an objectively verifiable definition of 'sustainable, resilient and resource-efficient buildings'.
13. Climate action			
Target 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.	13.1.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.	Based on Sendai Framework. Indicators also used for Target 1.5. The indicators should be confined to climate-related disasters for adaptation purposes.
	13.1.2	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework	
	13.1.3	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies.	
Target 13.2 Integrate climate change measures into national policies, strategies and planning.	13.2.1	Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other).	Requires objective verification of whether the policy/plan/strategy increases resilience and the ability to adapt.

Target 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.	13.3.1	Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula.	Indirect indicators
	13.3.2	Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions.	
Target 13.a Implement the commitment undertaken by developed-country parties to the UNFCCC to a goal of mobilizing jointly US\$100 billion annually by 2020 from all sources to address the needs of developing countries.	13.a.1	Mobilized amount of United States dollars per year between 2020 and 2025 accountable towards the US\$100 billion commitment.	Input indicator
Target 13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.	13.b.1	Number of least developed countries and small island developing States that are receiving specialized support, and amount of support, including finance, technology and capacity-building.	Specification of "specialized support" and how it relates to climate change planning and management is required.

Source: Based on Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs). 2019. *Global indicator framework for the Sustainable Development Goals*, analyzed by authors.

TABLE 10 Types of information produced by national adaptation M&E systems

Focus	Type of information	Country examples
Process / output-based	Extent of implementation of national strategies, plans, or processes	The M&E systems of Austria, France, and the United Kingdom measure the percentage of implementation of national action plans
	Extent of the mainstreaming of adaptation across sectors and levels of government	The M&E systems of Cambodia and Kenya measure the degree of mainstreaming of adaptation
Depending on the targets	Degree of achievement of adaptation targets, for example from the NAP process or the NDC	In Brazil, the adaptation M&E system is monitoring the implementation of the targets defined by the NAP
Outcome-based	Changes in climate risk or vulnerability over time	The M&E systems of Colombia, Germany, Morocco, and United Kingdom monitor climate vulnerability or risks over time at national, sub-national, or programme level
	Avoided negative impacts from climate change	Any systems whose methods and indicators focus directly on avoided impacts
	Achievement of development goals despite climate change impacts	Proposed for the M&E systems of Cambodia, Kenya, the Philippines, and South Africa

Source: Leiter (2017b, p. 33).

4 Current and evolving practices in agriculture and food security, cities, and finance and investments

Adaptation actions may be cross-sectoral, like mainstreaming adaptation into planning or developing national adaptation strategies. However, implementation often takes place in a sectoral or thematic context. To explore evolving practices of adaptation metrics within these contexts, this section provides examples from three important areas: agriculture and food security, urban areas, and finance and investment. The sections have been contributed by international organizations that have long experience of implementing or funding adaptation and are directly involved in developing and applying adaptation metrics and assessment frameworks.

4.1 Adaptation frameworks and metrics for agriculture and food security

4.1.1 THE CURRENT STATE OF ADAPTATION MONITORING AND EVALUATION FRAMEWORKS AND METRICS FOR AGRICULTURE

The Food and Agriculture Organization (FAO) of the United Nations has carried out a literature review of the different agriculture and non-agriculture M&E frameworks and addressing adaptation and resilience; it counted more than 25 of such frameworks, with more than 700 indicators.⁷⁰ These documents provide guidance in setting up adaptation M&E systems at different levels: national, project, community or household. The indicators are not all agriculture-specific but cover all dimensions of adaptation and resilience. The most comprehensive agriculture-specific resource reviewed in the report was the Climate Smart Agriculture (CSA) programming and indicator tool, developed by the Consultative Group on International Agricultural Research (CGIAR)'s Climate Change, Agriculture and Food Security Programme (CCAFS). This tool is built around 378 indicators across the three pillars of CSA: sustainable agricultural production, resilience and adaptation, and mitigation.⁷¹

4.1.2 EXPERIENCE IN INTEGRATING AGRICULTURE INTO NATIONAL M&E FRAMEWORKS AND ADAPTATION PLANS

Lessons on the integration of agriculture into national M&E frameworks and National Adaptation Plans (NAPs) are emerging from a number of sources, including the Integrating Agriculture in National Adaptation Plans (NAP-Ag) Programme,^{vi} which supports the development of indicators for tracking adaptation, resilience, and adaptive capacity in Nepal, Thailand, Vietnam, and Uruguay, while also supporting the development of M&E frameworks for the agricultural sector in Colombia, Guatemala, Kenya, the Philippines, and Uganda.⁷²

The NAP-Ag program's experiences in developing M&E systems and metrics highlights the importance of building on existing M&E systems and of integrating separate M&E protocols or systems and the information collected into existing ones, as has been done in Kenya, Uganda, Uruguay, and Vietnam. Existing M&E frameworks can provide insights into opportunities for aggregating and synthesizing country-level data and information.⁷³ In the case of Nepal, a review of existing agricultural M&E systems was crucial in identifying options to link the M&E systems of the Nepal Agricultural Development Strategy and targets related to climate resilience with the food security and nutrition theme of Nepal's NAP.⁷⁴ Another crucial element for success is institutional coordination. In Guatemala, a work plan for institutional coordination was developed by ten national institutions to review best practice concerning M&E in the agricultural sector and select the indicators to be included in the National Information System on Climate Change.⁷⁵

4.1.3 FAO'S TRACKING ADAPTATION IN AGRICULTURAL SECTORS METHODOLOGY

The FAO has developed a framework for tracking adaptation in agriculture at the national level,^{vii} which can also be customized for application at a local level depending on data availability.⁷⁶ The framework stresses the importance of capturing five general elements of adaptation: observa-

vi The program is a multi-year (2015-20) USD 17 million initiative co-led by UNDP and FAO and funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

vii Tracking here refers to "the monitoring of adaptation processes and outcomes along a continuum for three main dimensions of adaptation": 1) reducing vulnerability, 2) strengthening adaptive capacity, and 3) enhancing resilience.

tion of climatic and non-climatic variables; assessment of impacts, vulnerability, and risks; adaptation planning and mainstreaming; implementation of adaptation measures; and M&E. This framework operates with four categories of agricultural adaptation indicators:

1. Natural resources and ecosystems
2. Agricultural production systems
3. Socio-economics
4. Institutions and policy

The first two categories are largely outcome-based and refer to actions at the local level, whereas the last two categories are largely process-based and focus on the national level. The four indicator categories are divided further into 16 indicator subcategories with 111 possible indicators to choose from. The framework's approach to the assessment, mapping, and scoring of indicators provides a visual representation of progress that is simple to interpret.

4.1.4 THE DEVELOPMENT OF FOOD-SECURITY INDICATORS

Agriculture is often the core theme over which 'food security' is identified as a broad overarching goal.⁷⁷ Four dimensions of food security are commonly considered: availability, access, utilization, and stability. The FAO's Statistics Division compiles food-security indicators across these dimensions, which are available for varying periods of time.⁷⁸ The suite of indicators was introduced in the State of Food Insecurity in the World report and has subsequently been developed further.⁷⁹ The 2018 report tracks trends and progress toward meeting the targets for ending both hunger (SDG Target 2.1) and all forms of malnutrition (SDG Target 2.2).⁸⁰ To monitor hunger, the 'prevalence of undernourishment' indicator is used. More recently, a Food Insecurity Experience Scale (FIES) has been developed to establish a new global standard for the monitoring and tracking of the prevalence of severe food insecurity at the global and national level. The FIES measures access to food at the individual or household levels based on responses to a survey module that can be integrated into several types of population survey and that consists of eight questions regarding the ability to access adequate food.

CCAFS has compiled a list of existing national indicators for improving gender, poverty, food security, nutrition, and health outcomes from CSA planning, implementation, and

scale-out in order to integrate these indicators into country profiles, planning, and prioritization.⁸¹ A preliminary list of potentially suitable national indicators was compiled from the World Bank, FAO, and UN databases before being prioritized by a panel of inter-disciplinary experts and then shortened down to a list of 'core' indicators. The following food-security indicators were identified as core indicators for inclusion in country profiles: prevalence of undernourished of population; prevalence of stunting; and prevalence of severe wasting.

In general, food insecurity metrics are not designed to specifically consider climate change and adaptation-related impacts on food insecurity. However, it is possible to adjust the current indicators to take climate-relevant information into account that could be explored further (see sections 4.1.1 and 4.1.2). In addition, a number of tools and frameworks consider food security specifically in the context of climate change adaptation and resilience. These include the International Institute for Sustainable Development (IISD) Climate Resilience and Food Security framework, which attempts to link the assessment of food security at community levels to national policy indicators.⁸² The CRiSTAL Food Security 2.0 tool analyses key elements of food systems and how they are affected by climate change, as well as which indicators can help monitor the resilience of food systems based on community-level assessments.⁸³ FAO tools that address resilience and food security at the household level include the Resilience Index Measurement and Analysis (RIMA) and the Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists (SHARP). RIMA analyzes the ways in which households cope with stressors using household surveys that include questions covering food security, as well as access to basic services and aspects of income. SHARP is a tablet-based climate resilience self-assessment tool for farmers and pastoralists enabling them to assess household resilience based on surveys. The gathered information is integrated into broader-level climate data to help farmers prioritize their activities in building resilience in agro-ecosystems.

Finally, some countries are starting to incorporate food-security considerations into their existing adaptation M&E systems. The Philippines has included food security as one of the seven strategic priorities of its National Climate Change Action Plan Results-Based Monitoring and Evaluation System. The matrix for food security comprises

the following sample indicators: provincial-level agriculture and fishery sector vulnerability and risk assessment conducted nationwide; national and provincial agriculture and fisheries climate information and database established; number of appropriate adaptation technologies identified and implemented; and number of farmers and fishing communities trained in adaptation best practice.⁸⁴

4.1.5 RECOMMENDATIONS FOR OVERCOMING CHALLENGES TO TRACKING ADAPTATION IN AGRICULTURE

Concerning the global tracking of adaptation, FAO is the UN custodian agency that monitors at least 25 of around 230 SDG indicators across six SDGs (Goals 2, 5, 6, 12, 14, and 15). The FAO aims to use and apply the existing SDG indicators to track progress with adaptation and resilience, and its adaptation co-benefits. Furthermore, the FAO also proposes to adopt a similar approach under the UNFCCC as part of the so-called Koronivia Joint Work on Agriculture.^{viii} In its Koronivia submission, the FAO proposes “to develop a coherent indicators framework to monitor progress towards the targets that countries have set in adaptation, adaptation co-benefits and resilience, as part of the overarching 2030 Agenda for Sustainable Development and the Paris Agreement”.⁸⁵ The FAO recommends selecting a combination of quantitative and qualitative indicators, as it is challenging to assess the extent of progress based on numeric values alone. The inclusion of qualitative indicators facilitates a more comprehensive assessment of outcomes.

Concerning CSA, there is now a good overview of the main challenges related to the development of indicators and national M&E systems (see Figure 1). Most of these echo the findings of section 2.3. The second pillar of CSA, concerning adaptation and resilience, shows the most critical need to make progress on indicators. Initial discussions point to the relevance of agreeing on a limited number of generic indicators to enable comparison and aggregation, with it being understood that additional context-specific indicators are needed and can be added in order to glean granular information. Suggestions for generic outcome indicators include the number and percentage of farmers adopting adaptive practices – disaggregated by gender – and avoided economic damage. Again, this would not preclude the addition of context-specific indicators, at the output or outcome level, in

viii For further details, see <http://www.fao.org/climate-change/our-work/what-we-do/koronivia/en/> and <https://unfccc.int/sites/default/files/resource/docs/2017/cop23/eng/11a01.pdf>.

order to inform decision-making, provide accountability, or to track progress more effectively.

It is also clear that collaboration between the public and private sectors is key when it comes to the M&E of CSA. The private sector plays a large role in the implementation of CSA and generates data that needs to be incorporated into M&E in order to reflect agricultural practices on the ground accurately. Unless the private sector and other external agencies, such as NGOs, are included in M&E practices, impacts are likely being underestimated. The establishment of governmental machinery for the incorporation of data from external agencies provides one way forward. This top-down solution would help ensure that the national M&E system maintains a systematic flow of data and information from external actors, including the private sector and NGOs.

A related challenge is the harmonization of indicators between the public sector and external agencies. There are discrepancies between indicators monitored by the public and private sectors respectively. CCAFS conducted a stocktake of the World Business Council for Sustainable Development’s member companies and discovered inconsistencies in how companies track the progress of their indicators, for example, in terms of absolute versus relative progress. Furthermore, a majority of private-sector companies currently do not track indicators related to resilience.

4.2 Adaptation metrics and the city

4.2.1 CITIES AND CLIMATE CHANGE: PLANNING AND BUDGETING FOR URBAN ADAPTATION

Cities face challenges and opportunities from development, environment, and climate change perspectives that provide strong incentives for urban adaptation. By 2050 more than two-thirds of the world population will be urban, with the most rapid urban growth expected in lower income countries in Africa and Asia.⁸⁶ A number of publications analyze urban climate change impacts and potential knock-on effects, including on water availability and energy use.⁸⁷

However, urban adaptation planning and budgeting for climate change is generally still in its infancy. It often relies on a small team in the environment department that typically has fewer resources and more limited jurisdictions compared to the larger departments such as planning, transportation, water, or solid waste.⁸⁸

<p>Indicators</p> <ul style="list-style-type: none"> • Too many to choose from • No one-size fits all indicator for adaptation/resilience • Understanding exactly how CSA indicators map to SDGs and NDCs • Many countries do not have specific targets for agriculture, making the selection of indicators difficult • Scalability of project level indicators for national-level aggregation 	<p>Data</p> <ul style="list-style-type: none"> • Availability and accessibility of data • Sustainability of data collection • Lack of capacity to conduct quality assurance • Legal aspects of data sharing • Inadequate baseline data
<p>Institutions</p> <ul style="list-style-type: none"> • Lack of coordination within and between institutions • Lack of dedicated M&E staff and institutional memory due to high staff turnover • Inadequate funding • Difficulty in harmonizing/coordinating collection by responsible agencies (definitions, quality assurance across multiple agencies) 	<p>External agencies</p> <ul style="list-style-type: none"> • Different reporting requirements among the various actors • Lack of incentives for information sharing and collecting • Data collected by external actors often unable to interface with national system (i.e., lack of framework and oversight to enable “plug-in”)

Source: Produced by authors

Adaptive actions – whether strategy-, policy-, process- or outcome-oriented – tend to focus on specific threats and sectors and frequently lack a more holistic perspective. Political fragmentation, short election cycles, and a focus on ‘quick wins’ play into solutions that favor coping and incremental adaptation over transformative adaptation. Only a few cities, for example, Copenhagen and Rotterdam, focus on transformative adaptation.⁸⁹

4.2.2 CITY ADAPTATION METRICS

Adaptation metrics at the city level are influenced by the purpose of their use (e.g., to measure changes in vulnerability, to assist in project prioritization, or to assess progress with and the performance of implementation and adaptation effectiveness), the types of adaptive actions pursued, available resources and capacities, and the links to existing monitoring and reporting processes. A non-exhaustive overview of climate adaptation frameworks and related indicator categories relevant to urban adaptation is

presented in Table 11. Some of the frameworks focus specifically on cities or urban environments, while others are included because of their relevance to urban adaptation. Several cities, including Barcelona, Berlin, Copenhagen, Helsinki, London, Munich, New York, Rotterdam, and Vancouver, are also making progress in developing adaptation metrics,⁹⁰ either stand-alone or linked to national adaptation indicator frameworks. Table 11 specifies whether the indicators are based mainly on existing data, on new data, or on a mixture of the two. One disadvantage of existing indicators is that, as they were designed with a different purpose in mind, they might not always be the best fit for what it is intended to measure. In addition, they might not be of the right quality or frequency.

Indicator categories and definitions differ across publications. Rather than trying to mend or bridge differences in conceptualization and terminology, it might be more constructive to develop clarity and a common understanding

TABLE 11 Climate adaptation frameworks and indicator synopses with city relevance

Organization	Framework	Indicator Categories
ARUP / C40	Climate Risk and Adaptation Framework and Taxonomy (CRAFT) ⁹¹	Risks, progress, and impact (M)
C40	Measuring Progress in Urban Climate Adaptation Framework ⁹²	Process, progress, and impact
Covenant of Mayors	Sustainable Energy and Climate Action Template (SECAT) ⁹³	Process, vulnerability, progress, and impact (M)
ESPON	Climate Change and Territorial Effects on Regions and Local Economies ⁹⁴	Drivers, risks, and potentially impact (E)
GPSC	Urban Sustainability Framework ⁹⁵	Enabling environment (process) and outcomes (progress and impact) (N)
ICLEI Canada	Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation ⁹⁶	Process and progress (M)
ISO	Indicators for Sustainable Development and Resilience in Cities ⁹⁷	Performance on city services and quality of life, and impact (M)
ND-GAIN	Urban Adaptation Assessment ⁹⁸	Risk and readiness – covers progress and impact (E)
RESIN	European Climate Risk Typology ⁹⁹	Drivers, risks, vulnerability, and potentially progress (E)
UBA	DAS [Deutschen Anpassungsstrategie, i.e., German Adaptation Strategy] Indicator Monitoring System ¹⁰⁰	Progress, impact, and cross-cutting (M)

Source: Produced by authors

Notes: ESPON = European Observation Network for Territorial Development and Cohesion, GPSC = Global Platform for Sustainable Cities, ICLEI = International Council for Local Environmental Initiatives (now; Local Governments for Sustainability), ISO = International Organization for Standardization, ND-GAIN = Notre Dame Global Adaptation Initiative, RESIN = Climate Resilient Cities and Infrastructures, UBA = Umweltbundesamt [transl. German Environment Agency], (E) = mainly existing indicators / data, (N) = mainly new indicators / data, (M) = a mixture of existing and new indicators / data.

'Risks' covers indicators on risks, threats, hazards, and the impacts of climate change and climate change-related extreme weather events; 'process' includes indicators on the processes of capacity, strategy, and policy development, as well as prioritizing actions; 'progress' includes output, outcome, and performance, as well as action or response, depending on the publication; and 'impact' can focus either on the direct impact of an intervention or the impact towards the bigger picture of improved risk management, reduced vulnerability, reduced exposure, reduced impact of climate change and related extreme weather events, increased resilience, etc.

of differences in city adaptation metrics. In the overview above, the progress indicators focus on reaching a specific end-point and also include the achievement of specific outputs or outcomes, whereas process indicators focus on the course of action, that is, the processes that contribute to the achievement of outcomes.¹⁰¹ Most of the indicator categories in Table 11 are also used in the city of Melbourne example presented in section 4.2.4; including the process, progress, and (intervention) impact categories, where indicator consistency is expected to be most problematic.

Currently, the risks indicator category provides the best opportunity for consistency across cities. Compared to other cat-

egories, indicators on risks, threats, hazards, and the impacts of climate change and climate change-related extreme weather events seem to be more standardized, depart from existing data to a greater extent, and are often informed either by urban development or disaster risk management data sources. For example, indicators related to urban flooding cover the percentage of impervious surface area, increases in permeable surface area, the percentage of the population living in flood plains, and the number of buildings in flood plains. Examples of indicators related to extreme heat events include the percentage of urban land covered by tree canopy, increases in the green roof area, and the number of days with maximum temperatures above 30°C.

All the climate adaptation frameworks and indicator synopses mentioned in Table 11 apply equally to cities in high-, middle- and low-income countries. However, it should be recognized that there are differences across cities and city governments, who must tackle different risks with different levels of capacity, financial means, levels of jurisdiction, as well as differing in terms of how they balance development and climate change challenges and opportunities.¹⁰²

4.2.3 UNIVERSAL METRICS AND AGGREGATION

Any attempt to aggregate, compare, and benchmark cities' statuses on climate adaptation at the global level should consider trade-offs with respect to context-specificity and alignment with stakeholder needs,¹⁰³ and consider measurability challenges.¹⁰⁴ As Hallegatte and Engle frame it: "Regardless of the quality of an individual indicator and any associated complementary indicators, it is evident that aggregated quantitative resilience metrics will only take us so far. Resilience is as much about infrastructure and financial instruments as it is about governance, voice, and empowerment. But governance, voice, and empowerment are not easy to quantify and measure, and should not be ignored at the expense of the search for quantified metrics".¹⁰⁵ This is not to say there is no place for universal adaptation metrics.¹⁰⁶ However, the possibility of negative side effects, like cities losing out on finance or insurance due to poor performance, need to be considered and the limitations of global metrics to cater for multiple M&E purposes needs to be reflected on critically.¹⁰⁷

Berrang-Ford et al. conclude that there is a clear trade-off between the context-specificity and aggregation-ability of adaptation measurement frameworks.¹⁰⁸ The C40, GPSC, and ND-GAIN frameworks, and perhaps even the ISO indicators, provide an opportunity to benchmark and compare between cities. C40 CRAFT, for example, compares a city's performance against those of its peers and a global benchmark,¹⁰⁹ while ND-GAIN's urban adaptation assessment (ND-GAIN, 2017 and 2018) compares the risks and readiness of over 270 U.S. cities,¹¹⁰ but at the cost of context-specific information.

Based on the above, it might be neither feasible nor desirable to develop a small set of universal city adaptation metrics or an aggregation based on existing adaptation measurement frameworks to the global level. Instead, the use of existing city metrics and data should be strengthened, together with a focus on how metrics can be used

within city governance, for what purposes, and by whom. Satellite imagery and expert assessments could be used to fill data gaps and assess data quality. Links should also be explored with data from national measurement systems on sustainable development and climate adaptation, and UNFCCC reporting relying on sub-national information, as well as from international processes such as the Sendai Framework and other partnerships for measuring the performance of city adaptation.

City adaptation metrics should further be informed by the level of change envisaged and the types and mixture of adaptive solutions being deployed, and should balance the need for context-specificity against its costs. A need for new indicators is to be expected in the process, progress, and impact categories, where there is less coverage by existing indicators. As the upcoming Melbourne case demonstrates, some elements are harder to measure than others, and a mixture of existing and new indicators, quantitative and qualitative data, and a high level of community engagement is to be expected. Melbourne's ongoing indicator development might provide valuable lessons.

4.2.4 ADAPTATION METRICS IN THE CITY OF MELBOURNE

In 2009, the City of Melbourne (Melbourne) published a risk-focused Climate Change Adaptation Strategy.¹¹¹ At the time, Melbourne had already experienced a ten-year drought, heatwaves, and extreme flood events. In 2017 a strategy refresh was released that takes into account the progress made, the changing policy contexts, the high population growth, and lessons learned from other cities.^{ix 112}

Melbourne categorizes its climate change risks into four broad themes:

- Insufficient water supply, impacting on the health and maintenance of green infrastructure;
- Inundation from flooding, storm surges, sea-level rises, and flash flooding, causing risk to life, property, and infrastructure;
- Heatwave impacts to health, transport, communications infrastructure, and electricity demand, and;

ix Other city strategies that address climate change risks and support adaptation include the Total Watermark Strategy (2017), Climate Change Mitigation Strategy (2019), Urban Forest Strategy (2014), Open Space Strategy (2012), and Asset Management Strategy (2015).

- Storm events affecting emergency services, damaging buildings and assets, causing delays in transportation, and interrupting economic activities.

Experience with urban adaptation metrics and data collection

Metrics enable the city to track progress with its actions, collect data to support business cases, influence partners to achieve desired outcomes, and report to the city's council and community on how it is tracking its adaptation goals. Melbourne uses both quantitative and qualitative indicators to keep track of progress and efficiency in achieving its adaptation goals and to understand how effective its actions are (see also Box 2).

The results of many adaptation efforts in Melbourne can be quantified, such as increasing tree canopy cover or increasing permeable surfaces. However, using qualitative indicators helps us understand whether the city's chosen actions are resulting in the desired changes. This enables Melbourne to tell a story around adaptation and different types of change.

Melbourne collects data against indicators through the Council Plan and various city strategies. Indicators are selected based on how well they demonstrate change against strategic goals, plus how feasible they are. As well as the internally developed indicators, Melbourne uses external metrics, such as those developed by C40 and other cities.

Examples of indicators used by Melbourne include:

- The number of new tree species introduced to the municipality;
- Percentage of the city with tree canopy cover;
- The municipality's storm water storage capacity;
- Increase in area of permeable surfaces (e.g. by measuring the reduction in concrete areas through park expansion projects);
- Increase in the percentage of water sourced from alternative (non-potable) sources to meet municipal non-potable needs;

BOX 2

Examples of adaptation measures and metrics promoted in Melbourne

Cool routes: Melbourne is promoting 'cool routes' for pedestrians to move around the city safely and comfortably. This project is using available data (i.e., canopy cover, surface types, building height, pedestrian data and sensors) to determine the coolest routes through the city. As part of this project, there is an intention to engage the community to better understand how they behave during heat events, how they feel in different spaces/environments across the city (i.e., how they feel in a 'hot' spot versus a 'cool' spot) to help validate assumptions made in the model. To gather this information surveys and focus groups will be used. Consideration will need to be given to how this information is collected on an ongoing basis so any changes in behavior, and therefore the impact of the work conducted, can be tracked.

Citizen Forester: Community volunteers are trained and empowered to grow the urban forest and improve urban ecology by carrying out essential advocacy, monitoring and research tasks. An example of an activity the volunteers execute is the i-Tree Eco urban forest assessment to understand Melbourne's urban forest and quantify its benefits. Analysis stemming from the i-Tree Eco assessment method provides a more accurate valuation of Melbourne's urban forest than previous estimations.

Integrated water management: During the Millennium drought (2000–2010) Melbourne's green assets suffered significantly. To help make Melbourne drought proof, it adopted integrated water management. Using data, open space has been enhanced through improved irrigation efficiencies and soil management practices that maximize infiltration. Metrics are used to incentivize reductions in water pollution, for example, the metric for nitrogen reduction helps inform the interventions that are put in the ground by enabling the impact an intervention has on capturing nitrogen to be calculated. The city also has a permeability metric, which helps increase the amount of permeable surfaces in the city.

Source: Produced by author

- Number of hectares covered by green roofs; and
- Number of vertical green installations.

Melbourne has found it difficult to measure social resilience to climate change. The types of data the city collects to measure this differ from the data collection methods for its quantitative adaptation indicators and involve social surveys and community engagement.

Melbourne uses a range of methods to collect data, including sensors throughout the city, which measure things such as temperature, air quality, and pedestrian traffic. Lidar (pulsed laser light) is used to collect information about urban forest canopy cover. Melbourne's data is made available to the public through an open data platform.^x To complement this data, community groups and citizen scientists are also used to collect and validate data collected by Melbourne.

Future outlook

As adaptation M&E is an emerging field, Melbourne is committed to ongoing experimentation, testing, learning, and improvement. To reduce the risks of capacity and resource issues, where possible Melbourne uses existing indicators and data. It is often difficult to attribute particular adaptation outcomes to specific planned interventions, although monitoring combined with social research can help identify and quantify such causal links.

Melbourne has developed a framework that outlines how the city will monitor and evaluate its adaptation approach. Next steps for this involve further refining of indicators for adaptation and developing a data collection plan that will need additional data.

4.3 Experiences with climate resilience metrics by Multilateral Development Banks

4.3.1 BACKGROUND

The 2015 Paris Agreement calls for alignment of financing flows with climate-resilient development pathways.^{xi} This requires financing institutions, including MDBs, to develop approaches for assessing the extent to which their

x Available at: <https://data.melbourne.vic.gov.au/>

xi Alongside alignment with low-carbon pathways; see Paris Agreement Article 2.1c.

financing operations are aligned with and deliver climate resilience objectives. This creates a demand for climate resilience metrics that can express information about the quality and results of climate change adaptation financing activities conducted by MDBs.

In addition, there is increasing demand from the commercial finance sector for metrics to be used to integrate information about physical climate risks and climate resilience opportunities into financial decision-making (see Box 3). This may help to leverage much wider financial market action on climate resilience and help adaptation financing make the much-needed shift in scale, from billions to trillions. MDBs can play an important role in leading and piloting the development of climate resilience metrics that may ultimately have wider applicability across financial markets.

Over the past two years, MDBs have responded to this challenge by exchanging experience on emerging approaches to climate resilience metrics. This has included the Joint MDB Working Group on Climate Finance Tracking's initial draft paper on climate resilience metrics.¹¹³ Over this period, some members of this sub-group have also developed and piloted more detailed methodologies, such as the Green Economy Transition (GET) approach¹¹⁴ and the World Bank Group's (WBG) Resilience Ratings System, which is currently under development (see section 4.3.4).

4.3.2 CHARACTERISTICS OF A CLIMATE RESILIENCE METRICS SYSTEM FOR FINANCING OPERATIONS

The development of a metrics system for use in financing operations, whether by MDBs, other Development Finance Institutions (DFIs), or commercial financial institutions, will need to take into account the following considerations:

- Financing climate resilience requires a context-specific approach that defines the project-level climate vulnerabilities and climate resilience priorities. Applying climate resilience metrics therefore also requires a highly differentiated and context-specific approach, which can involve drawing on a broad and diverse range of metrics.
- There is a high degree of diversity in climate resilience financing activities, due to the context-specific nature of climate resilience and the diverse range of financing modalities across MDBs and other financial institutions. To accommodate this diversity, there is a need for a

In 2017 the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) called for metrics that financial institutions and corporates can use to disclose physical climate risks and climate resilience opportunities in business and financing operations.¹¹⁵

The European Union's Sustainable Finance Action Plan (2018) also called for the development of climate resilience metrics as part of its Adaptation Finance Taxonomy and climate-related disclosure proposals.¹¹⁶

In 2019, the Climate Bonds Initiative (CBI) launched an Adaptation and Resilience Expert Group (AREG) to develop a set of climate resilience principles for climate/green bonds, which requires the development of robust and comparable climate resilience metrics.¹¹⁷

Source: Produced by authors

broad and flexible approach to applying climate resilience metrics.

- A significant challenge for financial institutions in relation to climate resilience is that they need to make financing decisions today that have implications for climate resilience in the future in a context of uncertainty about future climate conditions. Therefore, climate resilience metrics must be able to cope with variable and often long timescales over which intended project results may be delivered and reported, including potentially long time lags between project design and implementation and achieving climate resilience results.
- In the same vein, as these timescales lengthen, the inherent uncertainties associated with future climate conditions and their implications for project performance may increase, making the reporting of project results even more challenging.

In response to these needs, MDBs are exploring an approach to climate resilience metrics based on a flexible framework and results chain that accommodates a broad and diverse range of climate resilience financing activities and financing institution mandates and business models, and that has varying and potentially long timescales, while explicitly recognizing uncertainties. This has the following features:

- It sets out high-level principles for climate resilience metrics to be used in financing operations, as opposed to setting out a prescriptive list of specific metrics that all types of financing institutions should use. This allows different types of financing institutions to apply these

principles in a way that suits their respective business models, using a common and consistent 'vocabulary' of metrics while allowing flexibility in the choice of the specific metrics to be used.

- It is based on a clear project-level logical model/results chain (see Figure 2), built on a robust theory of change that progresses from short to long time-horizons. This recognizes that climate resilience metrics may be used and reported at any of the points along this results chain, depending on the nature and context of the specific project in question, including its financing.
- It allows flexibility for climate resilience metrics to be used/reported at both the asset level and the system level. The asset level refers to the climate resilience of the project and of the specific assets/activities being financed. The system level refers to climate resilience achieved *through* the project that benefits the wider system in which the project is located and/or of which it is part. It may also be possible for a project to deliver climate resilience on both of these levels.

The logical model in the form of a results chain is shown in Figure 2. It is based on widely recognized project monitoring and evaluation definitions, for example, like those defined by the OECD.¹¹⁸ The components of the framework may be divided into two broad categories. The first relates to the *quality of project design and implementation*, and encompasses project diagnostics, inputs, and activities. The second relates to *project results*, and encompasses project outputs, outcomes, and impacts.

FIGURE 2 Logic model and results chain



Source: Joint Multilateral Development Bank Climate Finance Group (forthcoming)

4.3.3 EXAMPLES OF APPLICATION IN DIFFERENT KINDS OF FINANCING OPERATIONS

The principles outlined above provide flexibility in the use of climate resilience metrics in financing operations, while also providing consistency and coherence across the range of climate resilience metrics systems that may be used by different financing institutions. The principles, however, are not intended to replace financial institutions' individual systems, and they do not prescribe a one-size-fits-all approach. Different types of financial institutions may choose to apply these principles in ways that suit their respective business models. For project finance, for example, it may be appropriate to use climate resilience metrics for output- or outcome-level project results, as the financing interventions are more likely to be location-specific and to have more definable project boundaries. Conversely, for policy-based or sector-wide lending it may be appropriate to use climate resilience metrics that focus on the quality of project design and implementation, reflecting the fact that such financing interventions may be more wide-ranging and less location-specific or asset-specific.

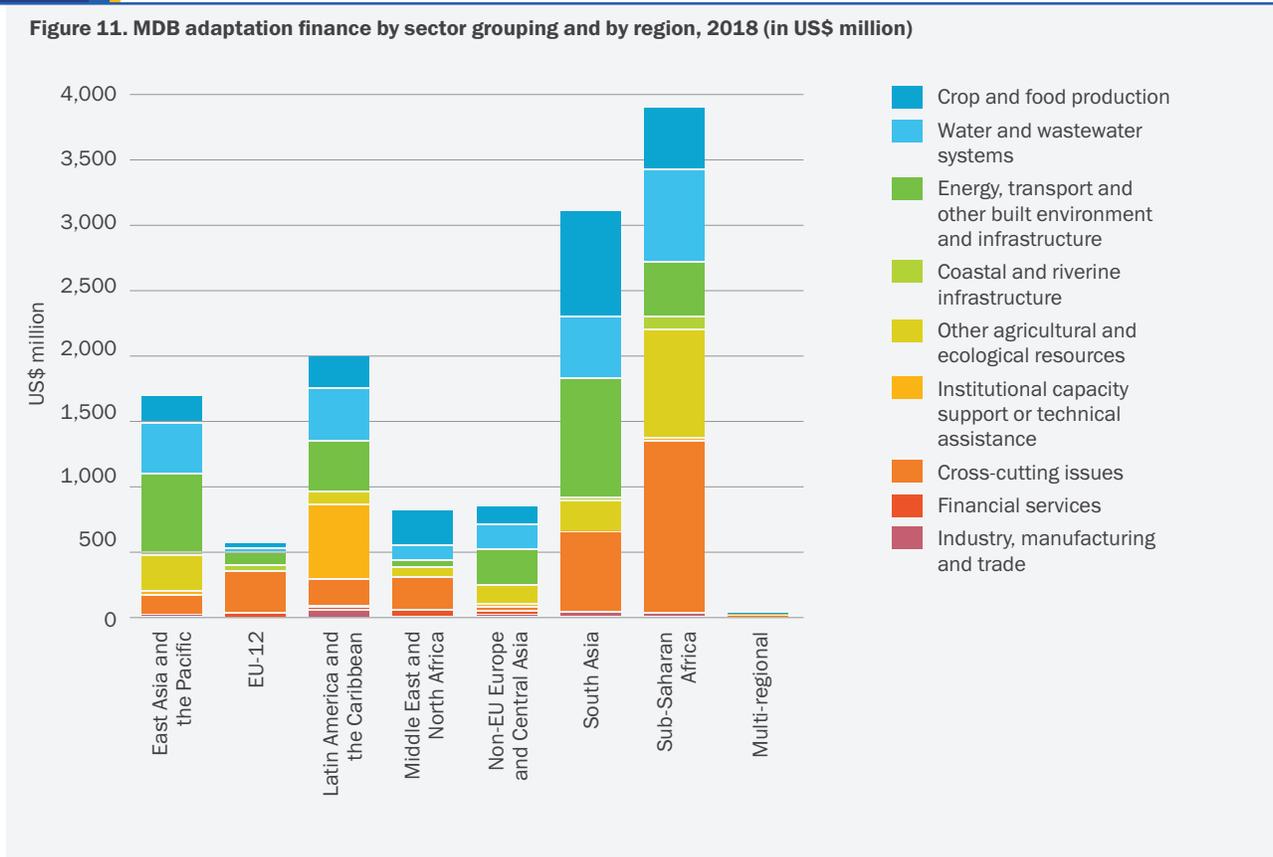
Project resources (input): Joint MDB adaptation finance tracking approach

In 2012, the Joint MDB Climate Finance Group adopted a joint methodology for tracking climate change adaptation finance.¹¹⁹ This approach focuses on reporting adaptation finance as an **input** to the project: in other words, the amount of finance within a project that is committed to the purposes of addressing climate vulnerabilities and building climate resilience. The specific metric used in this case is a unit of currency (specifically the United States' Dollar), as illustrated in Figure 3.

Project results (outcome): EBRD Green Economy Transition (GET) climate resilience approach

In 2018, the EBRD adopted a methodology for estimating project-level climate resilience benefits as part of its Green Economy Transition (GET) approach.¹²⁰ The GET approach aims to increase green financing to approximately 40 percent of total EBRD financing by 2020. The methodology entails the use of six climate resilience metrics on an

FIGURE 3 Breakdown of MDB adaptation finance 2018



Source: Joint Multilateral Development Bank Climate Finance Group (2019)

TABLE 12 Summary of climate resilience outcome types used in the EBRD GET climate resilience approach

Climate resilience outcome type	Description	Units	Valorized outcome
Increased water availability	Additional water made available in the face of increasing climatic variability as a result of the project, either through water savings or through the provision of additional usable water.	Δ m ³ /year	Value of additional water (€)
Increased energy availability	Additional energy made available in the face of increasing climatic variability as a result of the project, either through energy savings or through increased energy generation.	Δ MWh/year	Value of additional energy (€)
Increased agricultural potential	Additional capacity for agricultural potential achieved in the face of increasing climatic variability as a result of the project through improvements in soil quality, for example reduced soil erosion, increased soil carbon content or reduced soil salinity.	Δ tones/hectare/year (soil erosion)	Value of additional potential agricultural production (€)
Increased human health/productivity	Improvements in human productivity in the face of increasing climatic variability due to improved health and well-being as a result of the project.	Δ quality-adjusted life years (QALYs)	Value of additional QALYs (€)
Reduced weather-related disruption	Reduction in the amount of time that a system or elements of a system are rendered inoperable (i.e., lost operational expenditure) due to acute climate risks such as increasing numbers of extreme weather events, or chronic climate risks such as increasing hydrological variability or increasing heat stress.	Δ days/year downtime	Value of avoided downtime (€)
Reduced weather-related damage	Reduction in the damage to assets (i.e., lost capital expenditure), acute climate risks such as more frequent extreme weather events, or chronic climate risks such as increasing hydrological variability or greater heat stress.	Δ risk frequency of a damaging weather or climate event (acute risks)	Value of avoided damage (€)
		Δ service life (chronic risks).	Value of extended asset lifespan (€)

Source: European Bank for Reconstruction and Redevelopment (2018)

ex ante basis to estimate the **outcomes** delivered by the project, such as reduced water consumption or reduced down-time due to extreme weather disruption, taking into account the wider economic value of those benefits to society and the economy (see Table 12 for a detailed list).

Hybrid approach: Climate-related disclosures as recommended by the TCFD

In 2017, the Financial Stability Board’s Task Force on Climate-related Financial Disclosures (TCFD) issued a set of recommendations on the disclosure of climate-related risks and opportunities by financial institutions and corporates.¹²¹ While these recommendations primarily focus on the corporate

level, they also have implications for how financial institutions assess and disclose information about physical climate and climate resilience in relation to their financing activities.

Referring back to the results-chain approach outlined above, the disclosure of physical climate risks may be regarded as diagnostics, whereas the disclosure of opportunities that are expected to result from building climate resilience into financing operations falls into the output or outcome categories, albeit as projected rather than as realized benefits. In both cases, these are restricted to the asset level, as the TCFD is primarily concerned with the impact of physical climate (both negative and positive) on commercial considerations.

Table 13 provides some examples of how information related to physical climate risk and climate resilience may be included in climate-related financial disclosures as prescribed by the TCFD, based on analyzes carried out in 2018 by EBRD and the Global Center on Adaptation.¹²² Similar approaches to these are also being integrated into the European Union’s new requirements under the EU Non-Financial Reporting Directive,¹²³ which will have a major influence on the disclosure of climate-related information (including physical climate risk and climate resilience) by commercial financial institutions and businesses.

4.3.4 THE WORLD BANK’S RESILIENCE M&E AND RESILIENCE RATING SYSTEM

Resilience M&E system

The World Bank has developed practical guidance for the monitoring and evaluation of its operations that aim to increase resilience to climate-related natural disasters and long-term climatic changes.¹²⁴ The guidance aims to improve accounting for resilience in M&E and enable operational teams to design evidence-based resilience-building projects. The application of resilience-specific M&E may

TABLE 13

Illustrative summary of options for reporting physical climate risks and climate resilience opportunities in TCFD-style climate-related financial disclosures

Recommendations for physical climate risks disclosures			
	Supply chain	Operations	Markets
Hazards	<ul style="list-style-type: none"> Assess exposure to heat stress, extreme rainfall, drought, cyclones, rising sea levels, wildfire and other industry-relevant and/or locally-specific climate hazards across the corporate value chain. 		
Timeframe	<ul style="list-style-type: none"> Assess exposure to first-order (direct) impacts in the short to medium term (2-5 and 5-20 years) using a probabilistic approach; use scenario analysis for long-term risk (more than 20 years) and possible exposure to second-order (indirect) impacts. 		
Level	<ul style="list-style-type: none"> Location (country or city) of key supplier facilities and a measure of their importance. 	<ul style="list-style-type: none"> Location (country or city) of critical business facilities (such as production or support systems) and key distribution or logistics sites, as well as a measure of their importance. 	<ul style="list-style-type: none"> Breakdown of sales by country and by segment.
Impacts from recent extreme weather events	<ul style="list-style-type: none"> Decreased production capacity due to supply-chain interruption. 	<ul style="list-style-type: none"> Reduced revenues, including situations where a significant number of staff members are unable to get to work. Increase in operational expenditure (opex), such as repair costs, insurance premiums. Increase in capital expenditure (capex) such as impairment of fixed assets, inventory write-downs. 	<ul style="list-style-type: none"> Reduced revenues from lower sales due to the consequences of extreme weather events.
Impacts of weather variability	<ul style="list-style-type: none"> Increase in supply-chain costs due to changes in the availability of commodities. 	<ul style="list-style-type: none"> Increase in opex (energy costs, negative impacts on the workforce). Increase in capex due to weather or natural resources. 	<ul style="list-style-type: none"> Reduced revenues from lower sales due to variability in the weather.

Future risks of climate change	<ul style="list-style-type: none"> Suppliers or commodities likely to be affected by climate change. Value-at-risk (VaR) from 1:100 or 1:200 and annual average loss projections from disruption to key supplier(s). 	<ul style="list-style-type: none"> Number of sites and business lines exposed to relevant impacts of climate change. Projected change in production, revenues, opex or capex due to climate change. VaR from 1:100 or 1:200 impact on operations or production. Annual average losses from projected impacts of climate change. 	<ul style="list-style-type: none"> Markets or sales likely to be affected by climate change. VaR from 1:100 or 1:200 loss projections from impact on key customer(s) or markets.
Physical climate risk management and climate resilience strategy	<ul style="list-style-type: none"> Supply-chain risk-management strategy. Engagement with suppliers to help identify, assess and manage climate-related physical risks. Engagement of suppliers with local and national governments to identify, assess and manage these risks. 	<ul style="list-style-type: none"> Insurance and risk management instruments and total cost of risk (net risk exposure after risk management). Planned improvements, retrofits, relocations, or other changes to facilities that may reduce their vulnerability to climate impacts. Engagement with local or national governments and local stakeholders on local climate resilience. 	<ul style="list-style-type: none"> Logistics, distribution and sales risk management strategy. Engagement with distributors and key customers to help identify, assess and manage climate risks.

Recommendations for the disclosure of physical climate opportunities	
Opportunities	<ul style="list-style-type: none"> Identify opportunities inherent in managing existing and emerging physical climate risks. Identify opportunities based on adapting to market shifts driven by a changing climate.
Timeframe	<ul style="list-style-type: none"> Assess and disclose opportunities using an adequate timeframe, according to the industry and the type of opportunity: <ul style="list-style-type: none"> snapshot of current context (shortest timeframe) business planning timeframe asset lifespan (longest timeframe)
Level	<ul style="list-style-type: none"> Disclose physical climate opportunities at the segment level. Disclose climate resilience benefits at the facility-level for critical facilities.
Metrics for climate resilience benefits	<ul style="list-style-type: none"> Disclose benefits of climate resilience investments using the same metrics that are used for the disclosure or physical climate risks. In addition, whenever possible, assess and disclose public co-benefits from climate resilience investments (i.e., the wider economic benefits of managing physical climate risks).
Metrics for business opportunities	<ul style="list-style-type: none"> Disclose qualitative information on the life-cycle of a new commercial opportunity, including: <ul style="list-style-type: none"> the development stage of an endeavour; the business area and connection to company's core business; the size of the potential market; and the approximate timeframe for commercial viability.

Source: European Bank for Reconstruction and Development and Global Centre of Excellence on Climate Adaptation (2018)

provide a platform of evidence that can guide implementation and recommend corrective measures. The guidance recognizes that resilience-building occurs in the context of uncertain climate futures that present one of numerous methodological challenges to resilience M&E (see Table 5). These challenges translate into four guiding principles for designing a resilience M&E system that are outlined in the guidance (see Table 14). The guidance also discusses resilience-related design considerations for the respective components of an M&E system and results framework.

Development of a Resilience Rating System

Although the joint MDB methodology on adaptation finance tracking has helped provide comparable numbers across institutions, it has its limitations. The methodology is input-based

and uses a granular approach that captures only the financing that is dedicated to adaptation and resilience investments. However, it is not equipped to capture the benefits generated by these investments, which could be significantly higher than their costs. In other words, the climate finance estimated using this methodology may not capture the full value of project finance that contributes to climate resilience. For instance, the granular approach would capture the incremental financing required to construct storm-water drains designed to higher specifications than the standard, but it would fail to capture the value of the contribution that this project would have to the overall resilience of the drainage system and project area. Additionally, the methodology has limitations in capturing the benefits of activities that enhance the adaptive capacity of beneficiaries but are difficult to quantify.

TABLE 14 Guiding principles for designing a resilience M&E system

Principle	Explanation
Principle 1: Build innovative and flexible M&E systems that can be improved over time, and expand M&E to not only focus on accountability and building transparency, but also learning	The components of M&E systems designed for accountability (holding projects responsible for the delivery of a set of key results) often contrast—but need not to—with those of M&E systems that also integrate learning objectives. Having robust M&E systems leads to improved transparency, and thus improved decision-making, justifying their use. The continuous opportunities for improvement, learning should also be centrally incorporated into every resilience M&E system. Resilience M&E should intentionally focus on innovation, creativity, and experimentation. It should go beyond traditional good practice methods by recognizing the experimental, learning-by-doing nature of complex interventions and by adopting flexible results frameworks and indicators (e.g., moving away from fixed targets and defining evolving targets and regular course-corrections).
Principle 2: Emphasize local-contexts and a beneficiary focus by building on participatory approaches	Given that resilience depends on context, it is essential that resilience-building operations and their M&E systems are not only specifically designed for but also with the program’s intended beneficiaries. Design considerations for resilience M&E systems may require expert judgements and/or quantitative data that precisely identifies and measures subtle but critically important local features. A participatory approach that draws beneficiaries into the M&E process provides a means to not only overcome such constraints, but also the opportunity to strengthen task team understanding and interpretation of interacting factors and changing conditions with local knowledge.
Principle 3: Build from existing reporting frameworks, systems, and requirements to keep data and capacity needs manageable	As far as these are relevant and can properly capture resilience results, resilience M&E systems should look to align with existing M&E frameworks including: indicator systems of relevant international agreements; resilience related funds and initiatives; and corporate results frameworks.
Principle 4: Integrate multi-dimensionality, interactions between sectors and actors, and feedback-loops	Resilience M&E should consider the complexity and numerous dimensions of resilience through multiple climate and disaster hazards and their relationship with other stressors. Vertical interaction of different scales of decision making and project implementation (local, regional, national, etc.), as well as horizontal interactions (different stakeholders and sectors), different timescales (short, medium, and long term), and a variety of uncertain factors and drivers should also be considered. Multiplier, spill-over, and demonstration effects may be difficult to identify and characterize ex ante (e.g., maladaptation) – these and other impacts that go beyond the intervention’s direct scope should still be reflected in the resilience M&E system.

Source: World Bank (2017b)

Private investors are showing an increasing interest in measuring climate resilience but lack consistent guidance on what constitutes a climate-resilient investment. To identify these dimensions and complement existing measurement systems, the World Bank is committed to developing a *resilience rating system* to inform investors and decision-makers more appropriately on the resilience characteristics of their projects. This rating system would translate the highly technical information that already exists in project documents into a simple rating that can be of use to people without an engineering background.

The resilience rating system will rate projects along two dimensions of resilience:

*Dimension 1: the resilience **of** investments and projects.*

This dimension measures the extent to which a project has accounted for how climate and disaster risks may impact on the ability of an intervention to achieve its objectives. The rating, expressed in letter grades A+ to D, will assess the level of confidence that financial, environmental, and social underperformance as a result of climate impacts can be avoided. With a low rating, and everything else being equal, the expected rate of return will only be reached when disasters and climate change have no material effects on the investment.

*Dimension 2: resilience building **through** investments and projects.* This dimension measures the extent to which a project enhances resilience. Targeted investments, or specific components of investments, are often designed with the objective, or sub-objective, of building resilience for the community, ecosystem, or asset network. An example of this is when a seawall or a drainage system is needed to manage storm surges or heavy precipitation in cities. Such investments support resilience-building against current and future risks. The rating conditions for this category – also expressed with letter grades – will of necessity be less technical than those of the first category, and will depend, inter alia, on beneficiaries and related vulnerabilities.

The objective of this two-dimension rating system is to ensure that each and every investment made by the private or public sector gives due consideration to natural disaster and climate change risks by examining its own resilience and promoting those investments that help to build resilience. New metrics will be developed by building on past methodological work and case studies and will complement the adaptation finance methodology cur-

rently in use.¹²⁵ The new system will be piloted during fiscal year 2019–2020, with an anticipated roll-out to projects in relevant sectors by fiscal year 2021.

4.3.5 THE WAY FORWARD

Important insights can be gained from the TCFD 2019 Status Report,¹²⁶ which notes, that while important progress is being made with climate-related disclosures, the amount of information being disclosed is still insufficient for financial markets to take effective action in responding to the climate crisis. Notably, the report finds that financing institutions and companies struggle with the lack of standardized metrics and targets available for climate disclosures. There is a need for more clarity regarding the financial impacts of climate issues on companies, and climate-related disclosures need to result in more decision-useful information.

As this section has shown, the use of climate resilience metrics within financing operations is still in its infancy and will require much more innovation, piloting, and lesson-learning in the years ahead. At the same time, its development and dissemination across diverse types of financing institutions and across financial markets more widely is accelerating. MDBs and other DFIs have an important role to play in supporting the innovation and outreach that will be needed. This includes ensuring that emerging markets and developing countries are both included in the development of important methodologies and are able to benefit from subsequent developments that will influence the way in which capital is allocated with respect to the management of physical climate risks and the task of building climate resilience.

5 Lessons and recommendations from current practices on adaptation metrics

The review of the landscape of adaptation metrics and current practices in the previous sections leads to several lessons in guiding effective and useful applications of adaptation metrics. These are summarized under four main headings: (1) clarifying the purpose of metrics and ensuring supportive institutional arrangements; (2) promoting an understanding of adaptation outcomes that goes beyond monitoring; (3) making metrics fit for purpose and increasing their transparency; and (4) enhancing the com-

parability, consistency, and comprehensiveness of adaptation frameworks and their associated indicators. Finally, the section provides some recommendations on how the use of adaptation metrics can be promoted further.

1. Clarify the purpose of metrics and ensure supportive institutional arrangements

CLARIFY WHAT ADAPTATION METRICS ARE INTENDED TO ACHIEVE AND HOW

This paper highlights the importance of clarifying upfront the exact purpose of assessing adaptation and the use of metrics in order to do so. For every adaptation metric, one should therefore ask:

- **Whether the metrics actually measure what they are intended to measure.** As Hallegatte and Engle observe, there is a tendency to measure whatever is easiest to measure, even if it leads to an impartial view of what is intended to be measured. If a lack of data or other challenges mean that the actual phenomenon of interest cannot be measured directly, and indirect indicators are chosen mainly on the basis of data availability, then their validity needs to be scrutinized.^{xii} It might be useful to supplement such proxy indicators with additional (qualitative) information.
- **How the information generated by the indicators is being communicated and whether it reaches the intended audiences.** If metrics are supposed to promote adaptation, then the gathered data needs to be made accessible and linked to decision-making processes. For example, the UK Climate Act mandates the government to respond to the findings of the progress assessments made by the independent UK Committee on Climate Change. This procedure ensures that M&E findings will be inserted into the regular revision of the UK's National Adaptation Programme.

ENSURE INSTITUTIONAL ARRANGEMENTS ARE FUNCTIONAL AND SUPPORTIVE

Experiences from national and sectoral adaptation M&E systems show that getting suitable institutional arrange-

xii To reuse the example from section 2.2, the indicator "percentage of households with internet access" does not directly measure adaptation. Assumptions need to be made regarding how far it would be relevant (that is, valid) to capture something about adaptation or resilience.

ments in place can make all the difference between a well-functioning and a non-performing adaptation M&E system.^{xiii} Effective M&E requires collaboration among multiple actors, first in the development of the M&E system, including its metrics, and then in ensuring the exchange of data and information. On the technical side, this involves agreeing on the roles, responsibilities, and legal aspects of information generation and exchange, but equally important is obtaining active buy-in and support from various stakeholders to ensure the M&E system is perceived as legitimate and useful. Experience from several countries shows that it can be challenging to engage ministries and other (non-) government entities unless they see the value of adaptation M&E and that it is reasonably aligned with their own plans and activities.

2. Promote understanding of adaptation outcomes beyond simple monitoring

DEVELOP LOGICAL MODELS BASED ON SOUND THEORIES OF CHANGE TO SITUATE ADAPTATION METRICS

If adaptation metrics are meant to foster understanding of adaptation, they need to refer to a logical model of some sort, like a theory of change that outlines how adaptation is assumed to take place.¹²⁷ These logical models help us decide what metrics are needed and bring the chosen metrics in relation to each other (see Box 4). A theory of change needs to make explicit the assumptions under which activities are expected to lead to outcomes, which can also help in the interpretation of metrics. It is likewise important to monitor over time whether the assumptions made in the logical model hold true. Care should be taken to develop the theory of change in a participatory and inclusive way, since the social exclusion of key groups could negatively affect the effectiveness and legitimacy of adaptation measures.¹²⁸

GO BEYOND THE OUTPUT LEVEL

Many adaptation indicators still focus on simple counting, such as number of people or number of policies. While these may be useful process or output indicators in monitoring implementation, they do not convey information about the use and effectiveness of these outputs, i.e.,

xiii Examples of national adaptation M&E systems are available at: <https://www.adaptationcommunity.net/monitoring-evaluation/national-level-adaptation/examples-of-national-me-systems/>

A logical model is a way of illustrating how change is expected to happen, i.e., how activities are expected to lead to a desired outcome. Logical models have the potential to improve interventions by clarifying who and what needs to interact to achieve lasting positive change and what assumptions are being made along the way. For example, if an adaptation project provides climate information to farmers, the assumption might be that farmers will understand and use it and that this will eventually lead to greater food security (see, for example, McKunea et al.).¹²⁹ These assumptions should be validated by the target audience and reality-checked as implementation progresses. This should help avoid simplified assumptions which might turn out not to be correct. For example, male out-migration in Nepal has been found both to improve and to worsen the food security of their households, so assumptions of a linear and universally positive relationship would have led to misleading conclusions.¹³⁰

Logical models can take different forms, for example, as a traditional linear logical framework or as a theory of change (see Bours et al. for a comparison,¹³¹ and Mayne and Johnson for an example in the CGIAR research program).¹³² Theories of change offer the potential to capture dynamic interactions better, but their application varies greatly among organizations (see Vogel).¹³³ Whatever format is chosen, care should be taken to develop it in a participatory and inclusive way, since the social exclusion of key groups could negatively affect the effectiveness and legitimacy of adaptation measures.¹³⁴

Source: Produced by authors

their uptake and results in terms of climate risk reduction. To improve understanding of adaptation and resilience-building, it is essential to link these output indicators to outcome indicators. If it is not possible to measure outcomes due, for example, to the limited time horizon of an intervention, attempts should at least be made to measure the use of outputs, for instance, whether participants in capacity-building measures apply the knowledge they have learned, whether farmers adopt more adaptive techniques, or whether newly introduced climate services are indeed being sought by the target audience.

PAY CLOSER ATTENTION TO UNDERSTANDING, RATHER THAN JUST MONITORING ADAPTATION

The current practices of adaptation metrics focus on monitoring rather than evaluating whether adaptation has worked and for whom. Increased attention to evaluation is needed to enhance our understanding of adaptation, including whether those most at risk benefit from it. Evaluation seeks explanations for observed developments and can be done in a variety of ways and with different degrees of resource requirements (an overview of impact evaluation techniques for adaptation is presented in Silvestrini et al. and World Bank).¹³⁵ More attention should be paid to interpret monitoring results and to choose adaptation metrics that can lay the foundation for process or impact evaluations. Providing qualitative information next to quantitative indicators can aid their interpretation and counter some of the limitations of indicators (see section 2.3).

3. Make metrics fit for purpose and increase their transparency

ENSURE THAT INDICATORS AND TARGETS PROVIDE THE RIGHT INCENTIVES

As Levine pointed out in her review of resilience measurement frameworks, “when we try to measure what is important, we make important what it is that we measure”.¹³⁶ Care should be taken in the choice of targets, indicators, and data sources that are used as performance measures to avoid unintended consequences and false incentives, for example, that projects are developed in such a way as to maximize indicator values rather than development outcomes.¹³⁷ Conversely one should reflect over what has been left out of the process of measuring that might still be important in order to understand adaptation.

INCREASE THE TRANSPARENCY OF THE CALCULATION AND INTERPRETATION OF METRICS

The use and interpretation of adaptation metrics requires clarity and detail regarding calculations and data sources. Even indicators that are seemingly straightforward to measure, such as ‘number of beneficiaries’, can lead to different results if there is no guidance on whom to count as a beneficiary. Variability in measurement can render indicators unreliable to the point where their data can no longer be used.¹³⁸ Hence, even seemingly identical indicators are

not necessarily comparable unless the underlying methodologies are consistent and comparable and the respective data sources of similar quality. The international debate on adaptation metrics therefore needs to go beyond just seeking common indicator titles to discussing common methods of calculating indicators. The details that help make indicators operational and comparable can be specified in indicator factsheets as practiced by most international climate funds (see section 2.2).

CONSIDER THE TRADE-OFFS IN AGGREGATED METRICS

Be mindful of the purposes, or types of questions, that can be meaningfully explored by means of aggregated adaptation metrics. There is a trade-off between the level of aggregation and the context-sensitivity of adaptation metrics. This implies that aggregated metrics inevitably lose details that reduce their interpretive ability. Hence, global assessments based solely on quantitative standard indicators will not be able to explain the causes of progress. On the other hand, tracking adaptation progress across scales and contexts, and over time, is essential if our understanding of collective progress with adaptation is to be taken forward. The challenge is to find a compromise between comparability and meaningfulness.

USE INDICES IN CONCERT WITH OTHER METRICS AND EVALUATIONS

Indices that combine multiple factors into a single number have a certain attraction since they appear to reduce a complex reality to a single answer. Yet, as argued in section 2.3, the design of an index very much influences its results to the extent that indices that purport to measure the same phenomenon can reach very different conclusions.¹³⁹ Hence, there is often a disconnect between what indices are expected to do, namely guide decision-making, and what they can actually do well, namely to raise awareness and stimulate public debate. Before developing a new index, one should therefore reflect what information they can provide and how this could fulfil the intended M&E purpose.

PROMOTE CLARITY AND TRANSPARENCY IN TERMINOLOGY

Due to the differences in meanings attached to the same terms it is important to explain upfront the chosen terminology to avoid misinterpretations by others. This applies

to climate change as well as to M&E terminology (e.g., regarding the concepts of resilience and adaptation, or the terms 'metrics' and 'indicators'). Definitions should be transparent, and differences to key reference definitions such as those by the IPCC's latest assessment reports should be pointed out.

4. Enhance the comparability, consistency, and comprehensiveness of adaptation frameworks and associated indicators

LEARN FROM DEVELOPMENT APPROACHES

Adaptation processes are similar to and often inseparable from development and require similar approaches to establishing and using metrics. The close links between adaptation, development and non-climatic change reinforce the importance of adaptive management and robust models of results. As with sustainable development, there is no single global metric for adaptation, but there is great potential for creating sets of adaptation metrics that allow a certain degree of comparability and standardization within sectors and themes. Such metrics would be used alongside context-specific ones, and each would serve a different purpose.

INDUCE COLLABORATION BETWEEN KEY ACTORS IN VARIOUS SECTORS AND THEMATIC AREAS

The fact that available adaptation assessment frameworks are not designed with inter-comparison or synthesis in mind limits our ability to track and assess adaptation progress across contexts and scales, including our understanding of the factors that explain differences in performance across programs, sectors, regions, and countries.¹⁴⁰ This background paper highlights current practice in a few important areas (agriculture, cities, and finance and investment), where collaborative efforts to establish more systematic and comparable adaptation frameworks and metrics are progressing. Similar collaboration exists in a number of other sectors and thematic areas, but it could be advanced and incentivized further to create more systematic and transparent approaches to generating and selecting effective adaptation metrics.

EXPLORE OPTIONS TO BUILD ON AND FURTHER DEVELOP EXISTING FRAMEWORKS, INDICATORS AND DATA SOURCES

Key barriers for advancing the use of adaptation metrics include a lack of data and a lack of resources. Opportunities to build on existing frameworks, indicators, and data sources should therefore be explored. At the global level, the established framework under the 2030 Agenda for Sustainable Development could be the starting point for adaptation tracking. Many of its existing indicators can be used for adaptation assessment purposes, but they might need to be accompanied by country-driven assessments. Drawing more broadly on existing data sources and bases should be explored further as a means to overcome challenges in the availability and collection of data.

Building on these lessons, we recommend that the Global Commission on Adaptation promotes the following to foster the use of adaptation metrics:

PROMOTE LEARNING AND UNDERSTANDING OF ADAPTATION PROGRESS

Given the increasing magnitude of climate change and its associated risks, as documented in the IPCC 1.5°C report,¹⁴¹ it is essential to understand whether progress on adaptation and climate risk reduction is being made. The Paris Agreement therefore includes a provision for “monitoring and evaluating and learning from adaptation plans, policies, programs and actions” (Art. 7.9d). Eventually, adaptation evaluations need to go beyond the output level to examine how outputs have been used and whether they have had any effect on resilience. The Global Commission on Adaptation should therefore recommend to all implementers of adaptation, as well as their funders, that they embed continuous learning and assessments of adaptation outcomes into their operations and allocate resources appropriately. Experiences and findings should be made openly accessible online. Gaining better evidence of what works in respect of adaptation would enhance its effectiveness and support the collective assessment of progress towards achieving the long-term goals of the Paris Agreement.

UTILIZE TECHNOLOGY TO ENHANCE DATA SOURCES FOR ADAPTATION METRICS

Mobile phones offer a huge potential for people to provide and receive information related to adaptation and resilience. For instance, the World Food Programme’s mobile assessments proved to be faster and cheaper (3-9 USD/household) than conventional assessments (20-40 USD/household).¹⁴² In Tanzania mobile assessments have been used to monitor household resilience over time,¹⁴³ and such assessments have been found to be reliable compared to traditional survey methods.¹⁴⁴ Automatically generated data from mobile phones offers further opportunities, for example, to analyze people flows following natural disasters, which can inform emergency response measures.¹⁴⁵ Remote sensing also offers opportunities to gather data at higher frequencies, in comparative formats, and in areas that are otherwise difficult to survey. Earth observation data from the EU’s Copernicus Programme (available open access) has been found to strongly or significantly support data needs for up to 25 percent of SDG indicators.¹⁴⁶ Initiatives such as the European Space Agency’s Earth Observation for Sustainable Development promote the utilization of available data.^{xiv} Overall, big data has a huge potential to track progress on adaptation to climate change.¹⁴⁷

COMBINE MULTIPLE DATA SOURCES FOR MORE NUANCED ADAPTATION METRICS

Operationalizing more nuanced adaptation metrics beyond simple counting ones like ‘number of X’ often requires combining different data sets. For example, New York City combined data on road closures and extreme weather events, both of which were already being routinely collected, with a metric for climate-related impacts on road mobility.¹⁴⁸ To facilitate the combining of data from different sources, several international standards have been developed. The ISO 19000 series includes standards on geographical information.^{xv} Furthermore, synchronized collection and assessment of biophysical data (from earth observation, for example) with socioeconomic data (e.g., through high-frequency mobile surveys) helps improve understanding of adaptation responses and inform future actions.¹⁴⁹ Quantitative indicators may be accompanied by qualitative

xiv Available at: <http://eo4sd.esa.int/>

xv Available at: https://ec.europa.eu/eip/ageing/standards/ict-and-communication/data/iso-19000-series_en

information to aid in the interpretation and understanding of adaptation processes. Examples include the adaptation stories published by the Adaptation Fund alongside its results indicators, and the 'sNAPshot' briefings of the NAP Global Network.^{xvi}

PROMOTE ROBUST RESULTS MODELS AND ADAPTATION METRICS

Due to the diversity of adaptation, sectors or themes will likely be more meaningful for the exploration of similar adaptation metrics than searching for universal adaptation metrics that are often limited in specificity and outcome-orientation (compare section 2). Sectoral initiatives such as those by the FAO and the MDB group (see section 4)

xvi Available at: http://napglobalnetwork.org/resources/?resource-type=87#resource_list

offer an opportunity to be more systematic in advancing adaptation metrics and measurement methods that could be adopted by new adaptation actions. The goal should be to better account for adaptation benefits and for progress made beyond outputs. At the same time, the practices reviewed here also clearly indicate the continued importance of context-specific adaptation metrics and logical models. Both context-specific and more standardized metrics should complement each other by addressing different purposes. Moving towards making better use of adaptation metrics and understanding adaptation outcomes better could aid countries in their planning, implementation, and reporting in the context of their National Adaptation Plan processes and in providing information to the international community under the Paris Agreement.

ENDNOTES

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ABOUT THE RESEARCH INSTITUTION

UNEP DTU Partnership is a leading international research and advisory institution on energy, climate and sustainable development.

Its work focuses on assisting developing countries transition towards more low carbon development paths, and supports integration of climate-resilience in national development through in-depth research, policy analysis, and capacity building activities. UNEP DTU employs 70 researchers of 26 different nationalities working around the world from offices in UN City, Copenhagen.

As a UN Environment Collaborating Centre, UNEP DTU Partnership is actively engaged in implementing UN Environment's Climate Change Strategy and Energy Programme and as part of the Technical University of Denmark, one of Europe's leading universities, UNEP DTU Partnership is able to draw on a vast range of scientific expertise and to collaborate with world-leading scientific partners to conduct the research that serves as a foundation for its activities.

ABOUT THE GLOBAL COMMISSION ON ADAPTATION

The Global Commission on Adaptation seeks to accelerate adaptation action and support by elevating the political visibility of adaptation and focusing on concrete solutions. It is convened by 20 countries and guided by more than 30 Commissioners, and co-managed by the Global Center on Adaptation and World Resources Institute.