Literature study: Approaches to measure adaptation benefits

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Submitted to: The African Development Bank Group (AfDB)

Freiburg, Germany, 20.04.2020

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Abbreviations

ABM	Adaptation Benefit Mechanism
ABU	Adaptation Benefit Unit
AF	Adaptation Fund
AfDB	The African Development Bank Group
CAF	Cancun Adaptation Framework
CDM	Clean Development Mechanism
GCF	Green Climate Fund
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LDCF	Least Developed Countries Fund

NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
OECD	Organization for Economic Co-operation and Development
PA	Paris Agreement
PPCR	Pilot Program for Climate Resilience
SCCF	Special Climate Change Fund
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

Climate change is impacting social and ecological systems, as well as the interactions between them. These impacts can be both direct and indirect, and short term and long term. Impacts such as temperature rise, changes in precipitation patterns and other climate variabilities affect both people's livelihoods and ecosystems. As a global response to the threat of climate change, the governments in 1992 agreed to the United Nations Framework Convention on Climate Change (UNFCCC). The Convention has near universal membership (197 Parties) and is the parent treaty of the 1997 Kyoto Protocol (KP) and the 2015 Paris Agreement (PA). The latter aims at limiting the rise in average global temperatures to well below 2°C above pre-industrial levels, ideally to 1.5°C (UNFCCC, 2020a). However, even if either of those targets is achieved, climate change adaptation will still be needed, as many places have already experienced drastic impacts due to warmer temperatures, sea level rise, and stronger and more frequent extreme events (Donatti et al. 2019).

The definition of adaptation evolved other time and varies according to different practitioners or contexts. Adaptation as defined by the Intergovernmental Panel on Climate Change (IPCC) is *"the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects"* (IPCC, 2014), while the UNFCCC defines it as "*practical steps to protect countries and communities from the likely disruption and damage that will result from the effects of climate change*" (UNFCCC, 2020b). The variations in these definitions indicate the various approaches that are possible for understanding adaptation let alone how to measure it.

While mitigation market mechanisms such as the Clean Development Mechanism (CDM) or the EU Emissions Trading Scheme, incentivized global investment in low emission technologies in the last decade (African Development Bank Group, 2017), a number of challenges exist when it comes to promoting climate change adaptation activities. In the following, some of the most prominent challenges regarding adaptation are listed:

- Adaptation activities are highly **project and location specific**, and they respond to specific climate vulnerabilities. (Donatti et al. 2019)

- Adaptation can be applied in a wide range of contexts, and hence lead to a **very broad range of outcomes** (e.g. reducing disaster risk, reducing food insecurity, reducing water scarcity driven by climate change) encompassing both social and biophysical impacts (Donatti et al. 2019)

- Adaptation to climate change presents a complex methodological challenge. It calls for individuals to make decisions with **potentially very long-term consequences** on the basis of **incomplete knowledge and/or uncertain information about future changes** (uncertainties are related to climate projections as well as to developments in natural systems and sectors that are affected by other uncertainties) (Climate-ADAPT, 2020)

- **Adaptation is not a static concern**. Rather it evolves over time in response to a changing climate. Adaptation is perhaps best handled via a long-term transitional, continuous, flexible process that involves learning and adjustment (Chambwera et al. 2014)

- Adaptation takes place against a **moving baseline.** The conventional "ex-ante" and "ex-post" assessment tools (i.e. tools with a fixed baseline) are often unfit for adaptation processes (Christiansen et al. 2018)

- **Adaptation benefits are often not easy to monetize**, as they include non-market sectors, for example ecosystem services (UNFCCC 2009)

- Climate resilience and **adaptation are intrinsically linked to development**, it is difficult to distinguish between a "normal" development project and a development project that contributes to climate change adaptation (Micale et al. 2018)

All these obstacles have led to inconsistent and limited adaptation action compared to what was done regarding climate change mitigation. To tackle this problem, the parties of the PA adopted the Cancun Adaptation Framework (CAF) as part of the Cancun Agreements at the 2010 Climate Change Conference in Cancun, Mexico (COP 16/ CMP 6). In the Agreements, the Parties affirmed that adaptation must be addressed with the same level of priority as mitigation (UNFCCC 2010). Since 2001, a number of multilateral funds targeting adaptation were established and pledged for public adaptation financing e.g. the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF) and the Adaptation Fund (AF) (see figure 1 for adaptation actions over time in relation to UNFCCC processes). However, there is still far less financing for adaptation compared to mitigation. The Adaptation Finance Gap Report published in 2016 estimated that the total finance for adaptation in 2030 will need

to be significantly higher (6 to 13 times) than international public finance available (UNEP 2016).

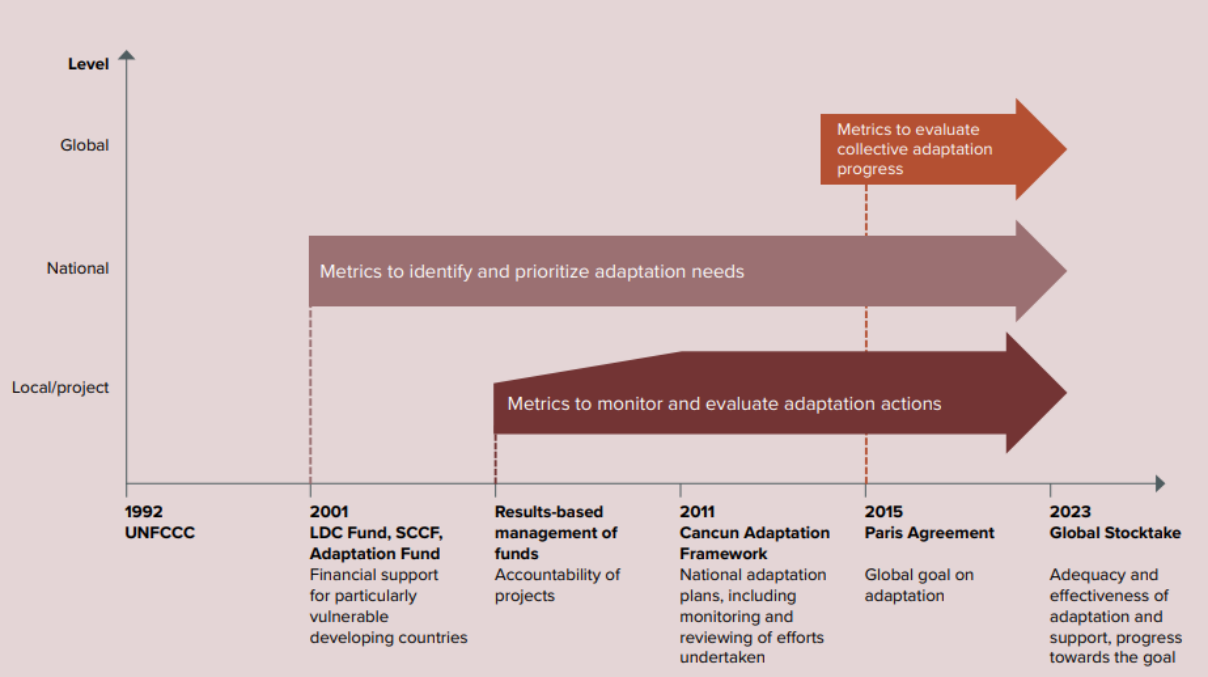

Figure 1: Adaptation metrics over time in relation to the UNFCCC process. Source: Christiansen et al. (2018)

To scale up adaptation finance, the private sector could play a significant role in closing the gap. To create an incentive, the African Development Bank (AfDB) in 2016 established the Adaptation Benefit Mechanism (ABM). The purpose of the ABM is to create a results-based finance business model to encourage private sector investment in adaptation. The ABM is a non-market-based mechanism that will generate so-called adaptation benefit units (ABUs) that are not internationally tradable and will instead be delivered directly to the end-user. The ABM builds on the concept of the Clean Development Mechanism (CDM), in which carbon credits are issued for mitigation impacts achieved against a baseline scenario, and considers their approach to using approved methodologies that specify MRV requirements to ensure transparency. To operationalize the ABM, a general approach and methodology which determines a metric for adaptation benefits is needed, taking into account all the obstacles related to adaptation projects which were listed above.

This literature review aims to summarize approaches already been developed to measure adaptation benefits from existing and publicly available information from Funds (e.g. Results Management Frameworks) or other sources (e.g. adaptation publications on measuring adaptation activities) and to discuss their similarities and differences.

Terminology

This study distinguishes between the terms “indicators” and “metrics” as Christiansen et al. (2018) did:

- **Indicator**: particular element of adaptation success being assessed (e.g. “the level of climate change vulnerability in a given population” or “the resilience of crop yields to climate change- induced drought”)
- **Metric:** “unit of measurement” with which to quantify the indicator (e.g. a specifically designated vulnerability index value, or water use in m^3/tonnes of harvest)

Hence, any given indicator could have several metrics whereas any given metric could refer to several different indicators.

What approaches are there to determine adaptation benefits?

The need for metrics for adaptation has been emphasized in the global negotiation under the UNFCCC process. The Bali Action Plan, which was agreed at the Conference of the Parties 13 (COP13) in Bali in 2007 states “Enhanced action on adaptation with consideration of …prioritization of actions…and support adaptation in a coherent and integrated manner”, and “Positive incentives for developing countries for enhanced mitigation and adaptation actions” (UNFCCC, 2007). To make actions in the agreement feasible, it is critical for them to be measurable, reportable, and verifiable with appropriate “metrics”. Once the metrics are established, it becomes feasible to prioritize and incentivize actions, driven by clear targets with a defined time frame and steps. Lastly, the standardized measurement system (adaptation metrics) can help set a baseline of adaptation to compare the progress and effectiveness (Prabhakar et al. 2010).

Since adaptation lacks a globally common metric similar to the GHG emission reductions used for mitigation (see text box 1), funds and institutions started in the early 2000s to use their own approaches to measure adaptation success. There are conflicting opinions as to whether there should be one common metric at all. Donatti et al. (2019) contend that firstly, the broad range of adaptation activities and outcomes precludes the use of a single common reference metric or indicator to measure adaptation outcomes in the same way that mitigation is measured. Secondly, they argue that what constitutes success following an adaptation intervention changes over space and time, as climate change impacts differ across sites, temporal and spatial scales, and affect a series of sectors. Moreover, some also argue that a universal metric

can only provide a rough snapshot of some adaptation outcomes and that there can be no "one size fits all" metric that is applicable to all countries (Christiansen et al. 2018).

Universal metrics of mitigation:

Common indicator: avoided emissions expressed in CO_2 equivalents

Mitigation benefit: 1 tonne of greenhouse gas (GHG) emissions abated

Mitigation costs: USD/tCO_2e abated

Effectiveness measure: efficiency of projects calculated in terms of currency units spent to achieve one t CO_2e reduced

Properties:

1. **Universal application**: equally applicable
   - ➔ In all contexts
   - ➔ All regions
   - ➔ For all types of interventions

2. **Uniform effect**: each ton of avoided emissions has the same effect
   - ➔ Irrespective the location
   - ➔ Irrespective of how many tons are reduced by any one intervention (no economies of scale)

Consequence: mitigation outcomes can be aggregated and compared across the globe

Textbox 1: Mitigation metrics. Adopted from Christiansen et al. 2018 and Donatti et al. 2019

Critics of the universal metric approach for adaptation also point out that there is no single metric for realizing sustainable development but rather 230 indicators are used to achieve the United Nations Sustainable Development Goals (SDGs), meaning that the nature of adaptation and the associated conditions of measurement are not assessable with a single or simplified set of global, all-purpose metrics (Leiter and Pringle 2018).

The advantages of a universal metric for adaptation are mostly concentrated in the effectiveness area (Michaelowa and Stadelmann 2018) because a universal, comparable set of adaptation metrics would set the basis for improved fairness and accountability in resource allocation of international donors and national budget managers. Moreover, it could increase the probability of prioritizing high value-for-money and impactful adaptation activities (Donatti et al. 2019). Ethically, universal indicators could help to bring transparency in assessing adaptation projects

Adaptation metrics from climate funds

Figure 4 and 5 give examples of adaptation indicators used by some of the most important finance vehicles financing adaptation.

The GEF administers the LDCF and SCCF, which together have provided USD 1.75 billion in funding for adaptation projects – 282 under the LDCF and 79 under the SCCF – as of March 2020. Supporting adaptation in agriculture is a major priority of the GEF, with agriculture being identified as a priority in 96% of NAPAs and 73% of NAPA projects. When assessing the impacts of adaptation projects, the GEF considers resilience as both a product (e.g. resilient infrastructure, automated weather stations, new crop varieties) and a long-term process resulting in institutional capacity-building or new policy development. The resilience-building process of absorbing shocks, adapting to change and transformation captures directly attributable benefits; value chain and system-level benefits (e.g. a resilient food system); contributions to national development objectives; systemic and transformational change in relation to climate policy and governance; and social inclusion benefits, including gender-disaggregated benefits. The LDCF and SCCF adaptation results framework for 2018-2022 focuses on impact-level indicators such as “the number of hectares of land under resilient management”, “number of policies/plans that will mainstream climate adaptation and resilience” and “the number of beneficiaries” (GEF 2019).

The Adaptation Fund supports 84 adaptation and resilience projects directly benefiting 6 million people as of March 2019 (UNFCCC, 2019). The Adaptation Fund allocates funds to countries through national, regional or multilateral implementing entities on the basis of numerous criteria. Figure 4 illustrates the five core indicators of the AF identified at the impact level (Figure 3), although the Fund has defined numerous indicators at the level of the eight outcomes identified under the Fund’s Results Framework (AF 2019). The AF has also developed specific methodology for calculating the five core indicators (AF 2014).

The Green Climate Fund (GCF), another important funding source which committed– as of 2019 - to support 70 adaptation-related projects, with funding amounting to USD 2.8 billion and an additional USD 8.2 billion leveraged. The anticipated outcomes of the projects include strengthened government, institutional and regulatory systems for climate-responsive development planning; increased generation and use of climate information in decision-making; strengthened adaptive capacity and reduced exposure to climate risks; and greater awareness of climate threats and risk-reduction processes. However, many of these indicators are simply framed and there is no agreed methodology for calculating them either which means that the task is being left to the project proponents as highlighted by Michaelowa and Stadelmann (2018).

The impact-level indicators used by the mentioned climate funds show great similarities e.g. “the number of beneficiaries” and “hectares of land under sustainable or resilient management” are indicators used by the GCF, the GEF and the Adaptation Fund. Leiter et al. (2019) argue that using overly simple indicators such as “number of beneficiaries” can lead to unreliable

results if there is no guidance on whom to consider as a beneficiary. They point out that for achieving a reliable use of adaptation metrics, it is not just the definition of the metric that matters, but also an agreement on its calculation and data sources. Furthermore, if indicators (e.g. “number of beneficiaries”) are too broad, they may not be useful in tracking adaptation success, that is also true for indicators which are too narrow since they may not capture all adaptation outcomes (Donatti et al. 2019).

Moreover, it becomes apparent that most of indicators in figure 4 and 5 are output indicators, meaning they quantify what has been done but not whether an actual reduction in vulnerability or climate risks took place. Such impact indicators measuring the effectiveness of the adaptation action are mostly missing. This observation was also made in earlier studies e.g. in Köhler and Michaelowa (2013) and Leiter (2017). However, the AF has developed a Results Tracker which allows implementing entities to monitor and report on indicators against a baseline, including effectiveness indicators such as “responsiveness of development sector services to evolving needs from changing and variable climate” or changes in the level of “capacity of national and sub-national centres and networks to respond rapidly to extreme weather events”. Moreover, adaptation success measured through proxy indicators such as the Pilot Program for Climate Resilience (PPCR) expected result: “Number of people supported to cope with effects of climate change” is highly debatable. According to the Adaptation Gap Report 2018, indicators of adaptation should ideally measure actual outcomes of actions, because most often the proxies used to measure adaptation results rely on value judgments and assumptions.

Expected results	GEF's LDCF/SCCF	Adaptation Fund	PPCR
Reduction of vulnerability	Number of direct **beneficiaries**	Number of **beneficiaries**	Number of **people supported** to cope with effects of climate change *(Quantitative reporting at the investment plan level)*
	Type and extent of **assets** strengthened and/or better managed to withstand the effects of climate change *(ha of land, km of road, km of coast)*	**Physical infrastructure** improved to withstand climate change and variability-induced stress *(Scale 5-1 ranging from fully improved to not improved)*	
	Population benefiting from the adoption of diversified, **climate-resilient livelihood** options *(number of people, % of females and of targeted population)*	Percentage of households and communities having more **secure** (increased) access to **livelihood** assets *(Scale 5-1 to express level of improvement of access)*	Change in percentage of households (in areas at risk) whose **livelihoods have improved** *(optional)*
Strengthened institutional and technical capacities	**Public awareness** activities carried out and population reached *(Yes/No, number of people, % of females)*	Percentage of targeted **population aware of predicted adverse impacts of climate change, and of appropriate responses** *(Scale 5-1 ranging from fully aware to not aware to express awareness)*	Quality of and extent to which **climate-responsive instruments and investment models** are developed and tested *(project or program-level qualitative assessment using scorecards)*
	Capacities of regional, national and sub-national institutions to identify, prioritize, implement, monitor and evaluate adaptation strategies and measures *(Number of institutions and score[a])*	**Capacity of staff** to respond to, and mitigate the impacts of, climate-related events from targeted institutions increased *(Number of staff, capacity determined via survey or questionnaire)*	Evidence of **strengthened government capacity and coordination mechanism** to mainstream climate resilience *(national-level focused qualitative assessment of a) strengthened government capacity to mainstream climate resilience; and b) strengthened coordination mechanism to mainstream climate resilience with scorecard)*
Integration of adaptation into relevant sectoral and development policies, plans and processes	Institutional arrangements to lead, coordinate and **support the integration of adaptation** into relevant policies, plans and associated processes *(score)*	Climate change **priorities integrated into national development strategy** *(Scale 5-1 ranging from all (fully-integrated) to none)*	**Degree of integration of climate change at national level, including sector planning** *(national-level focused qualitative assessment of relevant strategies, policies, plans and documents with scorecards)*
	Regional, national and sector-wide **policies, plans and processes** developed and strengthened to identify, prioritize and integrate adaptation strategies and measures *(number of policies/ plans/ processes and score)*	Number, type, and sector of **policies** introduced or adjusted to address climate change risks	**Changes in budget allocations** at national and possibly sub- national level of government to take into account effects of climate variability and change *(optional)*

Figure 2: Adaptation portfolio indicators measuring the achievement of expected results from international climate funds
Source: Christiansen et al. (2018)

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

Figure 3: Adaptation portfolio indicators currently used by international climate funds. Source: Leiter et al. (2019)

Adaptation metrics in global agreements and frameworks

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

- Paris Agreement under the UNFCCC
- The 2030 Agenda for Sustainable Development
- The Sendai Framework for Disaster Risk Reduction 2015–2030

The Paris Agreement set a global goal on adaptation ("enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change") but did not include any adaptation metrics nor did it request their development (Leiter 2017). The Agreement recognizes the importance of monitoring, evaluation and learning of adaptation (Article 7) and established the transparency framework to track progress made in implementing countries' nationally determined contributions (NDCs) and provide information related to climate change

impacts and adaptation (Art. 13) (Leiter at al. 2019). The global goal on adaptation is outcome-based, hence output-level indicators cannot be taken to sufficiently measure the global goal on adaptation.

The Sustainable Development Goals are comprised of 17 goals, 169 targets, and 232 indicators, many of which are directly or indirectly linked to adaptation, resilience and vulnerability. One of the goals, SDG 13, specifically targets urgent action to combat climate change and its impacts.

The Sendai Framework for Disaster Risk Reduction 2015–2030 is a voluntary, nonbinding 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". It includes seven global targets with 38 associated indicators.

Another important initiative to enhance adaptation action is the **national adaptation plan (NAP)** process which was established under the Cancun Adaptation Framework. It enables Parties to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. According to Article 7.9 of the Paris Agreement all Parties shall, as appropriate, engage in the formulation and implementation of national adaptation planning processes, such as the NAP process. The Paris Agreement also states that Parties should periodically submit an adaptation communication to the UNFCCC. It could be submitted as part of or alongside other communications or documents, such as a NAP, NDC and/or national communication. A GIZ report (GIZ 2017) highlights that as of May 2017, a total of 165 INDCs (on behalf of 192 countries) were submitted to the UNFCCC. Of these, 145 included an adaptation component, with 55 specifically referring to the NAP process as being planned or already in progress. The adaptation goals included in 73% of NDC adaptation components (72% of INDCs) are wholly qualitative (i.e. include descriptions of adaptation objectives, actions or plans), while 15% (17% of INDCs) provide quantitative adaptation goals (i.e. include numerical objectives and/or key milestones for delivery). The remaining 12% of NDC adaptation components (11% of INDCs) did not specify clear goals.

As of April 2020, 18 developing countries have submitted their NAP documents to the UNFCCC secretariat (UNFCCC 2020c). Some countries also established adaptation and vulnerability indicators and baselines to monitor and measure progress. The 2018 UNEP DTU study on adaptation metrics (Christiansen et al. 2018) highlighted the following adaptation indicators submitted in NDCs (see also figure 5 for national adaptation targets):

- Quantitative indicators: number of people benefiting from adaptation activities, number of hectares with drought-resistant crops under cultivation, forest coverage increases to 45%
- Qualitative indicators: degree of integration of adaptation into sectoral policies and plans, level of awareness)

Sector/area	National example
Water	• Ensure full access to drinking water by 2025 • Increase water storage capacity from 596 m^3 to 3,997 m^3 in 2015–2030 • Increase desalination capacity by 50% from 2015 by 2025
Agriculture	• Convert 1 million ha of grain fields into fruit plantations to protect against erosion • Increase the amount of irrigated land to 3.14 million ha • Reduce post-harvest crop losses to 1% through treatment and storage
Ecosystems and biodiversity	• Protect 20% of marine environments by 2020 • Regenerate 40% of degraded forests and rangelands • Establish 150,000 ha of protected marine areas
Forestry	• Increase forest coverage to 20% by 2025 • Maintain 27% forest coverage • Achieve 0% deforestation rate by 2030
Disaster risk reduction	• Ensure that all buildings are prepared for extreme events by 2030 • Reduce the number of the most vulnerable municipalities by at least 50% • Relocate 30,000 households
Energy	• Ensure that hydropower generation remains at the same level regardless of climate change impacts • Increase the proportion of renewable energy to 79–81% by 2030
Other	• Ensure that 100% of the national territory is covered by climate change adaptation plans by 2030 • Reduce moderate poverty to 13.4% by 2030 and eradicate extreme poverty by 2025

Figure 4: Examples of quantitative targets and goals included in the adaptation component of NDCs. Source: Christiansen et al. (2018)

Adaptation metrics in scientific studies

Early adaptation research tended to focus on particular climate impacts and their associated costs. One of the outputs of this research was to specify particular 'optimal' adaptations and their potential for cost savings (Eakin and Patt 2011). For instance, the World Bank's Economics of Adaptation to Climate Change (EACC) study (Word Bank 2010) had the objective to appraise adaptation costs both globally and in a collection of case study countries through top-down economic modelling. They also engaged in a 'social' component, addressing issues of differential vulnerability and adaptive capacity, which have a direct bearing on the effectiveness of the specific adaptation options that they had evaluated. The study used a cost-benefit analysis which means that countries invest in adaptation using the same criteria as for other development projects—until the marginal benefits of the adaptation measure exceed the costs. This leads to a portfolio of adaptation actions that either improve or deteriorate social welfare relative to a baseline without climate change. Adaptation costs were defined as the cost of actions attempting to restore pre-climate change welfare standards whose marginal benefits exceed marginal costs. To estimate the impacts of climate change and then the costs

of adaptation, the World Bank study compared, for each time period, the difference between the world with climate change and the world without climate change using GDP and population forecasts and sector-level performance indicators such as stock of infrastructure assets, level of nutrition, and water supply availability. Figure 6 illustrates which sectors have been included in the cost analysis. For the assessment they only considered “hard” adaptation options (building dams, dykes) since they can be valued and costed and did not take into account soft options such as early warning systems, community preparedness programs, watershed management, urban and rural zoning.

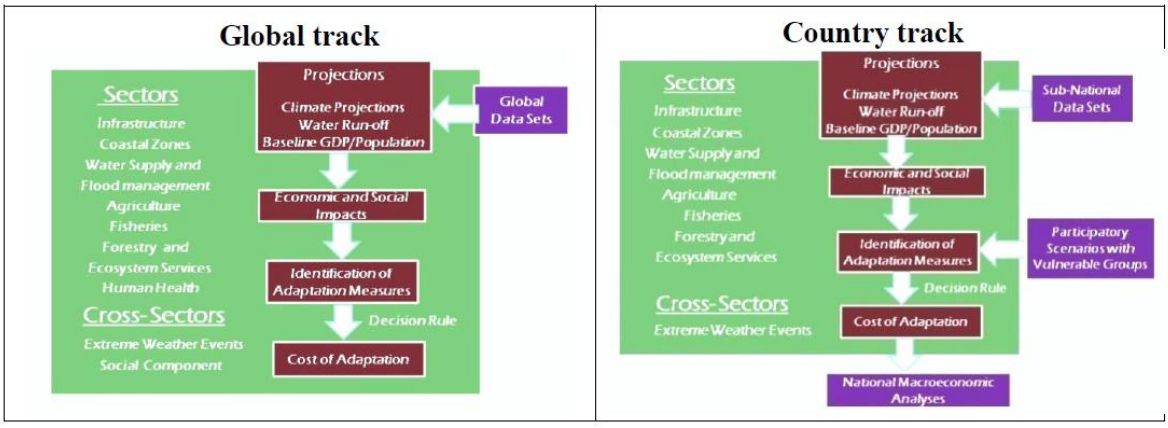

Figure 5: EACC study methodology: global and country tracks. Source: World Bank (2010)

Köhler and Michaelowa (2013) introduced two indicators for measuring the final adaptation impacts including a methodology for a coastal protection project in Vietnam. The total value of an adaptation project here is assessed via the indicator Saved Wealth (SW), covering the monetary value of public infrastructure, private property and income loss (indicator specifies wealth protected by an adaptation project against destruction by climate change impacts) and the indicator Saved Health (SH) which covers avoided disease, disability and life loss using the concept of Disability Adjusted Life Years Saved (DALYs).

The Repository of Adaptation Indicators, published in 2014 by the German Corporation for International Cooperation (GIZ) (Hammill et al. 2014) intended to illustrate possible adaptation indicators and their application context, thereby supporting the selection and context-specific formulation of indicators. Indicators are listed by the following focus area: climate parameters, climate impacts, adaptation actions and adaptation results. The repository systematically presents various indicators from a range of sectors that track different aspects of the adaptation context, process and results to determine if adaptation strategies or investments are meeting their objectives. It also describes their calculation, limitations, and the information needed to use it. Exemplary adaptation result indicators are: “Number of m^3 of water conserved” or

"Percentage of urban households with access to piped water". The whole repository can be assed via this link: http://www.adaptationcommunity.net/?wpfb_dl=221

Donatti et al (2019) reviewed the intended adaptation outcomes and indicators used by ongoing and completed Ecosystem-based adaptation (EbA) projects found in three major databases (UNFCCC, UNEP and GEF). They revealed that in 55% of 58 reviewed projects only output indicators were used (most commonly: "number of hectares restored", "number of hectares protected", "number of people trained"). 36% of all projects presented indicators to track outcomes (most commonly: "change in income") and 29% of all projects presented indicators to track both outputs and outcomes. The authors offered several reasons why only one third of the projects used outcome indicators: first, the adaptation outcome to be achieved by project activities is not clear therefore it is not measured. Second, as the outcomes of many projects will only be apparent after several years, potentially even decades after project implementation, many projects may not have resources to do the long-term monitoring needed to document potential adaptation outcomes. Third, many donors do not require outcome indicators to be reported from EbA projects, so there is little motivation for projects to undertake such monitoring on outcomes. Based on the 13 outcomes identified and indicators used by donors, institutions, and international frameworks, Donatti et al. (2019) suggest a set of seven indicators that can be used to measure the adaptation outcomes of EbA. The list of indicators can be viewed in the annex.

Conclusions

There is a high degree of controversy regarding the appropriateness of adaptation metrics. By acknowledging and learning from the pitfalls of existing adaptation metrics, practitioners, advisors and policy makers will have to decide how they want to measure adaptation benefits in the future. It is clear that there is a strong need for a common understanding on how to measure and track adaptation activities, especially regarding the differentiation between outcomes and impacts. Whether this happens through a single, all-encompassing metric or a number of adaptation outcome metrics still needs to be decided; views are highly diverse on that. The majority of practitioners and researchers leans towards differentiated adaptation metrics. Awareness of the strength and weaknesses of different metrics helps in putting them to use where they best suit the intended purpose.

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Annex

List of EbA indicators, adopted from Donatti et al. 2019

Table 2 Suggested gold-standard indicators to measure the adaptation outcomes that can be achieved through EbA, suggestions on how to take measurements, and the mid-term, process-based indicators that can be used in mid-term evaluation of the intervention and/or in case the "gold standard" indicators cannot be tracked due to lack of data and/or time and resource constraints

Adaptation outcomes from EbA interventions	Suggested "gold standard" indicators for measuring adaptation outcomes	Extreme events and long-term changes addressed by the interventions	Suggestion on how to take the measurements	Suggestion on where and when to take the data	Mid-term, process- based indicators
Reduced loss of assets of coastal communities and infrastructure due to extreme weather events Reduced loss of assets of urban and non-urban communities and infrastructure due to extreme weather events	1. % of infrastructure damaged after extreme events (e.g., hospitals schools (% of facilities damaged), homes (% of houses damaged), roads (% of km of roads damaged), protected areas (% of area damaged), agricultural land (% of hectares of agriculture damaged), cultural and recreation sites (% of area damaged) after extreme weather events.	Extreme events: hurricanes, typhoons, and storms[1], flooding[2], landslides[3], heatwaves[4] and fires[5]	1. Use of satellite images to take stock of existing infrastructure, agricultural land and extent of ecosystems (see UNISDR 2017); information on damages collected during emergency responses measures.	• After an extreme event, when the intervention was not yet implemented (baseline) • After an extreme event, when the intervention was implemented	1a. Decreased erosion (costal or hillside) before and after the EbA implementation
Reduced impacts of climate change on ecosystems that maintain livestock production, marine and freshwater fisheries, and natural products for household consumption Reduced negative (and direct) impacts of climate change on livestock and crop production (mainly through physical damage) for household consumption Reduced impacts of climate change on ecological interactions (pest, diseases, pollination) that affect crop and livestock production for household consumption	2. Prevalence of moderate or severe food insecurity in the population after extreme weather events or through time.	Extreme events: flooding[6], droughts[7], storms[8], fires[9], heatwaves[10], sea level rise[11] Long-term changes: terrestrial and oceanic temperature[12] that can affect crop, livestock and fish production	2. Questionnaire with communities to get information on % of the population that is food insecure. (Food Insecurity Experience Scale from FAO provides a set of questions to ask communities on that matter); Census data held by local administration	• After an extreme event or through time (yearly basis) when the intervention was not yet implemented (baseline) • After an extreme event or through time (yearly basis), when the intervention was implemented	2a. Crop, livestock and fish production for household consumption in the growing/production season before and after the implementation of the EbA intervention.
Reduced impacts of climate change on ecosystems that maintain livestock production, marine and freshwater fisheries, and tourism for profit Reduced negative (and direct) impacts of climate change on livestock and crop production (mainly through physical damage) for profit Reduced negative impacts of climate change on ecological interactions (pest, diseases) that affect crop and livestock production for profit	3. Average income from sustainable crop and/or livestock production, sustainable marine and freshwater fisheries, and/or eco-tourism of small-scale per household after extreme weather events, or through time.	Extreme events: flooding[6], droughts[7], storms[8], fires[9], heatwaves[10], sea level rise[11] Long-term changes: terrestrial and oceanic temperature[12] that can affect crop, livestock, and fish production	3.Surveys with communities to get information on income from crop and/or livestock production, sustainable marine and freshwater fisheries, and/or tourism of small-scale, producers /fisherman/ businessman per household	• After an extreme event or through time (yearly basis) when the intervention was not yet implemented (baseline) • After an extreme event or through time (yearly basis), when the intervention was implemented	3a. Income from crop, livestock and fish production in the/production season before and after the implementation of the EbA intervention
Reduced impacts of climate change on water quality and quantity for human use	4. % of population with access to enough and clean drinking water under extreme events, or through time.	Extreme events: droughts[13], flooding[14], heatwaves[15] Long term changes: precipitation[16]	4. Use census information to get data on the number of people in a location that have access to water year-round and during extreme events	•After an extreme event or through time (yearly basis) when the intervention was not yet implemented (baseline)	4a. Water provision for human consumption before and after the implementation of the EbA intervention.
Reduced loss of lives in urban and non-urban communities due to extreme weather events Reduced loss of lives in coastal communities due to extreme weather events	5. Percentage of deaths and missing persons in various demographic groups after extreme events.	Extreme events: hurricanes, typhons and storms[17] and the associated flooding[18], landslides[19], extreme heat[20], fires[21]	5.Use local or national statistics to get the number of people that have died from extreme weather events (see UNISDR 2017)	• After an extreme event or through time (yearly basis), when the intervention was implemented	5a. not available

Adaptation outcomes from EbA interventions	Suggested "gold standard" indicators for measuring adaptation outcomes	Extreme events and long-term changes addressed by the interventions	Suggestion on how to take the measurements	Suggestion on where and when to take the data	Mid-term, process- based indicators
Reduced impacts of climate change on the incidence of vector borne diseases	6. People's years lost or deaths due to vector borne diseases of various demographic groups within the population after extreme weather events.	Extreme events: flooding events[22] and drought[23]	6 and 7. Use national or regional statistics to calculate the disability-adjusted life year (DALY) from WHO, a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death; use local or national statistics to get the number of people that have died from extreme weather events (see UNISDR 2017)		6a. Prevalence of vector species before and after the implementation of the EbA intervention.
Reduced negative health effects (respiratory distress and heat stroke) due to temperature extremes and fires	7. People's years lost or deaths due to vector borne diseases related to climate change, respiratory distress and heat stroke, of various demographic groups within the population during extreme weather events.	Extreme events: extreme heat[24] and fire[25]		• After an extreme event, when the intervention was not yet implemented (baseline) • After an extreme event, when the intervention was implemented	7a. Levels of pollution in the air before and after the implementation of the EbA intervention. 7a. Local air temperature before and after the implementation of the EbA intervention.