



Working paper

Measuring adaptation and resilience: An annotated bibliography

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Introduction

Climate change is happening, and it is having profound impacts on social and ecological systems. Governments and communities are taking action to adapt and become more climate-resilient.¹ Adaptation intervention and resilience-building are thus taking place in all countries, particularly in developing contexts. Some of these are uniquely vulnerable to climate change, such as small island developing states (SIDS). It is critical that adaptation and resilience-building are measured to determine whether key indicators are being met and outcomes achieved. This is particularly important for developing country governments that must make the case for financing, and international climate finance institutions that are mandated to provide funding. SIDS, especially, seek to make their systems more adaptive and resilient but often lack the human, financial and technological resources to do so, or to report fully on progress made and generate prospects for further funding support. This annotated bibliography provides a summary of 45 sources from the policy and academic contexts; they outline ways that adaptation and resilience are, or can be, measured. It is of general relevance to those working in climate and development but is produced specifically with SIDS in mind.

A wealth of measurement ideas, tools and metrics have emerged in the past two decades to understand and track progress on adaptation and resilience. This annotated bibliography presents a range of important reference works in the field, focusing on sources after 2000, and with a particular emphasis on works published since 2010, which may reflect recent advances. The approach taken to prepare this document involved two processes: (1) using Google Scholar and websites of think tanks and international organisations to identify articles. These were initially screened using their titles and abstracts. Those selected were then read

to extract relevant information; and (2) the bibliographies of these documents were used to identify other articles. This annotated bibliography uses the *Chicago Manual of Style* 17th Edition Full Note.

This work mainly excludes studies that, while they may examine adaptation and resilience measurements, are focused on a developed country, non-SIDS context (though exceptions were made in areas where there are notable applications to SIDS). For example, case studies such as 'Climate Resilience Metrics: Putting them to Work in California' were excluded. Developing non-SIDS contexts were also consulted, such as articles about the Sundarbans mangrove forests of India. This annotated bibliography targeted articles that are about human resilience in the context of social and ecological systems affected by climate change. It does not consider articles about other species' resilience in the absence of an explicit connection to society and economy.

This work excluded most meta-analyses – documents that outline or analyse resilience and adaptation frameworks. These were, however, consulted to gather other resources via snowballing. It also does not cover works that are solely concerned with vulnerability assessment, although levels of climate-related vulnerability are currently one element of people's, institutions' and systems' climate resilience and progress on climate change adaptation. There is a plethora of climate vulnerability and risk assessment methods and metrics, including a High Level Panel on the Multidimensional Vulnerability Index that is currently preparing its final report. The criteria for inclusion in this annotated bibliography were that the work should be addressing not only the measurement of climate-related vulnerability but also measures of adaptive capacity, readiness or preparedness to act in the face of imminent climate shocks; and/or adaptation progress.

¹ IPCC (2023) *Synthesis Report of the IPCC Sixth Assessment Report (AR6)*. Geneva: Intergovernmental Panel on Climate Change (https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf).

Books and journal articles

Béné, Christophe. "Towards a Quantifiable Measure of Resilience." *IDS Working Papers* 2013, no. 434 (2013): 1–27. <https://doi.org/10.1111/j.2040-0209.2013.00434.x>.

This paper proposes a new framework that seeks to address some of the concerns and limitations of resilience measurement identified within the existing literature. The main argument put forward is that 'the costs of resilience' provide an appropriate and independent metric to measure resilience across scales and dimensions. Therefore, it proposes measuring resilience in terms of the costs that a household (or community or ecosystem) has to pay to pass through a particular shock. These costs can be broken down into three categories: *ex ante* investments in preparation for the shock, cost of destruction following the shock, and cost of recovery.

The author offers a simple formula: resilience costs = anticipation costs + impact costs + recovery costs, and postulates that quantifying these resilience costs 'gives an indication of the level of resilience of a system' (p. 14).

Berrang-Ford, Lea, Robert Biesbroek, James D. Ford, Alexandra Lesnikowski, Andrew Tanabe, Frances M. Wang, Chen Chen, et al. "Tracking Global Climate Change Adaptation among Governments." *Nature Climate Change* 9, no. 6 (June 2019): 440–49. <https://doi.org/10.1038/s41558-019-0490-0>.

This paper proposes a comprehensive conceptual framework for assessing adaptation progress by governments that is scalable over time and across contexts. This involves bringing into alignment four components: vulnerability profile and context, adaptation goals and targets, adaptation efforts, and adaptation results. Key concepts, elements and questions are then used to systematically assess adaptation over time and across governments. For example, under 'vulnerability profile and context', descriptive assessment is a key element, and a critical question to be answered is: what are the key climate risks (exposures), non-climatic factors (sensitivities)

and coping/response capacities (adaptive capacity) affecting vulnerability? (pp. 441 and 442).

Christiansen, Lars, Gerardo Martinez, and Prakriti Naswa, eds. *Adaptation Metrics: Perspectives on Measuring, Aggregating and Comparing Adaptation Results*. UDP Perspectives Series 2018/1. Copenhagen: UNEP DTU Partnership, 2018. https://resilientcities2018.iclei.org/wp-content/uploads/UDP_Perspectives-Adaptation-Metrics-WEB.pdf.

This guidebook brings together global experts and practitioners who present unique and novel perspectives on measuring adaptation. The guidebook has chapters that explore the development of universal metrics for adaptation and resilience effectiveness, and contains case studies such as the development of national and subnational adaptation metrics in Kenya. This case study highlights Kenya's national system capable of aggregating subnational adaptation data through the monitoring, reporting and verification (MRV+) system. The MRV+ uses such process and outcome indicators as:

- percentage of classified roads maintained and rehabilitated
- number of urban slums with physical and social infrastructure installed annually
- number of households in need of food aid
- percentage of people by gender in a country permanently displaced from their homes as a result of floods, drought or rising sea levels
- percentage of water demand that is supplied in counties.

In the case study, national adaptation plan indicators were also used to measure indicators at the national, sectoral and county levels. These include Human Development Index, amount of private sector financing for adaptation, and percentage of population requiring humanitarian assistance.

Constas, Mark A., Marco d'Errico, and Rebecca Pietrelli. "Toward Core Indicators for Resilience Analysis: A Framework to Promote Harmonized Metrics and Empirical Coherence." *Global Food Security* 35 (December 1, 2022): 100655. <https://doi.org/10.1016/j.gfs.2022.100655>.

This article is centred on the concern that there are too many resilience measurement approaches in circulation. It specifies core indicators for resilience analysis and offers a framework on which harmonised metrics for resilience measurement may be based. It proposes a core indicator resilience analysis (CIRA) structured around: (1) foundational resilience concepts; (2) resilience measurement domains; and (3) integrated resilience measurement (p. 2). These are used in conjunction with broad indicator categories – i.e. well-being and shocks and stressors – and resilience measurement sensitivity properties such as thresholds and temporal qualities. These are then used with more specific indicators, such as personal safety and physical and mental health.

Craft, Brianna, and Susannah Fisher. "Measuring the Adaptation Goal in the Global Stocktake of the Paris Agreement." *Climate Policy* 18, no. 9 (October 21, 2018): 1203–9. <https://doi.org/10.1080/14693062.2018.1485546>.

This article proposes that progress on adaptation can be measured using the following approaches:

- Using a set of common domains with some core and context-specific metrics. This involves using a combination of core indicators for aggregation and national-level metrics that are context specific.
- Using process/institutional and outcomes-based indicators. The latter bring long-term perspectives and require parties to outline national pathways for each outcome, which supports learning and the enhancement of national activities. The former, captured using scorecards through participatory methods, can be used to monitor institutional change.
- Using national data on adaptation that can be found in national climate change plans and United Nations Framework Convention on Climate Change (UNFCCC) reporting, as well as in indicators within development plans, national statistical surveys and reporting, among other sources.
- Using expert assessments and/or a composite index to supplement national compilation.

DasGupta, Rajarshi, and Rajib Shaw. "An Indicator Based Approach to Assess Coastal Communities' Resilience against Climate Related Disasters in Indian Sundarbans." *Journal of Coastal Conservation* 19, no. 1 (February 2015): 85–101. <https://doi.org/10.1007/s11852-014-0369-1>.

This article 'attempts to develop a five dimensional community resilience assessment framework and a composite resilience index against climate related disasters with special application to the coastal rural communities in the developing world' (p. 85). The study used surveys to assess 19 coastal administrative blocks of Indian Sundarbans (103 low-lying deltaic islands). Specifically, the study developed dimensions, indicators and variables that can be applied at the community scale in rural coastal areas, then assessed the community resilience profile of the study area through methodological application of the framework. The framework considered five dimensions of coastal resilience: socio-economic, physical (structural), institutional, coastal zone management (ecological) and environmental/natural resilience (p. 88). Under each dimension, 5 major indicators and 25 variables were framed, and 125 variables were also applied. A questionnaire was formulated on this framework and used to prioritise components (the variables, indicators and dimensions), to which weights were then added. A composite resilience score was then calculated from the weighted mean score of the five dimensions.

Donatti, Camila I., Celia A. Harvey, David Hole, Steven N. Panfil, and Hanna Schurman. "Indicators to Measure the Climate Change Adaptation Outcomes of Ecosystem-Based Adaptation." *Climatic Change* 158, no. 3 (February 1, 2020): 413–33. <https://doi.org/10.1007/s10584-019-02565-9>.

This article reviews 58 ecosystem-based adaptation projects implemented globally, and obtained recommendations from experts on what indicators ought to be used to measure outcomes. This is to allow for identification of adaptation outcomes that could be achieved through Ecosystem Based Adaptation (EBA) projects, such as reducing the loss of coastal communities due to extreme events, and the indicators that could be used to measure corresponding adaptation outcomes. The article identified seven indicators to monitor the success of EBA projects. It also outlines commonly used indicators to measure outcomes, such as 'change in income', and the most commonly used output indicator: 'number of hectares protected'.

Engle, Nathan L., Ariane de Bremond, Elizabeth L. Malone, and Richard H. Moss. "Towards a Resilience Indicator Framework for Making Climate Change Adaptation Decisions." *Mitigation and Adaptation Strategies for Global Change* 19, no. 8 (December 1, 2014): 1295–312. <https://doi.org/10.1007/s11027-013-9475-x>.

This article recommends using a resilience assessment framework that utilises both quantitative and qualitative sources to inform development decisions in the context of climate change adaptation. The authors advocate for more case study research, focus groups, interviews and surveys to supplement quantitative measurements and mitigate their shortcomings. These, they argue, 'provide process-related and context-specific information that indicators often miss' (p. 1301). They advocate consulting with stakeholders to develop indicators across five categories: (1) governance and security; (2) natural resource systems; (3) social systems; (4) economic systems; and (5) built environment/infrastructure. The authors propose developing two dimensions within each category: short-term coping and long-term adaptation indicators, to capture both temporal aspects of resilience. The indicators should then be presented at different spatial scales: immediate project objectives and the broader community (aggregate) (p. 1303). The paper goes on to outline five principles that the hybrid framework should apply.

Ford, James, Lea Berrang-Ford, Alex Lesnikowski, Magda Barrera, and S. Jody Heymann. "How to Track Adaptation to Climate Change: A Typology of Approaches for National-Level Application." *Ecology and Society* 18, no. 3 (September 27, 2013). <https://doi.org/10.5751/ES-05732-180340>.

This paper outlines a 'typology of approaches by which climate change adaptation can be tracked globally at the national level' (p. 39). It highlights three challenges involved in tracking adaptation: (1) defining what it looks like in practice; (2) defining success criteria relating to reducing vulnerability; and (3) identifying appropriate data sources needed to develop and track indicators on adaptation, and developing data collection methods and reporting. The paper outlines such mechanisms as outcome-based, preparedness, process and policy-based approaches to adaptation tracking, as well as institutional factors that can be used to evaluate adaptation readiness. For example, an outcome-based evaluation could quantify changes in

the negative outcomes of climate change, by tracking climate-related losses, mortality and morbidity over time. Analysis of this data would be informed by adaptation measures being taken over the same period. A data source could be an emergency events database (p. 40).

Guillaumont, Patrick. "Measuring Vulnerability to Climate Change for Allocating Funds to Adaptation." In *Towards a Workable and Effective Climate Regime*, edited by Scott Barrett, Carraro Carlo, and Jaime de Melo. London: CEPR Press, 2015. <https://cepr.org/publications/books-and-reports/towards-workable-and-effective-climate-regime>.

This chapter examines how the concessional funds for adaptation should be allocated. It proposes a vulnerability-based allocation (VBA) principle where funds are allocated to developing countries primarily according to their vulnerability to climate change (p. 515). The chapter proposes the use of a 'physical index of vulnerability to climate change that is exogenous, implies no socioeconomic estimates, and captures in an adaptive way the impact of change, rather than just the climate itself' (p. 521). It proposes the use of 'adaptation credits', which would be distributed using a formula based on physical vulnerability to climate change, size of the population and income per head (and/or the level of human capital). A simulation was run using the formula; it demonstrated that least developed countries (LDCs) would receive over half of adaptation credits.

Hallegatte, Stephane, and Nathan L. Engle. "The Search for the Perfect Indicator: Reflections on Monitoring and Evaluation of Resilience for Improved Climate Risk Management." *Climate Risk Management* 23 (January 1, 2019): 1–6. <https://doi.org/10.1016/j.crm.2018.12.001>.

This article outlines the importance of resilience metrics for the continued improvement of development aid delivery. The paper's central theme surrounds the dangers of using the wrong indicators to measure outcomes, as it is easy for maladjustments to occur, and for development agencies and climate support organisations to pursue perverse incentives. The usefulness of this paper is its application of thought experiments and scenarios to tease out a number of risks that bedevil the development of indicators for resilience outcome measurement in projects.

The paper outlines a list of seven characteristics important to development projects but which may be compromised by flawed resilience indicators: efficiency, context specificity, fairness, transformational quality, comprehensiveness, robustness and difficulty. It offers examples of how indicators can be improved and designed to capture various dimensions. These include combining several indicators. If an indicator is based on aggregated benefits, and therefore risks favouring better-off beneficiaries over poorer ones, a complementary indicator could be the same measure of aggregated benefits but only counting people who are in the bottom income percentile. The rationale of the authors is that 'a set of complementary indicators is less likely to lead to large negative outcomes than a single indicator' (p. 5).

Jones, Lindsey, and Thomas Tanner. "'Subjective Resilience': Using Perceptions to Quantify Household Resilience to Climate Extremes and Disasters." *Regional Environmental Change* 17, no. 1 (January 1, 2017): 229–43. <https://doi.org/10.1007/s10113-016-0995-2>.

This article advocates for the use of subjective methods of measuring resilience at the household level, using individuals' cognitive and affective self-evaluation of their household's capabilities and capacities in responding to risks. The article describes 'a number of options, and associated strengths and limitations in designing questions related to subjective resilience' (p. 234). These include coming to a decision on the type and scale of resilience to be investigated (livelihood resilience, community resilience, economic resilience, etc.). The article provides guidance on how to conduct qualitative resilience assessments. Specifically, it advocates for structured surveys that are 'easy to understand, low in ambiguity and do not burden the respondents' (p. 236), among other principles to be followed.

Klonschinski, Andrea. "Universal Metrics for Climate Change Adaptation Finance? A Cautionary Tale." *Sustainability* 13, no. 16 (January 2021): 9428. <https://doi.org/10.3390/su13169428>.

This paper is a critique of two recently proposed metrics: *Saved Wealth* and *Saved Health*. It outlines

the weaknesses of the metrics and proposes areas for further research to improve them. As noted by the author, '[T]he upshot of this paper is modest but important: designing universal adaptation metrics incorporating different adaptation aims is tremendously difficult and may not be feasible at all. To determine whether it is, further research on fundamental concepts, such as vulnerability, and the role efficiency considerations can and should play in priority setting is warranted' (p. 12).

Leiter, Timo, and Patrick Pringle. "Pitfalls and Potential of Measuring Climate Change Adaptation through Adaptation Metrics." In *Adaptation Metrics: Perspectives on Measuring, Aggregating and Comparing Adaptation Results*, edited by Lars Christiansen, Gerardo Martinez, and Prakriti Naswa, 29–47. UDP Perspectives Series 2018/1. Copenhagen: UNEP DTU Partnership, 2018. <https://unepccc.org/publications/adaptation-metrics-perspectives-on-measuring-aggregating-and-comparing-adaptation-results/>.

This article outlines different concepts for measuring adaptation through metrics, and highlights their potential and pitfalls. It 'examines distinct characteristics of climate change adaptation and mitigation and the implications for measuring progress in these two interrelated policy domains' (p. 29). It then presents and analyses the multiple purposes of adaptation metrics, including identifying adaptation needs, allocating resources, tracking implementation, assessing results and aggregation across scales. The paper, interestingly, notes that there is no universal indicator of adaptation, and argues that more effort should be placed on understanding how qualitative learning can interact with metrics. The chapter goes on to outline that vulnerability cannot be objectively defined, and thus will always involve value judgements. It proposes the use of national adaptation monitoring and evaluation (M&E) systems, accompanied by improved connectivity across policy themes and M&E systems that are designed to facilitate learning to gain important insights into adaptation. It points out that 'national adaptation systems provide opportunities to understand progress on adaptation and to inform national and international planning and decision making' (p. 40).

Prabhakar, S.V.R.K., Takuro Kobashi, and Ancha Srinivasan. "Monitoring Progress of Adaptation to Climate Change: The Use of Adaptation Metrics." *Asian Journal of Environment and Disaster Management (AJEDM) – Focusing on Pro-Active Risk Reduction in Asia* 02 (January 1, 2010): 435. <https://doi.org/10.3850/S1793924011000848>.

This article concludes that adaptive capacity of people and policies are important elements for identifying metrics, and recommends that adaptation metrics use more qualitative indicators. It goes on to outline critical criteria for adaptation metrics, including reliability, cost-effectiveness, measurability, comparability and local applicability. The article does not provide a framework for building adaptation metrics; however, it provides critical elements as to what the process should entail.

Quinlan, Allyson E., Marta Berbés-Blázquez, L. Jamila Haider, and Garry D. Peterson. "Measuring and Assessing Resilience: Broadening Understanding through Multiple Disciplinary Perspectives." *Journal of Applied Ecology* 53, no. 3 (2016): 677–87. <https://doi.org/10.1111/1365-2664.12550>.

This article discusses 'the strengths, limitations and trade-offs involved in both assessing and measuring resilience ... use[s] a range of disciplinary perspectives to draw lessons on distilling complex concepts into useful metrics' (p. 677). It draws on multiple disciplinary perspectives to explore resilience assessment and measurement in a range of contexts, and discusses some of the opportunities and challenges that come with its broadened applicability. The article concludes that how resilience strategies are organised and how governance systems are structured has implications for conducting resilience assessments. The same goes for whether the system is dynamic and itself resilient. Therefore, depending on the system itself, it can 'shift the focus from evaluating whether a local agricultural system is resilient, to whether management interventions applied to the agricultural system are resilient' (p. 684).

The article emphasises the principle of simplicity in designing resilience assessment and measurement, as this helps make sense of broad patterns and identify emergent properties – meaning that learning is maximised, new insights are detected, and new solutions derived.

Singh, Chandni, Soundarya Iyer, Mark G. New, Roger Few, Bhavana Kuchimanchi, Alcade C. Segnon, and Daniel Morchain. "Interrogating 'Effectiveness' in Climate Change Adaptation: 11 Guiding Principles for Adaptation Research and Practice." *Climate and Development* 14, no. 7 (August 9, 2022): 650–64. <https://doi.org/10.1080/17565529.2021.1964937>.

This article is mainly theoretical/conceptual: a demonstration of 'how different normative views on adaptation outcomes, arising from different epistemological and disciplinary entry points, can lead to very different interpretations of adaptation effectiveness' (p. 650). It argues that how 'effectiveness is framed will significantly impact adaptation implementation and outcomes' (p. 650), which is important as SIDS negotiate for adaptation funds in bilateral and multilateral arenas. The paper also distils principles in a way that pluralises guidance in international processes such as the Global Stocktake, as well as national and subnational exercises on tracking and monitoring adaptation.

Sono, Douglas, Ye Wei, and Ying Jin. "Assessing the Climate Resilience of Sub-Saharan Africa (SSA): A Metric-Based Approach." *Land* 10, no. 11 (November 2021): 1205. <https://doi.org/10.3390/land10111205>.

This article uses sub-Saharan countries as a study area to construct a pragmatic resilience metric called a composite national climate resilience index (CNCRI). The study assessed the CNCRI constructed from different components of five dimensions of climate resilience: social, economic, infrastructure, environmental and institutional. It sought to evaluate and compare the resilience of countries in sub-Saharan Africa through the use of composite index measurement and a vulnerability and readiness metric. Indices were created by combining different sets of variables using simple mathematical and statistical methods. The study is useful, as a similar method can be used to measure resilience in SIDS, given that Mauritius and Seychelles were included in the study.

Sterling, Eleanor, Tamara Ticktin, Tē Kipa Kēpa Morgan, Georgina Cullman, Diana Alvira, Pelika Andrade, Nadia Bergamini, et al. "Culturally Grounded Indicators of Resilience in Social-Ecological Systems." *Environment & Society* 2150-6779, no. 8 (September 2017): 63–95. <https://doi.org/10.3167/ares.2017.080104>.

This paper presents case studies on locally grounded indicators of resilience that include both socio-cultural (institutions, networks, knowledge systems) and ecological (biodiversity, habitat, ecosystem services) components and their combined ability to respond to disturbances (p. 64). The authors use this paper to advocate for a biocultural approach to developing indicators – one which includes local communities – as this ‘greatly facilitates local understanding of their development and use, and therefore may increase community ownership, adoption, and acceptance’ (p. 64). The article examines seven case studies and one framework to explore the development of locally relevant and culturally grounded indicator sets assessing coupled socio-ecological systems (p. 85).

International/non-governmental organisations (policy literature)

African Development Bank, Asian Development Bank, Asian Infrastructure Investment Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank, International Development Finance Club, and Islamic Development Bank. *A Framework and Principles for Climate Resilience Metrics in Financing Operations*. Washington, DC: Inter-American Development Bank, December 2019. <https://doi.org/10.18235/0002040>.

This report underscores the importance of metrics in assessing the outcomes of financial flows and the success of adaptation activities in achieving climate resilience goals. The report ‘sets out principles, including core concepts and other characteristics of climate resilience metrics, together with a high-level framework for such metrics in financing operations, focusing mainly on Multilateral Development Bank (MDB) and International Development Finance Club (IDFC) operations but with wider applicability to other types of finance institutions’ (p. 4). The report proposes a climate resilience metrics framework based on a logical model and results chain. It thus sets out principles and a high-level framework for climate resilience metrics in financing operations, focusing on systems of measurement. It sets out key characteristics that

climate resilience metrics should have, such as a name and a description of what is being measured.

The paper then proposes a common framework for climate resilience underpinned by four core concepts that should be used to define context-specific indicators: (1) a context-specific approach; (2) compatibility with the variable and often long timescales over which the intended project results may be delivered and reported (‘metrics should be appropriate for the project-specific temporal as well as spatial scales’, p. 15); (3) metrics that are able to cope with the inherent uncertainties associated with future climate conditions; and (4) metrics that are able to cope with challenges associated with determining the boundaries of climate resilience projects. The components of the framework are to be implemented using a two-step process: (1) a quantity-specific element focusing on the quality of the project design, which includes diagnostics, inputs and activities; and (2) a quality descriptive element which includes outputs, outcomes and impacts. These can then be mapped across a results chain.

Alfani, Federica, Andrew L. Dabalén, Peter Simonsen Fisker, and Vasco Molini. “Can We Measure Resilience? A Proposed Method and Evidence from Countries in the Sahel.” Policy Research Working Paper. Washington, D.C.: World Bank, January 2015. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/568441468193780225/Can-we-measure-resilience-a-proposed-method-and-evidence-from-countries-in-the-Sahel>.

The World Bank proposes a framework that uses quantitatively derived data to measure household resilience. The formula involves conducting a survey of households and individuals who experienced a shock (the treated group) and those who did not (control group). Separate welfare outcomes are then estimated for those who received the shock and those who did not. The methodology involves simulating the welfare outcomes households would experience if faced with a different state of the world compared to the current state. This counterfactual was obtained by using the Oaxaca–Blinder framework.

Beauchamp, Emilie, and Cecilia da Silva Bernardo. *Progressing the Global Goal on Adaptation – Key Issues*. London: International Institute for Environment and Development, January 2021. <https://www.iied.org/17773iied>.

This article makes a number of claims, including that numbers alone are inadequate to measure adaptation progress, and that qualitative measures, including social perceptions, are also necessary. Furthermore, there is ‘no single – nor any specific set of – metrics or indicator that can appropriately represent the breadth and variety of adaptation efforts across the world’. The article points out that in any case a robust methodological framework is difficult to implement in most developing contexts where resources are limited. This can lead to differences in data quality, and a negative bias in the data, which can make it appear as if developing countries are not progressing on adaptation. Climate adaptation M&E systems being proposed should at best complement existing ones, and be tailored to suit the context.

Brooks, Nick, Susannah Fisher, Neha Rai, Simon Anderson, Irene Karani, Tamara Levine, and Dave Steinbach. *Tracking Adaptation and Measuring Development: A Step-by-Step Guide*. London: International Institute for Environment and Development, December 2014. <https://www.iied.org/10100iied>.

This report proposes a conceptual framework to monitor and evaluate climate change adaptation. Specifically, it offers a step-by-step guide for government officials, development agencies and non-governmental organisations (NGOs) to assess the effectiveness of adaptation. The manual also offers a ‘step-by-step guide on developing a robust M&E framework that can be used as part of national planning systems, or to assess and compare specific interventions’ (p. 5). This teaching tool is a useful resource. While it may be outdated in the face of newer, emerging methods for measuring adaptation, and lacks universal applicability, it may serve as a useful resource in developing tailored M&E systems to suit particular contexts.

Brooks, Nick, Simon Anderson, Illari Aragon, Barry Smith, Tracy Kajumba, Emilie Beauchamp, Stefano D’Errica, and Neha Rai. *Framing and Tracking 21st Century Climate Adaptation*. London: International Institute for Environment and Development, November 2019. <https://www.iied.org/10202iied>.

This report proposes a framework for developing climate adaptation, monitoring, evaluation and learning systems (CAMELS) based on the adaptation principles embodied in Article 7 of the Paris Agreement, viewed through the lens of relevance, quality, effectiveness and adequacy. It features a review of national adaptation M&E systems as a means of showing whether, and how, Article 7 principles are reflected in them. A template is provided by the developers to help develop a CAMELS framework at the national level. The framework proposed claims to be flexible enough to accommodate diverse contexts while ensuring national-level consistency.

Carugi, Carlo. “Experiences with Systematic Triangulation at the Global Environment Facility.” *Evaluation and Program Planning* 55 (April 1, 2016): 55–66. <https://doi.org/10.1016/j.evalprogplan.2015.12.001>.

This article argues for the use of systematic triangulation ‘to address common challenges in evaluation, such as the scarcity or unreliability of data or the complexities of comparing and cross-checking evidence from diverse disciplines’ (p. 55). Triangulation is a powerful research technique that facilitates cross-verification using more than two data sources (p. 56). The paper asserts that this is an effective systematic approach to identify and evaluate findings. Given its successful use by the Global Environment Facility (GEF) Independent Evaluation Office (IEO), it is worth exploring.

Triangulation of evaluation evidence is conducted by collecting data/information from a number of different sources and/or applying different evaluation methods and tools to the same evaluation question. According to the article, ‘the procedure elaborated by the IEO in its country-level evaluations applies triangulation in a systematic way to the entirety of the qualitative and quantitative information collected. The collected evaluative evidence is categorized into three major research areas: Perception, Validation and Documentation, each of which uses one or more research area specific evaluation method[s]’ (p. 59). During country programme evaluations, indicators, sources of information and methodology components are identified for key evaluation questions. These are grouped by the three main evaluation criteria: effectiveness/results, relevance and efficiency. Findings from qualitative and quantitative data and information are triangulated with the findings that emerged from other methods related to the same evaluation question. For this method to work, however, preconditions need

to be met, one of which is having a well-developed evaluation matrix.

Climate Investment Fund. *PPCR Monitoring and Reporting Toolkit*. Washington, DC: Climate Investment Fund, 2018. https://www.cif.org/sites/cif_enc/files/knowledge-documents/ppcr_mr_toolkit_july_2018.pdf.

Created in 2008, the Pilot Program for Climate Resilience (PPCR), a \$1.2 billion concessional financing mechanism, was 'designed to pilot and demonstrate ways to integrate climate resilience into core development planning and complement ongoing activities in developing countries around the world' (p. 5). It established an M&E system that supports recipient countries to track progress in climate resilience action. These countries are being supported by the PPCR to develop programmes for climate resilience.

Every PPCR country is required to monitor five core indicators: resilience, development planning, adaptive capacity, decision-making and innovative investment approaches. The PPCR monitoring and reporting system provides for two compulsory streams of annual data, which come from the national level, as well as an intermediary entity (a Multilateral Development Bank [MDB]) that also provides project-level data to the PPCR. Both the countries and MDBs develop their own results frameworks but must include core indicators from the PPCR. A scorecard is used to indicate core indicators, level of data collection and data collection instruments to report on the project. A workshop is held with relevant stakeholders to assess and validate the progress of the programme against the indicators.

Coger, Tamara, Sarah Corry, and Robbie Gregorowski. "Reshaping Monitoring, Evaluation and Learning for Locally Led Adaptation." Working Paper. Washington, DC: World Resources Institute, January 22, 2021. <https://www.wri.org/research/reshaping-monitoring-evaluation-and-learning-locally-led-adaptation>.

This working paper recommends a systemic shift towards monitoring, evaluation and learning (MEL) that is locally led, context-aware and adaptive. Specifically, the paper discusses 'how MEL can support local agency and reflect priorities and expertise in the interest of more effective and equitable locally led adaptation interventions' (p. 2). It makes a number of recommendations to donors, implementing

agencies and MEL practitioners that involve, among other things, awareness of structural inequalities and power dynamics. The paper offers considerations for supporting locally led adaptation, and reviews approaches, methods and tools specific to the MEL cycle.

Engle, Nathan L., Ariane de Bremond, Elizabeth L. Malone, and Richard H. Moss. "Towards a Resilience Indicator Framework for Making Climate-Change Adaptation Decisions." *Mitigation and Adaptation Strategies for Global Change* 19, no. 8 (December 1, 2014): 1295–312. <https://doi.org/10.1007/s11027-013-9475-x>.

This paper 'lays the groundwork for an assessment framework that can make future development and adaptation choices more resilient' (p. 1295). It offers a framework to bridge the divide between the adaptation research community and policy-makers and development practitioners. It is a hybrid framework that focuses on both the short-term coping and long-term adaptation aspects of resilience. It attempts to link national/regional investigations with local/project-level analyses, and is open to qualitative (case studies and stakeholder input) and quantitative methodologies (the usual indicator sources) (p. 1302).

The framework contains three processes: (1) identifying exposure to climate variability and change in the context of multiple stresses; (2) identifying and elaborating categories for indicators; and (3) calibrating and verifying indicators for iterative learning and improvement (p. 1302). In applying the framework, the paper recommends five categories of indicators: governance and security, natural resource systems, social systems, economic systems and built environment/infrastructure. In applying the framework there are principles to be followed, including investing in ongoing engagement with stakeholders to continually verify and adapt the processes to ensure outcomes.

FAO. *Analysing Resilience for Better Targeting and Action: Resilience Index Measurement and Analysis – II*. Rome: Food and Agriculture Organization of the United Nations, 2016. <https://www.fao.org/3/i5665e/i5665e.pdf>.

The Food and Agriculture Organization of the United Nations (FAO) promotes an approach called Resilience Index Measurement and Analysis (RIMA-II), which uses both direct (descriptive) and indirect (inferential)

approaches to determine food security loss and recovery. Among other things, it uses a resilience capacity index (RCI) and a resilience structure matrix (RSM) to connect the two and gauge household resilience to food security. The RCI provides a useful baseline and policy analysis tool to inform, target and rank households. It can be used to identify those households most at risk and to isolate the specific areas of resilience weakness, while the RSM explains the combination of relevance of variables in explaining resilience.

Faulkner, Lucy, Jessica Ayers, and Saleemul Huq. "Meaningful Measurement for Community-Based Adaptation." *New Directions for Evaluation* 2015 (September 1, 2015). <https://doi.org/10.1002/ev.20133>.

This report outlines Community-Based Adaptation (CBA) as an action–research approach that operates at the community level to identify, assist and implement community-based development initiatives that strengthen the capacity of the poorest and most marginalised people to adapt to climate change impacts (p. 90). This adaptation must be understood as a process that is built on cultural norms within communities. The M&E framework used to measure this adaptation must therefore also be community-focused. This will involve moving away from asking 'Are we doing what we said we would do?' to 'Does it work?' and 'Who does it work for?' (p. 92). The latter question will especially inform the question 'What are we measuring?' and 'How do we do it?' (p. 93). The report emphasises that these questions must be viewed within, and engage with, the wider political economy.

Government of the United Kingdom. "Number of People Whose Resilience Has Been Improved as a Result of ICF." KPI 4 Methodology Note. Climate Change Compass. London: Government of the United Kingdom, September 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835527/KPI-4-number-people-resilience-improved1.pdf.

Key Performance Indicator (KPI) 4 measures the number of people with improved climate resilience due to United Kingdom (UK) International Climate Finance (ICF) support. It is a means used by the UK Government to side-step the lack of a universal metric to count resilience *per se*, and instead to count the number of people with improved climate resilience (p. 5). It uses the

number of people with improved climate resilience as a proxy for climate resilience. Specifically:

- it measures the number of people with a change in climate resilience at outcome level
- it focuses on changes in climate resilience that have been positively influenced by the programme/project in question
- it is not a measure of absolute resilience.

It works mainly by, among other elements:

- constructing a survey questionnaire
- calculating the number of people with improved climate resilience
- subtracting from the baseline
- calculating the percentage that can be attributed to the UK Government.

This methodology of measuring resilience is used by the UK Government for its own programmes.

IIED, ADA Consortium, and National Institute for Drought Management. *Resilience Assessment Toolkit*. National Institute for Drought Management, International Institute for Environment and Development, and ADA Consortium, January 2016.

This toolkit promotes a three-stage process for conducting resilience assessments at the community level. Developed and piloted in some arid and semi-arid lands in Kenya, the toolkit involves a multi-day workshop with representations, a focus group meeting with community members, then home interviews with community members to corroborate and refine the information gathered at the workshop. The document supports a qualitative and quantitative method of resilience assessment data collection.

IPCC. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. New York: Intergovernmental Panel for Climate Change, 2022. https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf.

This report highlights that ‘despite a lack of systematic methods for assessing general adaptation effectiveness, there is some evidence of risk reduction for particular places and hazards, especially flood and heat vulnerability’ (p. 2434). Importantly, it notes that investments in flood defences, better monitoring and forecasting, and better design and infrastructure have led to a reduction in mortality and social vulnerability, with the greatest reduction seen in low-income countries. The report, however, incorporates secondary data to ascertain this information. In the absence of a systematic assessment of the adequacy and effectiveness of adaptation on a global scale, the authors of the report assessed evidence for transformational adaptation documented in peer-reviewed publications identified by a global stocktaking initiative (p. 2435).

Lessy, Mohammad Ridwan, Jefry Bemba, and Nani Nagu. “Assessing Community Resilience to Natural Disaster and Climate Change in Maitara Island, North Maluku – Indonesia.” *MATEC Web of Conferences* 229 (2018): 02002. <https://doi.org/10.1051/mateconf/201822902002>.

This study ‘aims to analyse the resilience of coastal communities on a small island in terms of disasters and climate change, and to identify the strategies and adaptations that communities have undertaken as anticipatory [sic] for disaster and climate change in the future’ (p. 1). The study used qualitative (in-depth interviews conducted with stakeholders, field survey and questionnaire) and quantitative data analysis methods. The technique used by the authors involved exposure, sensitivity and adaptability to analyse the assessment of resilience to natural disasters and climate change. The study used 26 indicators (education level of the population, condition of the coastal ecosystem, availability of coastal resources information, among others) to cover five aspects of community resilience: human development, business development, resource development, environment/infrastructure and disaster preparedness. Using the interviews and focus group discussions, a mathematical formula (Relative Resilience Index [RRI] = $a + b + c + d + e$ which represents the five aspects of community resilience) was used to calculate and assess a village’s resilience. Each aspect of community resilience was given a maximum score of 30 and a minimum score of 10. Scores were based on how well a community performed in each of the five aspects of community resilience.

OECD. *National Climate Change Adaptation: Emerging Practices in Monitoring and Evaluation*. Paris: Organisation for Economic Co-operation and Development, 2015. https://read.oecd-ilibrary.org/environment/national-climate-change-adaptation_9789264229679-en.

This report provides a number of case studies on how adaptation is tracked in various countries, Kenya being the context most closely aligned with that of SIDS. The report outlines Kenya’s framework, which makes use of the Tracking Adaptation and Measuring Development (TAMD) methodology developed by the International Institute for Environment and Development (IIED). The framework combines top-down indicators that assess institutional (adaptive) capacity and bottom-up indicators to measure vulnerability. These are linked to national-level indicators already being measured regularly.

Kenya identified 10 county-level institutional adaptive capacity indicators, and 63 national-level, process-based indicators on institutional capacity. The county-level indicators include, among others, the percentage of roads in the county that have been made climate resilient or that are not considered to be vulnerable, and the percentage of water demand that is supplied in the county. National-level, process-based indicators include, among others, the number of new and existing port and harbour facilities designed to cope with rising sea levels, and the number of urban development plans that incorporate disaster risk reduction actions for poor communities, with specific recognition of the problems faced by women.

Oxfam Policy & Practice. *A Multidimensional Approach to Measuring Resilience*. Oxford: Oxfam, August 2013. <https://policy-practice.oxfam.org/resources/a-multidimensional-approach-to-measuring-resilience-302641/>.

This article promotes the Alkire-Foster method used to measure multidimensional poverty. It is reframed by Oxfam to be applicable to resilience measurements. The method involves developing several composite indices based on a number of indicators that reflect various manifestations of the multidimensional construct of interest – i.e. poverty. This is then broken down into sub-dimensions, such as living standards, which are then broken down into indicators such as cooking fuel, sanitation, water

and electricity. Indicators are weighted and scored between 0 and 1. Oxfam highlights the limitations of this method when applied to climate resilience, and proposes the use of complementary investigations such as community consultations and follow-up qualitative research.

Price, Roz. "Metrics and Indicators to Assess Adaptation." Helpdesk Report. Brighton: Institute of Development Studies, March 8, 2022. <https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/17385>.

This is a rapid review of key papers on adaptation metrics, as well as a mapping of climate adaptation metrics and measurements currently in use. The review also outlines overall challenges in measuring adaptation, as well as the limitations in doing so. The paper also presents examples of current measurements being used by countries of various sizes, ranging from the UK to St Lucia. St Lucia 'designed a "simple" and "ready-to-use" M&E system to track progress towards its National Adaptation Plan (NAP) and the core elements of its broader climate adaptation policy' (p. 15). It works by 'collecting information through simple questionnaires on measures that contribute to the implementation of the NAP or other adaptation initiatives' (p. 15). Questionnaires are distributed to members of the country's national climate change committee to obtain information on elements such as whether sectoral strategies were elaborated, and whether adaptation relationships were established. Based on the completed questionnaires, St Lucia's Department of Sustainable Development completes a monitoring template that aggregates the information (p. 16).

UNDP and Drylands Development Centre. *CoBRA Conceptual Framework*. New York: United Nations Development Programme, August 15, 2016. Accessed March 22, 2023. <https://www.undp.org/publications/cobra-conceptual-framework>.

This report outlines the United Nations Development Programme's (UNDP) Community Based Resilience Analysis (CoBRA) conceptual framework and methodology. The CoBRA model supports measuring resilience and the impact of interventions by firstly establishing baseline information by identifying: (1) the main characteristics of resilience at community and household levels; (2) which households are more resilient and able to cope with shocks and stresses;

(3) the kinds of factors that are affecting their ability to cope; and (4) how communities score their attainment of these priority characteristics in a normal period and in a crisis period (p. 9). Indicators can be developed around these questions, and surveys and focus groups can be conducted to quantitatively and qualitatively assess resilience.

UNEP. *Too Little, Too Slow: Climate Adaptation Failure Puts World at Risk*. Nairobi: United Nations Environment Programme, 2022. <https://www.unep.org/resources/adaptation-gap-report-2022>.

This report promotes the use of plural metrics that reflect different dimensions and normative goals to assess adaptation effectiveness and adequacy over space and time, noting that this is key to understanding longer-term outcomes (p. 38). The report argues that while the effectiveness of adaptation will only be demonstrated through long-term trajectories, this can be inferred on shorter timescales through assessments of losses and damages, exposure, vulnerability and resilience. Effectiveness of adaptation can also be evaluated based on whether the adaptation interventions abide by key adaptation principles (p. 39). The report proposes 'an "architecture" of risk reduction, including principles, actions and outcomes that can be used as a basis for assessing actual or likely adaptation effectiveness' (p. 40). It includes principles such as inclusion and co-production, and actions such as those that reduce exposure to hazards. Outcomes would include reduced hazards, reduced exposure, enhanced resilience/reduced risk, and improved human and ecosystem well-being, among others.

This 'architecture' of actions and outcomes related to successful risk reduction provides a framework for identifying entry points for interrogating actual and likely adaptation effectiveness (p. 40).

The report offers valuable learning, such as the idea that adaptation effectiveness depends on which metrics are used. More specifically, 'utilitarian metrics tend to focus on costs versus benefits, whereas equity and justice-based framings of effective adaptation tend to highlight outcomes for procedural, recognitional and distributive justice – i.e. who is benefiting and how are they included/excluded' (p. 42). The report identifies important gaps and shortcomings in adaptation practice, such as interventions that entrench existing power relations, inadequate metrics, and neglecting the root causes of vulnerability (p. 43). It then offers principles for effective adaptation (p. 44).

UNFCCC Adaptation Committee. "Approaches to Reviewing the Overall Progress Made in Achieving the Global Goal on Adaptation." Technical Report. Bonn: United Nations Framework Convention on Climate Change, 2021. https://unfccc.int/sites/default/files/resource/AC_TP_GlobalGoalOnAdaptation.pdf.

This report outlines some of the approaches proposed within the policy arena (governments, inter-governmental organisations and donors) and academic environments to measure adaptation and resilience. It assesses systems currently in use, outlining their merits as frameworks that can be used to undertake the global stocktake. Specifically, it covers such measures of quantitative indicators as the number of National Adaptation Plans (NAPs) submitted, the use of modified data and indicators from existing metrics such as the Sustainable Development Goals (SDGs) and the Sendai Framework, and the conducting and aggregating of in-depth evaluation proximity to target analysis. It uses case studies of how countries use these indicators. For example, Bolivia 'uses indices to calculate the results of the actions included in its nationally determined contributions (NDC). It uses a formula whereby Hydric vulnerability = Hazard + Sensitivity – Water adaptability' (p. 48). The report notes that these can have limitations. For example, using quantitative indicators such as the number of NAPs submitted 'does not reveal the extent to which adaptive capacity has been enhanced or resilience strengthened'.

USAID. *Design and Use of Composite Indices in Assessments of Climate Change Vulnerability and Resilience*. Washington, DC: United States Agency for International Development, July 1, 2014. <https://www.climatelinks.org/resources/design-and-use-composite-indices-assessments-climate-change-vulnerability-and-resilience>.

This report presents an overview of existing approaches to the design, use and improvement of composite indices, demonstrating their applicability to climate change impacts, vulnerabilities, adaptation and resilience. It outlines the advantages and disadvantages of using composite indices and provides guidance on how they should be developed; this is by considering the right questions. For example, what specifically is the composite index intended to measure and monitor, and towards what goal(s)? It also advocates using 'participating processes that encourage input and feedback from experts and/or that incorporates public opinion' (p. 4). It further emphasises the importance of data quality. After the composite is developed, it will

need to be carefully validated. One method of doing this is to 'consider an external outcome measure that is conceptually relevant, such as infant mortality, deaths from heat stress, or morbidity from a climate-related disease, and then determine whether or not the composite index helps to predict the observed spatial patterns' (p. 19).

USAID. *2022 Resilience Policy Revision DRAFT*. Washington, DC: United States Agency for International Development, December 2022. <https://www.usaid.gov/sites/default/files/2022-12/Resilience-Policy-Revision-Jan-2023.pdf>; and USAID. *An Overview of the Recurrent Monitoring Survey (RMS)*. Washington, DC: United States Agency for International Development, 2022. https://www.fsnnetwork.org/sites/default/files/an_overview_of_the_recurrent_monitoring_survey_rms._0.pdf.

In these reports, the United States Agency for International Development (USAID) promotes the use of recurrent monitoring survey (RMS) to capture resilience in real time. This is done by using RMS to track key resilience information such as shocks, stresses, perceived recovery and well-being outcomes to provide data on resilience dynamics and allow for timely programmatic adaptation after a shock (p. 31). The framework uses quantitative data and periodic community qualitative surveys with a small number of households (for instance, every two months for a year). This allows the measurement of real-time impacts and changes in how people cope at different points after a disaster, and their rate of recovery.

The framework allows for analysis across households to identify and compare resilience capacities and strategies to pinpoint what makes some more resilient than others in, for example, food security.

USAID, University of Arizona, and Global Resilience Partnership. *Advancing Resilience Measurement Consultation Report*. USAID, University of Arizona, and Global Resilience Partnership, no date. <https://www.resiliencelinks.org/resources/reports/advancing-resilience-measurement-consultation-report>.

This report seeks, among other things, to identify and affirm core principles and priorities for resilience measurement. Consultations were conducted to identify resilience under four themes: (1) demand-driven resilience measurement and evidence; (2) psychosocial resilience measurement; (3) systems-level resilience

measurement; and (4) climate adaptation. The report outlines a number of principles and priorities under each theme. For example, for demand-driven resilience measurement and evidence, one principle is to engage users – including communities – in the co-production of knowledge to ensure resilience measurement and evidence are demand-driven and contribute to strengthening individual and collective agency (p. 2). One corresponding priority item is to develop a map and typology of resilience evidence users, uses and needs at different scales (p. 3).

Winderl, Thomas. *Disaster Resilience Measurements: Stocktaking of Ongoing Effort in Developing Systems for Measuring Resilience*. New York: United Nations Development Programme, February 2014. <https://floodresilience.net/resources/item/disaster-resilience-measurements-stocktaking-of-ongoing-efforts-in-developing-systems-for-measuring-resilience/>.

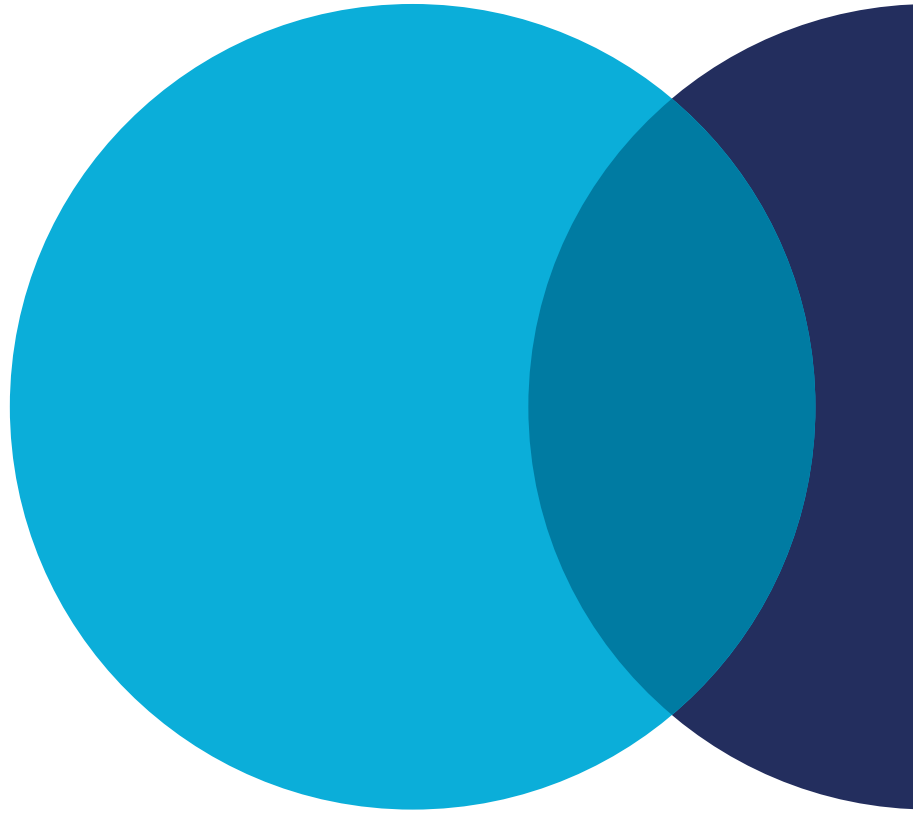
While this document is a stocktake of ongoing efforts in developing systems for measuring resilience, it outlines frameworks that should be conducted in doing so. These include steps to identify which elements of resilience are to be included in the measurement, such as: measuring well-being before and after a disaster, measuring resilience capacities to cope, adapt and transform after a disaster, measuring programme results, reaction to and recovery from disasters. The report outlines frameworks used by countries to measure resilience and recovery from disasters. Indonesia's Disaster

Recovery Index is highlighted, which 'measures progress of recovery and resilience in communities affected by the Mount Merapi eruption in 2010 and Lahar floods in 2011. The Index utilizes 22 variables to determine how communities are recovering from the volcanic eruption in terms of restoring infrastructure, housing, livelihoods and social structures, among other things' (p. 8).

WRI. *The National Adaptive Capacity Framework: Key Institutional Functions for a Changing Climate*. Pilot Draft. Washington, DC: World Resources Institute, November 2009. http://pdf.wri.org/working_papers/NAC_framework_2009-12.pdf.

The World Resources Institute (WRI) proposes within its National Adaptive Capacity (NAC) framework a new way of thinking about adaptation evaluation. It involves moving away from a solely asset/resources-based assessment of adaptation to a functions-based one. The question, it notes, should be 'What am I able to do to help me adapt?', rather than purely 'What resources do I have to help me adapt?' (p. 1). NAC can be used to identify strengths and gaps in a country's adaptation system.

NAC assessments start with an overview of the political landscape and its decision-making context. It then uses five function tables to cover the following functions: (1) assessment; (2) prioritisation; (3) coordination; (4) information management; and (5) climate risk reduction. Information is gathered to assess whether each function is present and adequate.



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