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Economics of Climate Adaptation (ECA) in Development Cooperation: A Climate Risk Assessment Approach

Supporting decision making on climate change adaptation measures

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Content

Executive Summary

Already today, extreme weather events present a significant risk to ecosystems, societies and their economies. Climate variability and change have the potential to aggravate these risks becoming one of the most serious threats to the development prospects in many countries around the globe. The approach taken under the umbrella of "Economics of Climate Adaptation (ECA-approach)" provides decision-makers with information about potential climate-related damage to their economies and societies. It can foster comprehensive adaptation strategies by analysing and proposing a variety of specific adaptation measures in a systematic way. Well-targeted, early investments to improve climate resilience are likely to be less cost-intensive and more effective than complex post-disaster relief efforts, both locally and on an aggregated global scale.

The ECA approach has been introduced by KfW Development Bank to development cooperation as an innovative way to identify and prioritize adaptation measures within comprehensive adaptation programmes on the local or regional scale, ensuring an active involvement of a broad range of stakeholders.

Introduction to the ECA Approach – Specifying Climate Adaptation Measures

In 2013 KfW started to implement two pilot studies[1] in Bangladesh (Barisal) and El Salvador (San Salvador) testing the ECA approach to prepare climate change adaptation (CCA) measures in urban areas. KfW had identified the ECA-methodology as a valuable approach to (1) provide local decision makers with the fact base to develop their own adaptation strategy, (2) foster the development of KfW's CCA portfolio to include more loan and program based finance as well as climate risk insurance approaches, not least in the context of (3) the future challenge of National Adaptation Plans (NAPs), and to (4) learn for its climate screening procedure, too.

The objective of this paper is to briefly present the process of the ECA methodology and to share the experience on advantages, challenges and recommendations to use ECA for further development of a comprehensive CCA portfolio.

The ECA approach was developed by the Economics of Climate Adaptation Working Group[2], a partnership between reinsurance group Swiss Re, McKinsey & Co., the Global Environment Facility (GEF), ClimateWorks, the European Commission, the Rockefeller Foundation and Standard Chartered Bank. The ECA approach[3] (Figure I) evaluates current and potential costs of climate change and how to prevent them by determining a location's total climate risk – calculated by combining existing climate risks, climate change and the value of future economic development.

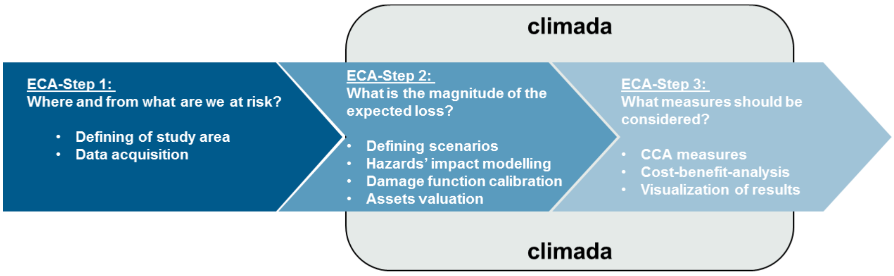

Figure I: The three principal ECA-steps with their conceptual questions and main elements of activity. In step two and three the integrated probabilistic model "climada" (cp. next chapter) plays a key role regarding the methodology (Modified according ECA Report, 2009).

[1] https://www.kfw-entwicklungsbank.de/Internationale-Finanzierung/KfW-Entwicklungsbank/Wer-wir-sind/News/News-Details_232192.html
[2] http://media.swissre.com/documents/rethinking_shaping_climate_resilent_development_en.pdf
[3] http://www.swissre.com/eca/

ECA uses a cost-benefit analysis to create a list of location-specific measures to adapt to the identified risk. Thus, ECA provides key information for investment decisions such as quantifying the potential climate-related loss to the economies and societies over a defined time period and suggesting the most cost-efficient adaptation measures to avert the prospected loss.

climada - The Analysis Engine

climada[4] is an open source probabilistic natural catastrophe modeling platform available on GitHub[5] that implements the ECA methodology. climada plays a key role in assessing and addressing the risk (cp. Figure I). It calculates averted weather-related damage (benefit) in a comprehensive manner for adaptation measures of any kind and is based on four elements:

- People & assets i.e. geographical distribution of people, houses, activities, public infrastructure, etc.
- Hazards i.e. tropical cyclones, storm surge, torrential rain, landslides, etc.
- Damage functions (vulnerability curve) relating impact to economic consequence - or any other pertinent metric, like people affected
- Adaptation measures i.e. improved building codes, seawalls, drainage systems, mangroves, etc.

Rather than simply analyzing one event, climada is programmed using the information of the four elements to simulate many possible events within the hazard element that could unfold within a certain time period – performing a so-called probabilistic risk assessment. The model generates a (long) list of event damages which makes it possible to understand the relationship between damage potential and occurrence frequency, and hence the cost of average and extreme damage impacts (climada manual 2016). climada allows to process large data sets with correspondingly high spatial detail providing great flexibility and expandability (as it is an open source tool). However, it requires a certain level of expertise to professionally operate.

All stakeholders in the ECA process may benefit directly from climada's simulation possibilities as the calculation results can be visualized (Figure II) in many ways –

[4] climada is a tool running either on MATLAB or Octave and can be downloaded free of charge. MATLAB is a basic and common computer language (http://ch.mathworks.com/products/matlab), Octave is open-source and free of charge (www.gnu.org/software/octave). For more details about the damage calculation process, please refer to the climada manual, https://github.com/davidnbresch/climada/blob/master/docs/climada_manual.pdf, p 5ff. and as a first intro to the climada Wiki, i.e. https://github.com/davidnbresch/climada/wiki

[5] https://github.com/davidnbresch/climada/wiki/NatCat-modelling

and its speed allows using it during workshops to test hypotheses and ‘play’ with assumptions.

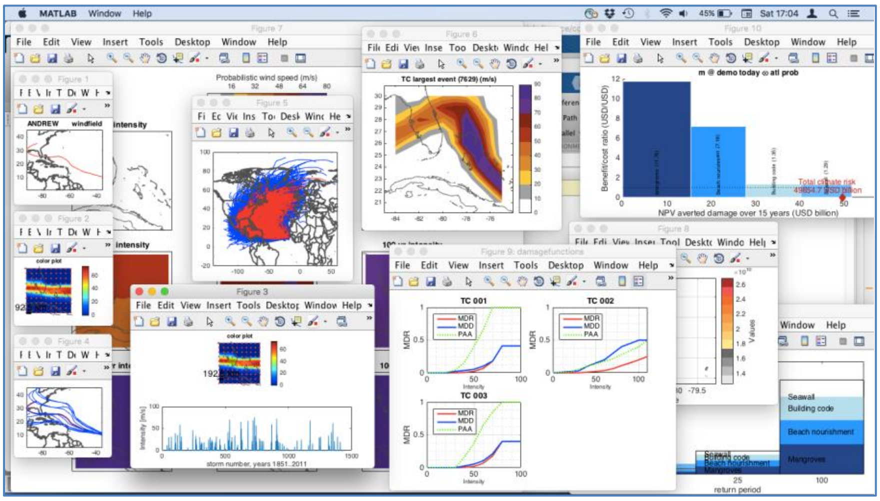

Figure II: Exemplary compound screenshot of most climada functions and products (climada manual 2016[6])

This allows for good transparency regarding both, assumptions and results. The transparency of the results and inputs as well as the inclusive approach (workshops & discussions) taken with stakeholders results in a strong basis for a long-lasting collaboration and strong confidence in the adaptation opportunities.

[6] https://github.com/davidnbresch/climada/wiki/NatCat-modelling

ECA Step 1: Study Scoping and Data Acquisition

In this first step the principal tasks are to define the study area and gather the relevant data. A number of scoping decisions need to be made, e.g. the geographic area, most relevant hazards, time period, scaling/resolution, etc. One or more stakeholder workshops are realized to ensure inclusiveness of people, areas at risk and hazards. Based on scope and focus, comprehensive data acquisition is necessary, such as on population and assets (at risk), socio-economic development, climate change and variability, disaster history, damage records and others.

This data is needed to follow a rigorous risk management approach to assess local total climate risk, comprising (1) today's climate risk, (2) the economic development paths that might put greater population and value at risk and (3) the additional risks presented by climate change and variability. Specifically for the second and third ECA step, the climada model is essential. Figure III provides an impression of the flood risk in San Salvador under a moderate climate change scenario until 2040 modelled by climada.

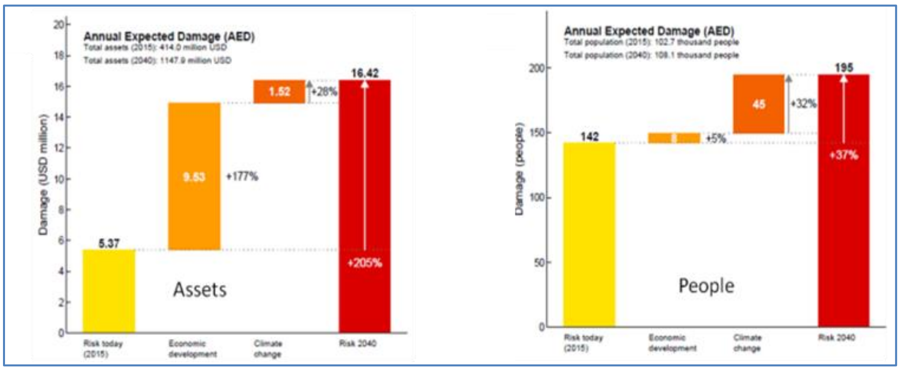

Figure III: San Salvador: the risk today (annual expected damage 2015), the additional risk due to economic development and to climate change until 2040 (under a moderate climate change scenario). Flood risk to assets (left) is primarily driven by economic development, while flood risk to people (right) does primarily increase due to climate change (KfW (2015): Vulnerability Report San Salvador).

ECA Step 2: Assessing the Risk

The second step determines the basics for the vulnerability analysis and is therefore also the key step for the later provision of specific CCA measures and their cost-benefit ratio. Assessing the risk to quantify weather-related damages in a comprehensive way by means of climada requires several inputs:

(1) Scenario building: On basis of the latest climate assessment report by the Intergovernmental Panel on Climate Change (IPCC)[7] three climate change scenarios (no change, moderate change, and extreme change) for an individually defined time horizon are derived. Additionally different socio-economic scenarios are developed considering development plans and data on drivers such as economic and population growth, technical innovations, etc.

(2) Hazard modelling: Hazard intensities have to be modelled to create plausible hazard scenarios/maps characterized by a set of assumptions regarding their frequency and intensity.

(3) Asset valuation: Existing assets of physical and socio-economic infrastructure as well as population living in the study area need to be valued and located (cp. Figure IV). The assets are defined according to different classes or categories and are geographically located (geo-coded) in order to estimate the expected damages from climate change and variability effects under the different socio-economic scenarios. Within the KfW pilot studies a pro-poor approach has been developed and integrated in order to focus not only on the assets with the highest absolute values.

(4) Building the damage function (vulnerability curve): The damage function relates the intensity of a given hazard to the damage caused on a certain category of asset. Thus, for all asset categories (including pro-poor) and all hazards damage functions have to be elaborated and tested.

These building blocks are combined in climada for estimating potential damages. This approach may generally be applied to all forms of natural hazards, whether storm, flood or any other type of risk. Risk quantification can thus be performed for

[7] https://www.ipcc.ch/report/ar5/

risk today (today's hazard and assets/population) as well as for future conditions (future hazard shaped by moderate and strong climate impact scenarios and future assets/populations).

Figure IV: Urban flood risk area (San Salvador) with key infrastructure and asset values (poor / non-poor) as well as 100-year-flood event zone (KfW (2015): Vulnerability Report San Salvador).

ECA Step 3: Addressing the Risk

The third step seeks to give answers how to respond to the potential hazards' impact averting the expected damages by implementing CCA measures. Adaptation to a certain hazard or a set of hazards can be achieved in either reducing the hazard intensities or the response to a given hazard. CCA measures may include infrastructure and their modification (i.e. building codes against storms, sea walls), reservoirs and wells to combat drought or prevent flooding, technological measures (i.e. fertilizers, drip irrigation, early warning systems), behavioral initiatives (awareness campaigns, new agricultural farming systems), institutional measures, socio-economic development and others. Risk transfer or insurance measures also play a key role in addressing rare but severe weather events[8].

However, a basket of CCA measures is required to address the total climate risk. After proposing a long list of CCA measures with the participation of local and international experts, local decision-makers, citizens as well as local institutions and universities, experience and literature, this has to be cut down to a short list by using a multi-criteria selection during stakeholder workshops. Then climada can be used to assess the selection of CCA measures (investments) on an economic basis to propose a prioritization (CCA-measures cost curve). For the cost-benefit analysis (CBA), the benefit is calculated as the averted loss and any additional revenues if applicable. The costs include capital (CAPEX) and operating expenses (OPEX) as well as any potential operating savings derived from the measures. The stream of costs is discounted back to today's dollars using local discount rates. The discount rate needs to be set individually for the location/country[9]. climada provides a consistent approach to assess the cost and damage aversion potential of any CCA measure[10]. Each CCA measure can be specified to act on any component of the model (scenario, hazard, assets and damage function), or even a combination thereof. To feed climada with CCA measures (short list) to be analyzed these need to be parameterized beforehand. In order to support this process a half-standardized list of CCA measures[11] has been generated on the basis of the ECA pilot studies and literature review. In this regard it should be mentioned that the

[8] climada does comprise a quite extensive list of nearly hundred 'template' measures, see https://github.com/davidnbresch/climada/blob/master/data/entities/catalogue_of_standard_measures.xlsx
[9] Or even for specific measures (i.e. yield curves of government bonds for financing...)
[10] climada does support measure-specific discount rates and time-dependent yield curves etc.
[11] https://github.com/davidnbresch/climada/blob/master/data/entities/catalogue_of_standard_measures.xlsx

specific potential damage aversion comes with a certain degree of uncertainty, even for measures for which extensive research exists, e.g. for building codes to fix roofs against hurricanes. Hence, an iterative approach, i.e. to re-run climada with a range of parameters in order to converge to a consistent evaluation (calibration) is strongly recommended.

Finally, the CBA is used to evaluate which investments and measures are the most cost-effective and feasible to adapt to the expected risk. The output of this cost-benefit exercise is an adaptation cost-curve (cp. Figure V). The cost-curve should be used to initiate a structured discussion about the proposed measures to avert the expected damage and /or protect people.

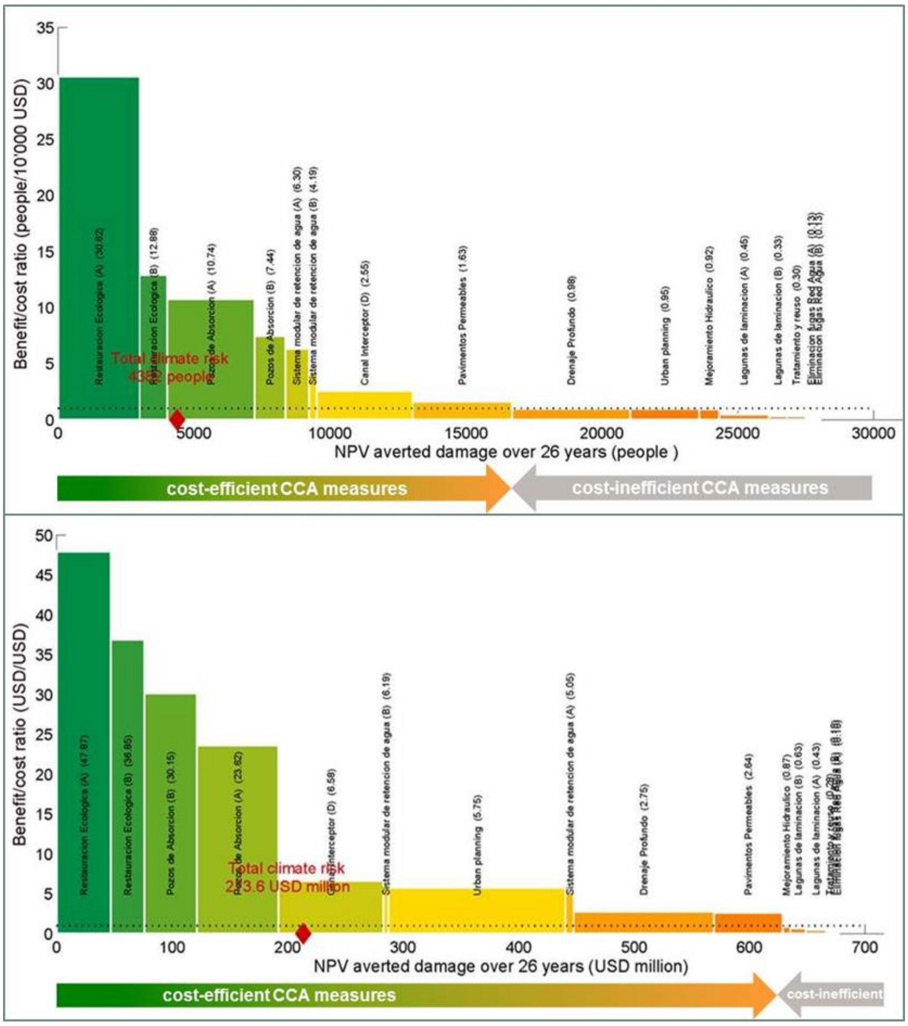

Figure V: CCA measures to enable flood-resilient development analyzed for both, people (affected) and assets (damaged). The horizontal axis depicts the total climate risk and indicates the extent of the loss averted by each measure (width of column) (Modified acc. KfW (2015): Vulnerability Report San Salvador).

A lot of additional criteria are essential to keep in mind and the model results need to be contextualized before coming up with a proposal. This curve is a key source of information along with policy, capacity and other considerations that a country, region or city can use to assemble a comprehensive adaptation strategy. Policy makers are thus provided with the necessary information to prioritize among possible CCA measures, as CBA demonstrates e.g. the advantage of ex-ante measures such as risk prevention and insurance over post disaster measures.

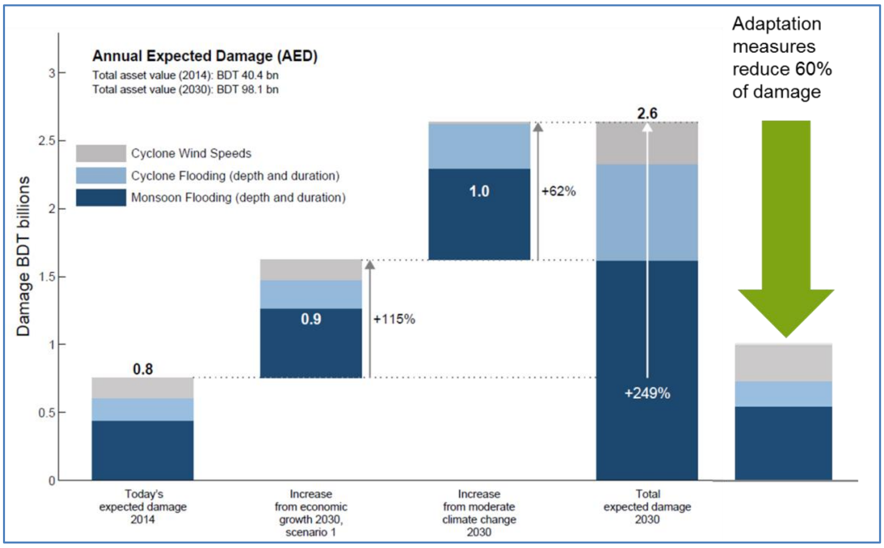

Figure VI: For Barisal the risk more than triples by 2030 (risk today + economic development + climate scenario). According to ECA results cost-effective adaptation measures can reduce damage by up to 60% (KfW (2015): Barisal Vulnerability Report 2015).

In the case of Barisal the biggest climate risks the city faces are cyclones and floods (cp. Figure VI). The economic development is a main driver (115 %) for the increase in risk as the strong urbanization trend contributes significantly to a changing risk patterns. However, the ECA approach identified a list of CCA measures that have the potential to avert up to 60 % of the prospected damage – most of it in the poorer, western parts of the city.

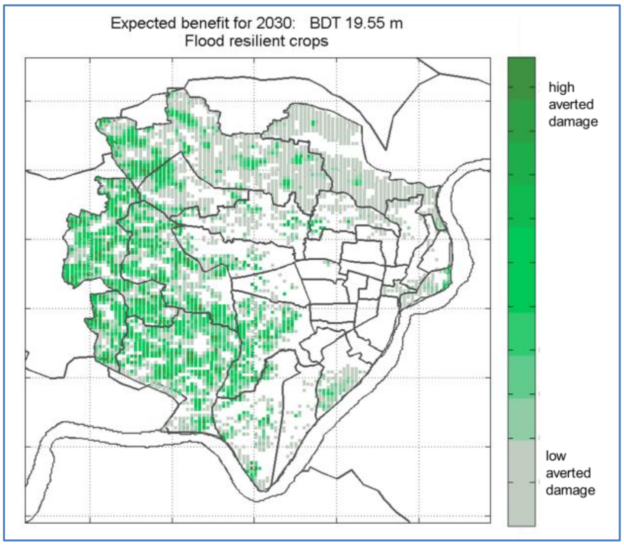

Figure VII: Flood resilient crops reduce agricultural losses by 40%, mostly in the western part of the city of Barisal (Barisal Vulnerability Report 2015)

The most effective CCA measures include choosing/planting flood resilient crops (cp. Figure VII), reinforcing river embankments and improving solid waste management of Barisal.

Residual Loss - Including Climate Risk Insurance in a Comprehensive CCA Portfolio

The damage that cannot be prevented by CCA measures or climate risk insurance is called the residual loss. We cannot protect against all risks by investing in CCA measures, especially not very rare ones. However, financial consequences of the expected residual risks can be mitigated considerably also ex-ante by transferring (financial) risks. Risk transfer via insurance e.g. can provide efficient additional protection against low frequency, high severity events (i.e. a once-in-100-year storm surge). For such rare events, risk transfer represents additional protection by capping losses and smoothening the costs of climate events to individuals, corporations and governments. It can thus protect livelihoods against catastrophic events and increase the willingness of decision-makers to invest in economic development. At the same time risk-based premium figures for the insurance cover provide decision-makers with valuable additional information and incentives to invest in risk preventive measures as lowering potential future losses will lower future risk premiums. Risk prevention and risk transfer are thus mutually reinforcing. While insurance is a useful component in a given adaptation portfolio, keeping insurance premiums in check by minimizing residual risks through prevention measures is equally important. The objective is providing a comprehensive climate risk management system for the future. Therefore, e.g. the G7 initiative on climate risk insurance, InsuResilience[12], aims to offer climate risk insurance to poor people in developing countries who are especially at risk due to climate change.

Finally, the ECA findings need to be summarized and presented in a transparent, well-structured manner using maps, charts and figures according to the objectives, the target audience, the stakeholders and the beneficiaries of the study. Here ECA allows an excellent visualization of the results. Apart from the cost-curves and other figures above, this map (Figure VIII) shows an example for geo-coded localization of CCA measures in a high resolution map in San Salvador.

12 http://www.bmz.de/de/themen/klimaschutz/Klimarisikomanagement/g7_initiative_klimarisikoversicherung/index.html

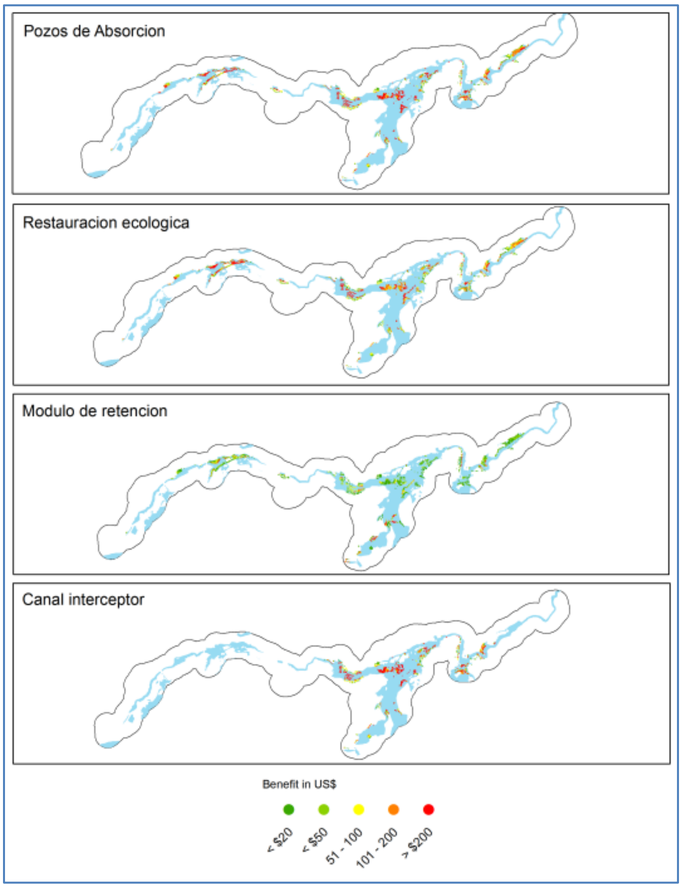

Figure VIII: Localizing four principal CCA measures to avert flood damage in high resolution mapping (benefit in USD) for poor urban areas in San Salvador (KfW (2015): Vulnerability Report San Salvador).

In the final proposal for the decision makers the selected, cost-efficient CCA measures are presented including some pre-feasibility information such as design of the infrastructure, beneficiaries, locations, possible responsible institutions, costs, existing examples and experience, involved actors, risks of implementation, framework conditions and others.

Experience from KfW's ECA Pilot Studies

The ECA methodology and the climada model have been tested and further developed in the context of Germany's Financial Cooperation (implemented by KfW) in order to analyze practicability and added value. After finalizing the studies KfW initiated a comprehensive review. This included in addition to numerous discussions and observations during the studies' implementation, an online survey on the experience with the pilot studies among the participating stakeholders, a final field visit with workshops and in-depth interviews with key persons. In a final workshop participants proposed the following conclusions on the ECA methodology:

Experts consider the ECA approach useful – particularly for climate adaptation strategies and strategic investment plans in adaptation finance including insurance approaches. At the end of the day the relative high costs and substantial time frame required, need to stay in a positive correlation to the planned investment volume. The studies showed both strengths and limitations of the ECA methodology for the stated purpose of use by KfW. The potential of the methodology lies (1) in its unique probabilistic approach (climada), which unites the physical variability of climate change with the cost-effectiveness of CCA measures and (2) in the clearly structured involvement of all stakeholders initiating a transparent in-depth discussion fostering a consensual process.

ECA provides a climate risk scenario analysis (economic and climate development) within a robust methodology to select CCA measures with best cost-benefit ratio. It contributes to decision making about CCA measures and provides an assessment of the strategic potential of measures (strategic investment planning). Its systematic and transparent approach builds trust and initiates in-depth stakeholder discussion across sectors helping to avoid a premature restriction on particular sectors or measures. Further, ECA gives guidance on what aspects to focus on during a feasibility study and provides key information for programme based approaches, insurance approaches and has potential to support National Adaption Plans' (NAPs) development.

Perceived as one of the biggest challenges, was the selection of the appropriate study area. One has to essentially rely on an informed decision by ECA-non-experts at the beginning of the ECA-process.

The initial acceptance was limited due to a complex methodology, an innovative approach and the probabilistic modelling. That's why the method requires strong process-oriented and expectation management and intensive consultation with public authorities and stakeholders. It requires substantial data input which in some cases requires supplementary analysis, which may be time consuming. One has to be aware of the fact that the focus is principally on physical assets with an option to capture affected people and pro-poor elements indirectly. Finally, it offers limited suitability for high-frequency, low-impact hazard regimes and requires high level of expertise (hazard modelling, climate risk, probabilities, engineering acumen, and economics) and MATLAB/Octave-expert necessary to avoid the risk of black box use of climada.

Recommendations for improving efficiency of future ECA studies are to follow an iterative process not going into too much detail in advance to find out the adequate resolution required to represent the hazard - live with uncertainties. For sustainable use and further development it is recommendable to integrate more capacity building for local partners in the project set-up. In this sense, sufficient time and guidance at the beginning and for the phase between ECA-results and feasibility study is crucial for an efficient process. Finally, considering the cost and the time required for implementing the ECA-approach, a selective use for development cooperation is recommended - in particular for climate change adaptation strategies, strategic investment planning, applicable to programme based approaches with relatively strong partner institutions.

Next Steps

The ECA approach has been introduced to development cooperation as an innovative way to identify and prioritize adaptation measures within comprehensive adaptation programs at the local or regional scale, ensuring an active involvement of a broad range of stakeholders.

In order to make future use of the ECA methodology more efficient and user friendly, KfW decided to elaborate a detailed practitioner process guidebook with concrete examples based on the experience made. Standardization, e.g. a half-standardized list of CCA-measures with their basic parametrization can facilitate a more efficient application of the ECA approach. This could significantly help to increase the acceptance among stakeholders and reduce the initial orientation time as well as the work load of study implementation. Also it should be explored how a reduced form of ECA modelling (desk study) can be utilized as an optional pre-screening tool for adaptation projects – building both, on the strength of the comprehensive methodology and the transparency of the open-source model.

The ECA guidebook is available on KfW's website.

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