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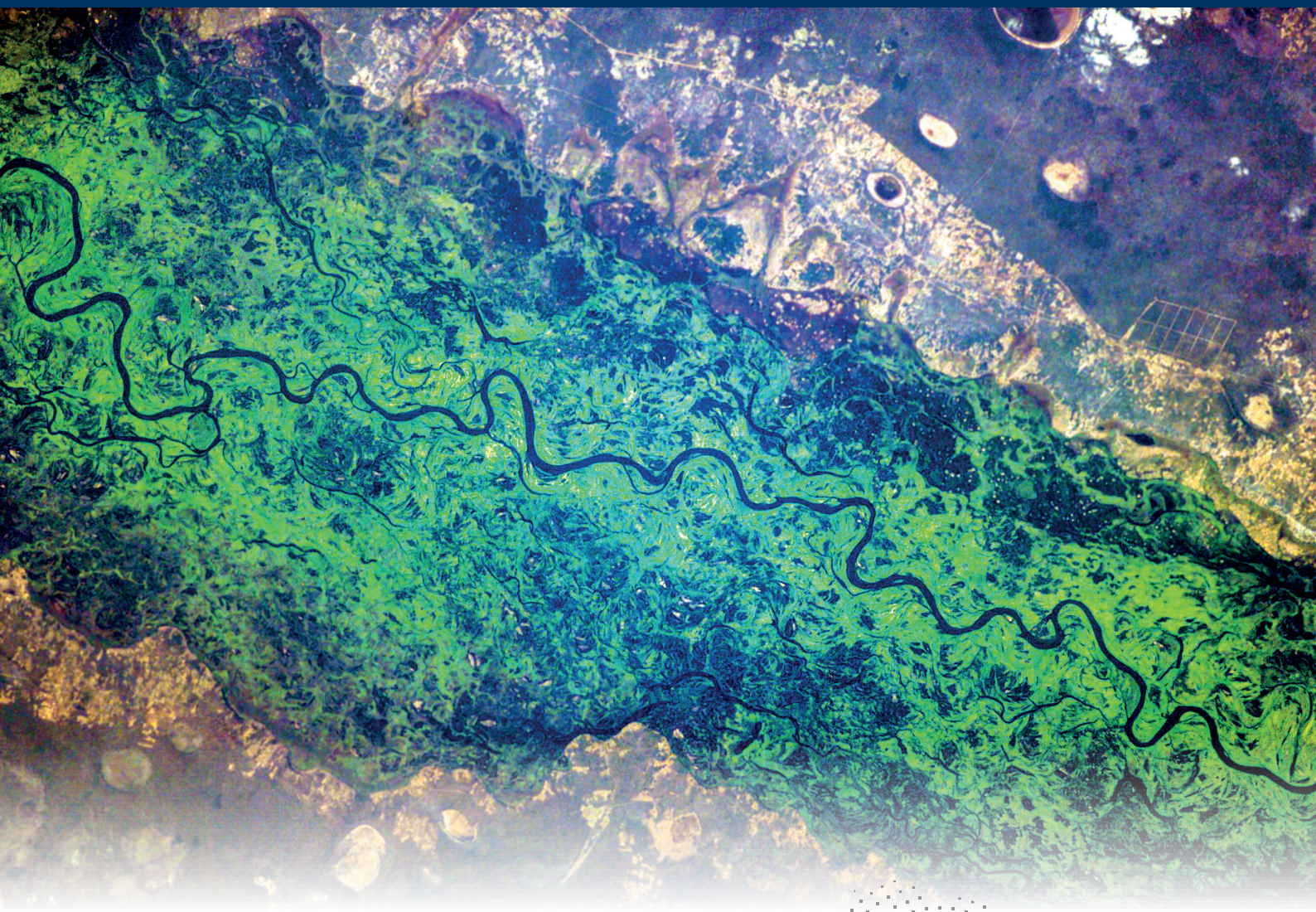
Guidance Note on Using the Probabilistic Country Risk Profiles for Disaster Risk Management



Building Disaster Resilience in Sub-Saharan Africa

Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities

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Guidance Note on Using the Probabilistic Country Risk Profiles for Disaster Risk Management

International Centre on Environmental Monitoring

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Acronyms & Abbreviations

AAL	Annual Average Loss
ACP	African, Caribbean, and Pacific group of states
BCR	Benefit-Cost Ratio
CBA	Cost Benefit Analyses
CCA	Climate Change Adaptation
CCRIF	Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company
CIMA	International Centre on Environmental Monitoring
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EU	European Union
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GIZ	Gesellschaft für Internationale Zusammenarbeit
IFRC	International Federation of Red Cross and Red Crescent Societies
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
M&E	Monitoring and Evaluation
NAP	National Adaptation Plan
NDMAF	National Disaster Management Advisory Forum
NDP	National Development Plans
NGO	Non-Governmental Organization
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
PCP	Participatory Campaign Planning
PML	Probable Maximum Loss
RCP	Representative Concentration Pathway
SDGs	Sustainable Development Goals
SPHERA	System for Probabilistic Hazard Evaluation and Risk Assessment
SSPs	Shared Socio-economic Pathways
STAG	Scientific and Technical Advisory Group
SURE	Strengthening Urban Resilience and Engagement
TGE	Total Growth Effect
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	United Nations for Disaster Risk Reduction
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNPEI	United Nations Poverty-Environment Initiative
USD	United States Dollars
WHO	World Health Organization

Tables of contents

Introduction

1.1 Introduction

In 2018, as part of the "Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities" programme, UNDRR, with the help of CIMA Research Foundation, VU Amsterdam, and Wageningen University and Research developed country risk profiles based on a probabilistic risk assessment methodology for floods and droughts at the national level in sixteen African countries. Through a quantitative estimation of the impacts of floods and droughts and their associated likelihood in the present, as well as in a projected future, the probabilistic country risk profiles provide a comprehensive view of risk of floods and droughts in a changing climate.

The country risk profiles improve the understanding of risk at the national and sub-national levels by providing quantifiable data on economic and population disaster impacts. They can be an important tool for informing disaster management actions already in place or, used as a first step towards designing new actions to curb the deadly cost of disasters. However, given the complexity and density of the probabilistic approach, the potential uses of the country risk profile are often not fully understood.

This guidance document therefore outlines a number of practical applications, aiming to promote the use of probabilistic risk information.

1.2 The Risk Profiles and Probabilistic Risk Assessment Methodology

The added value of a probabilistic disaster risk assessment is often misunderstood, viewed as a highly technical method that is difficult to apply or understand by decision-makers and policy makers. These difficulties represent a challenge for using risk information in practice. A probabilistic disaster risk assessment should be seen as a risk diagnosis instrument. It provides indications on possible hazardous events and their impact taking into consideration past and probable future events in a comprehensive risk assessment exercise.

In the probabilistic country risk profiles referred to in the present document, two different climate scenarios were considered:

- current climate conditions: with disaster risk assessed using the observed climate conditions in the 1979 - 2018 period;
- projected climate conditions: with disaster risk being assessed under projected climate conditions (projected period 2051 - 2100), considering the IPCC scenario RCP 8.5 which foresees an increase in the global temperature between 1,5˚C and 4˚C by 2100, and assuming that further risk mitigation measures will not be put in place.

Probabilistic country risk profiles consider all possible risk scenarios in a certain geographical area. This means that both low frequency, high loss impact events, as well as high frequency, lower loss impact events are calculated. Included is their probability of occurrence, and all elements of the risk equation (Risk = Hazard x Exposure x Vulnerability / Capacity), their variability and uncertainty ranges.

Events which have never been historically recorded but might occur in projected climate conditions are also considered in the risk analysis. This feature is particularly useful in the context of climate change, which is dramatically increasing uncertainty about future hazard patterns, pushing governing bodies to calculate their worst possible impacts in order to be prepared. Bearing this in mind, a probabilistic analysis offers the distinct advantage of improved quantification. By assigning a probability of occurrence to each event magnitude, a probabilistic country risk profile quantifies the expected direct impacts of disasters through economic metrics and affected population, both at aggregated and at disaggregated levels (ex. affected children, women and people with disabilities, different regions and development sectors). As this risk information is framed within return periods as a conventional probability measure, a probabilistic approach provides a clear vision of the risk trends.
This risk information - expressed in an AAL and a PML is calculated both at a national scale, as well as by sector and by region, allowing for a geographic and quantitative comparison of disaster losses, as well as within a country and/or between countries. These analyses and comparison exercises are an important step of the risk awareness processes, key in pushing for risk reduction, risk adaptation and risk management mechanisms to be put in place.

1.3 Scope of the Guidance

The experience developed by UNDRR – Regional office of Africa and CIMA Research Foundation, demonstrated the added value for DRM practitioners and authorities to access risk quantitative risk information on potential impacts of disaster expressed in monetary terms (average annual losses), and disaggregated by geographic areas and economic sectors. However, the existence of the information does not directly imply its use and integration into different strategic sectors. The country risk profiles contain advanced risk information that needs to be properly understood, tailored, and applied.

This guidance document was developed to give an overview of the possible applications of the probabilistic country risk profiles. It therefore outlines a number of practical applications connected to disaster risk management and development, with the aim of guiding the users towards the best use of probabilistic risk information. It is the result of internal consultations and external research – a tool to inspire policymakers and decision-makers to apply risk information according to their own needs.

This document is expected to be used as a starting point for the integration of advanced probabilistic risk information. Where the important value of this information appears, a more detailed process should be developed in order to better expand on specific country needs and tailor the information found in the country risk profile.

The table on the following page provides a summary of the areas of application analysed and the possible uses of the country risk profiles.

Application	*Use of Risk Profile*
Policy Coherence for DRR	• Homogeneous risk information • Resource optimisation • Institutional coordination
National Development Planning	• Contribute to the push towards truly evidence-based NDPs, used in the elaboration of national long-term or short-term development plans, and mainstreamed to the different sectoral and regional plans
National Adaptation Plans	• Raise awareness among stakeholders. • Enhance policy coherence • Initial indication of vulnerability rankings for adaptation measures. • Categorizing risk by economic sector, which facilitates the integration of DRR and CCA with other development priorities
DRR Strategies and Mainstreaming	• Define the objectives and monitoring indicators • Create synergy • Help with advocating for funds • Prioritize capacity building
Preparedness and Emergency Response Planning	• Advocate for resources to be allocated to preparedness and prioritize sectors that may require greater investments in preparedness • Support the evaluation of the preparedness level achieved and eventually define corrective actions for its improvement
Recovery Planning	• Guide recovery investments and resource allocation, especially for medium and long-term reconstruction • Support the inter-sectoral and intra-sectoral prioritization considering geographic (different risk maps) and economic (AAL values) inputs • Priorities capacity assessment at local levels (local governments and other local actors) in order to establish arrangements for the recovery program
Risk Communication	• Multi-level awareness raising and improved dialog among institutions and citizens • Behaviour change
Education for Disaster Risk Reduction	• Promotion of DRR in teaching and learning • Promotion of school safety and of safe schools' environments
Land-Use Planning	• Support planners by identifying, at the national level, which provinces are likely to be exposed to disaster events with the highest impacts • Guide decision making on strategic directions for the utilization of land at a large coverage, harmonizing different spatial plans and defining operational guidelines
Disaster Contingency Funds	• Provide the required information for governments for given disaster scenarios or return periods • Used to inform financial decision making with a better understanding of potential future disaster losses by the use of the different risk metrics (AAL and PML)
Cost Benefit Analyses	• Calculating 'benefits': avoided losses if a specific DRR measure is implemented

Applications of the Probabilistic Country Risk Profiles

2.1 Application on Policy Coherence for Disaster Risk Reduction

2.1.1 Application Outline

Policy coherence is an approach to policy making that integrates all relevant policy fields to achieve common policy outcomes by maximizing synergies and eliminating trade-offs. It ensures that different bodies of government pull in the same 'direction' across all stages of policymaking and implementation. Policy coherence can be a challenging process, particularly in countries where mechanisms for policy dialogue are not yet in place and the capacities to provide evidence-based inputs to policymaking are weak. From the perspective of disaster risk reduction and resilience, policy coherence requires that policies address the following dimensions: Horizontal, Vertical, Spatial, Temporal, Equality (UNESCAP, 2018).

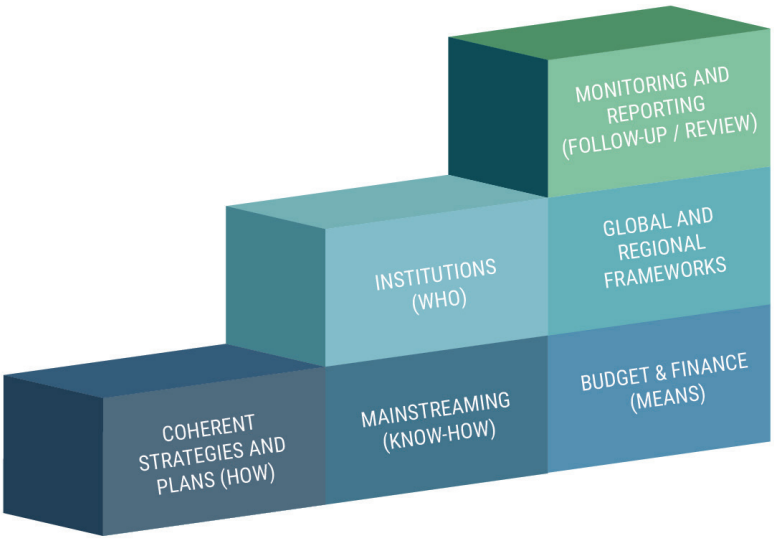


Figure 1: Building Blocks for Policy Coherence (source adapted from UNESCAP, 2018)

2.1.2 Potential Uses of the Probabilistic Country Risk Profile

It is well documented that disasters can derail decades of hard-earned development plans and progress (UNDRR, 2020), and that investments in DRR can contribute to the achievement of development goals, examples of which include poverty eradication, economic growth, reduction of inequalities and the development of sustainable cities and settlements. Inversely, the lack of progress in DRR can curb the achievement of such goals.

Disaster risk reduction and sustainable development converge in the concepts of resilience and vulnerability. Yet this convergence is neither simple, nor automatic. Enabling resilience-building initiatives and holistically reducing communities' vulnerabilities requires high levels of political engagement and institutional coordination. This coordination, in turn, calls for a sound knowledge of risks as a result of evidence-based risk information. Acquiring it depends on specific scientific tools that assess and quantify hazards and risk at different levels and scales, to effectively address DRR through sectoral policies, strategies and planning. Again, this convergence is complex, but its benefits to development are crucial.

The probabilistic country risk profile estimates risk in terms of numbers of people affected and value of losses at different scales, time periods and sectors, as well as measures of frequency and severity of events, both for present and future climate conditions. By providing such numerical data, a probabilistic country risk profile can be used as a common baseline of risk information among multi-sectoral policy makers and planning actors, facilitating the identification of national development priorities and the review of policy options, considering risk as a crosscutting issue. Although there isn't a "one size fits all" approach to building coherence, building blocks (Fig. 1) can be used to guide the process, counting on the contribution of the probabilistic country risk profile:

2.1.2.1 Coherent Strategies & Mainstreaming of Disaster Risk Reduction into Sectors

Policy coherence requires domestic political commitment, cross-sectoral collaboration based on shared priorities and a clear alignment to overarching development goals and to regional and international frameworks (OECD, 2015). This process, which sees multiple stakeholders coming from various backgrounds, can be facilitated by providing policy makers with numerical and objective data, aligning them to the same level of existing risk information. In the case of DRR, risk information such as the probable maximum loss (PML) and annual average loss (AAL) - assessed both nationally and provincially across sectors - constitute a solid basis for the creation of risk awareness at the political level and for fostering an evidence-based dialogue. By providing a detailed picture of the country risk level, the probabilistic country risk profile guides the integration of risk reduction targets into national development plans, helping set intervention priorities based on sectoral and geographical risk information, allowing users to understand:

- How are disaster impacts affecting the national or regional GDP?
- What regions and sectors are more disaster prone?
- In what regions are people most affected by floods or droughts?
- What are the future projections for each type of hazard/ sector/ region/ loss?

2.1.2.2 Budget and financing

The recognition that DRR is essential for sustainable development can be translated into the national budget and financing. A public budget document reflects the national and local policy priorities, which means that specific budgetary and finance measures should not only be incorporated into the mandate of institutions beyond the national disaster management agency, but that these measures should not be used for cross-purposes (UNESCAP, 2018). Within the budget allocation process the country risk profile can be used as the first step to identify investment priorities and to elaborate cost-benefit analyses in order to determine economically efficient measures, allowing users to understand.

By how much, in terms of economic and human losses - AAL/PML/People Affected - could a DRR measure in a certain area (e.g. river defenses, water retention mechanisms, etc.) reduce disaster loss?

2.1.2.3 Coherent Institutions

Fostering coherent institutions is a vital step towards strategically influencing planning, budgeting, laws and sectoral programmes in the medium and long term. Fostering coherence may

include the creation of inter-agency working groups and/or the strengthening of existing work approaches in order to ensure that institutions are able to deliver on cross cutting issues, such as disaster risk reduction, climate change adaptation and sustainable development (UNESCAP, 2018). In this process, the country risk profile can function as an institutional aggregator.By assessing data availability and by identifying data/knowledge needs or inconsistencies, the country risk profile can spotlight the necessity to create new capacities or to strengthen existing ones. Simultaneously, the process of doing, updating or validating a country risk profile represents an opportunity to engage different stakeholders to participate and contribute to the assessment process, fostering a sense of ownership towards a national risk vision. Moreover, if used as the government's official source of risk information, the country risk profile ensures that all the relevant institutions share scientific-revised data and projections towards policy making, allowing users to understand:

- Which institution(s) take the responsibility of the results of the risk assessment(s)?
- Are the institutions responsible for addressing crosscutting issues using the same baseline risk information?
- What risk information is used to inform policy making?

2.1.2.4 Regional and global frameworks

Regional and global frameworks can reinforce efforts made by countries as they promote norms across the international community. As an example, the 2030 Agenda for sustainable development includes a dedicated target (17.14) on enhancing policy coherence for sustainable development. In the same way, risk reduction and resilience, are embedded in the various global frameworks adopted in 2015 and 2016, such as the Addis Ababa Action Agenda, the Paris Agreement, the Agenda for Humanity, the New Urban Agenda and the Sendai Framework for Disaster Risk Reduction. To date, four of the Sendai framework indicators form part of the Sustainable Development indicators, namely: i) Goal 1 - ending poverty; ii) Goal 2 - ending hunger; iii) Goal 11 - developing cities and human settlements; iv) Goal 13 - addressing climate change. This alignment can optimize countries' efforts to achieve policy and institutional coherence. Within this process, the country risk profile can be an important tool to create risk consensus and to advocate for vulnerability reduction and resilience building, crucial milestones for sustainable development, allowing users to understand:

- Are regional and global frameworks translated into domestic strategies and plans?
- Are the results of risk assessments being used for DRR/CCA/SDG implementation?
- Is there a coordinating agency at the national level for the monitoring of SDGs, Sendai and Paris Agreement?

2.1.2.5 Coordinated monitoring and reporting tools

Monitoring and reporting systems keep track of progress towards DRR and resilience building and provide feedback to decision-makers and to the public on policy synergies and contradictions, allowing for gap analysis, knowledge needs, scientific updates and adjustments in case of unintended effects (UNESCAP, 2018). In this process, the country risk profile can help assess the consistent use of risk information and the progress of implemented policies and plans in terms of exposure, vulnerability and losses saved (AAL/PML)allowing users to understand:

- Is risk information used consistently among sectors for monitoring and reporting activities?
- Are the reporting mechanisms capturing disaster risk reduction and resilience issues and progress?

2.1.3 Case Study: Philippines (Sandholz, Simone, and others, 2020)

In response to the increasing exposure and vulnerability to climate change and disaster risk the Philippines introduced a number of legal documents. In 2009 and 2010, respectively, the Philippines developed and introduced the Climate Change Act and the Disaster Risk Reduction and Management Act. As a sound legal basis, these acts initiated the mainstreaming of aspects of disaster risk management and climate change adaptation across policy planning and implementation, culminating in the establishment of a sophisticated and complex multi-level, cross-sectoral policy framework with oversight institutions such as the Climate Change Commission (CCC) for managing climate change and disaster risk even before the Post-2015 Agendas came into being. The developed structures allowed for a prompt mainstreaming and alignment of Post-2015 Agendas goals in existing plans such as the national long-term development agenda AmBisyon Natin 2040, as well as in the Philippine Development Plan (PDP) 2017–2022. Following a hierarchical process from national to lowest administrative level, plans and goals are translated to the regional, provincial and municipal level where they are finally planned and implemented through local policies and programmes. Due to the Local Government Code of 1991, policy planning, implementation and accountability is significantly decentralized, giving local government units (LGUs) considerable autonomy and responsibility.

2.2 Application on National Development Planning

2.2.1 Application Outline

> *"Sustainable and resilient development can best be achieved through an integrated approach that builds on the synergies of actions on climate, development and resilience."*
>
> *(UNDP, 2017)*

National development plans (NDPs) are used by governments to define a country's desired development goals and investments, build consensus on the required paths to achieve them, define the roles and contributions of different sectors and stakeholders, and provide a strategic framework within which more detailed planning and budgeting can take place. They outline a country's vision for development over a five to twenty-five-year horizon - with countries usually adopting complementary long-term, mid-term, and annual plans to ensure achievability and continuation in the planning process (UNPEI, 2017).

National development plans are an important medium through which the integration and mainstreaming of Agenda 2030 on Sustainable development (SDGs), the Sendai Framework for Disaster Risk Reduction and the Paris Agreement on Climate Change can be implemented in order to achieve multiple development benefits conjointly (UNDP, 2017).

2.2.2 Potential Uses of the Probabilistic Country Risk Profile

National development plans have surged in use as an instrument of coordinated development in recent years. In 2006, 62 countries had national development plans of one sort or another. By 2018, this number had more than doubled to 134. Following a review of all the current NDPs around the world, Chimhowu, Hulme and Munro (2019) found, however, that many existing NDPs lack strong evidence, are incoherent, and "intellectually weak". They attempt to produce top-down or bottom-up development plans, but fall short of producing rationally obtained results (Chimhowu, Hulme & Munro, 2019).

The country risk profiles can contribute to the push towards truly evidence-based NDPs. As they offer an evidence-based national outlook on both the present, and projected future climate change and layered socio-economic scenarios, they can be used in the elaboration of national long-term development plans (projected future climate) or short-term development plans (present climate), and mainstreamed to the different sectoral and regional plans. They should be read comparatively: used as a tool to identify potential problem areas when analysed with the existing economic, social and environmental strategies set by the national and regional governments. An examination of Zambia's country risk profile and its national development plan offers a concrete example of the first can directly inform the latter.

2.2.3 Case Study: Zambia

In 2005, Zambia returned to the use of development planning as a strategy to achieve its socio-economic growth goals. Since then, development plans have continuously been updated, and in 2016, it launched its seventh national development plan for 2017-2021. This NDP, as the ones that preceded it, are aimed towards the long-term vision of bringing Zambia to becoming a "prosperous middle-income country by 2030" (Ministry of Development Planning, 2017).

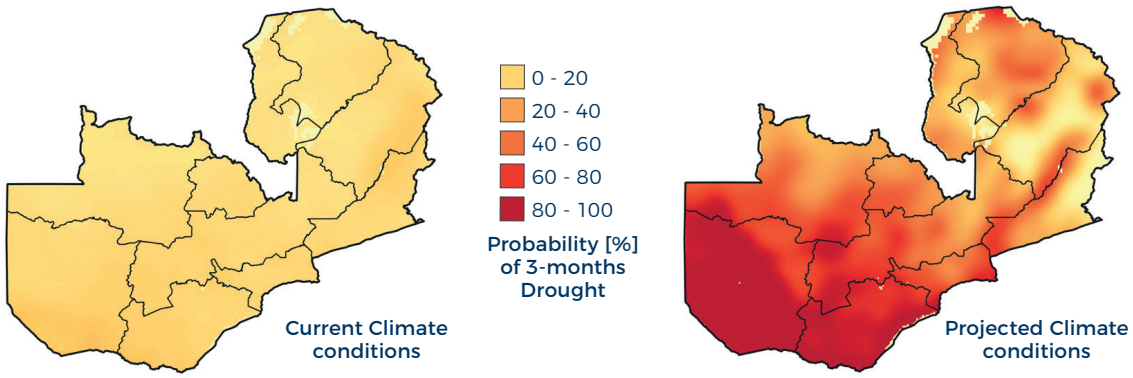
The 7NDP aims to create a "diversified and resilient economy for sustained growth and socioeconomic transformation" and it places particular emphasis on agriculture as the medium through which to do so (Ministry of Development Planning, 2017). This development plan is the first in the country to use an integrated approach that recognizes the "multi-faceted and interlinked nature of sustainable development", in which challenges must be addressed in a coordinated matter (Ministry of Development Planning, 2017). This coordination is emphasized within the country, but also on the international level, as the plan aligns itself with the UN 2030 Agenda for Sustainable Development and the African Union Agenda 2063. Ultimately, the country expects that this integrated approach will prevent government ministries from competing with each other and increase the harmonization of their policies.

The integrated approach recognizes the multi-faceted and interlinked nature of sustainable development which calls for interventions to be tackled simultaneously through a coordinated approach to implementing development programmes. By using the integrated multi-sectoral development approach, the 7NDP has the advantage of considering the comparative and competitive advantages of the regions in the allocation of resources towards the implementation of the multi-sectoral strategies. It can set in motion a series of mutually supporting activities in different sectors with the general objective of delivering the national agenda. Ultimately it is envisaged that the integrated development approach in the 7NDP will help change the focus of government line ministries and provinces from competing to coordinating with each other (Ministry of Development Planning, 2017).

The country risk profile tailored to Zambia can be part of the country's integrated approach, adding to the information already present and used so as to make sure that the plan is based on evidence. It provides new information on the evolution of risk in the country, specifically risk caused by climate change. For example, the profile projects an important increase in meteorological drought (figure 2), crop losses (figure 3), and livestock losses (figure 4), particularly in the country's Southern and Western provinces. Yet the 7NDP does not specifically address this issue. On the contrary, it highlights the Southern Province's potential for "livestock and crop" production and the Western Province's "productive pastures that are suitable for cattle rearing" (Ministry of Development Planning, 2017). Future climate considerations are crucial because the plan emphasizes agriculture as a major sector to diversify the economy away from copper mining, yet climate change projections show losses will increase in this sector in the long-term future (figure 5). Of course, there are limits to how this data can be interpreted. Climate and environmental changes are highly variable across localities. Nonetheless, provincial generalizations provide warning signs for development, showing that these regions need increased attention and more localized analysis.

INDEX

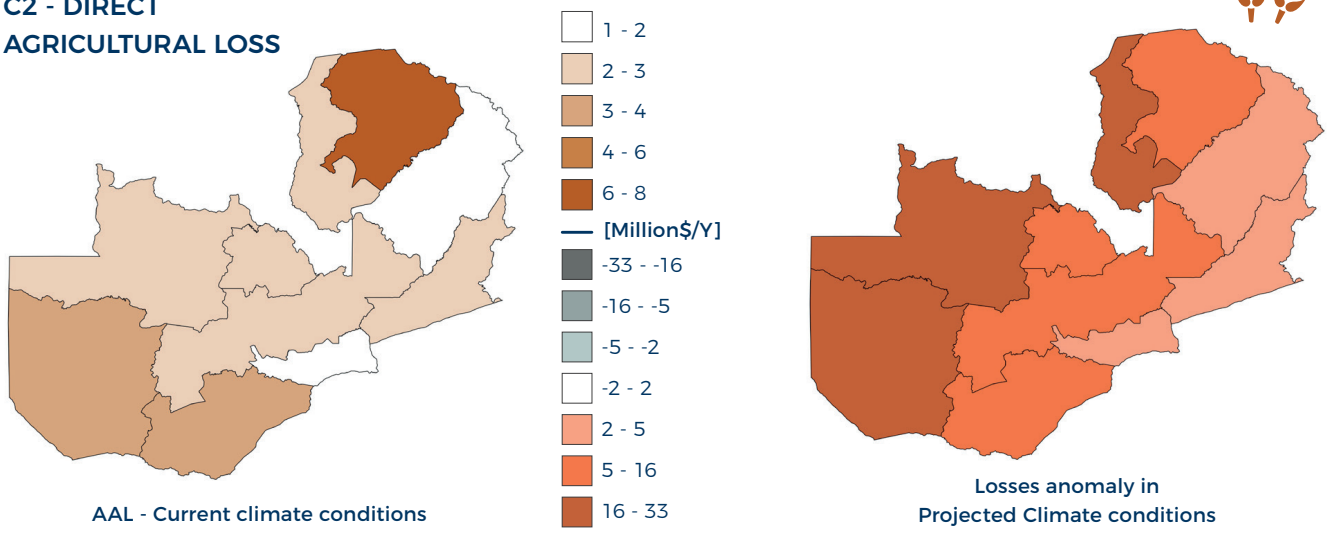
HAZARD



These maps denote the average annual chance of a meteorological drought occurring (%). Droughts are defined as 3 months of precipitation minus evapotranspiration values considerably below normal conditions; calculated through the Standardized Precipitation – Potential evapotranspiration Index (SPEI). In the south west of Zambia, the probability of droughts will increase the most. This is particularly important for areas dependent on rainfall for their water resources.

Figure 2: Increase in Likelihood of a Three-Month Meteorological Drought Between the Present and Projected Future Climate Conditions (CIMA, UNDRR et al., 2019)

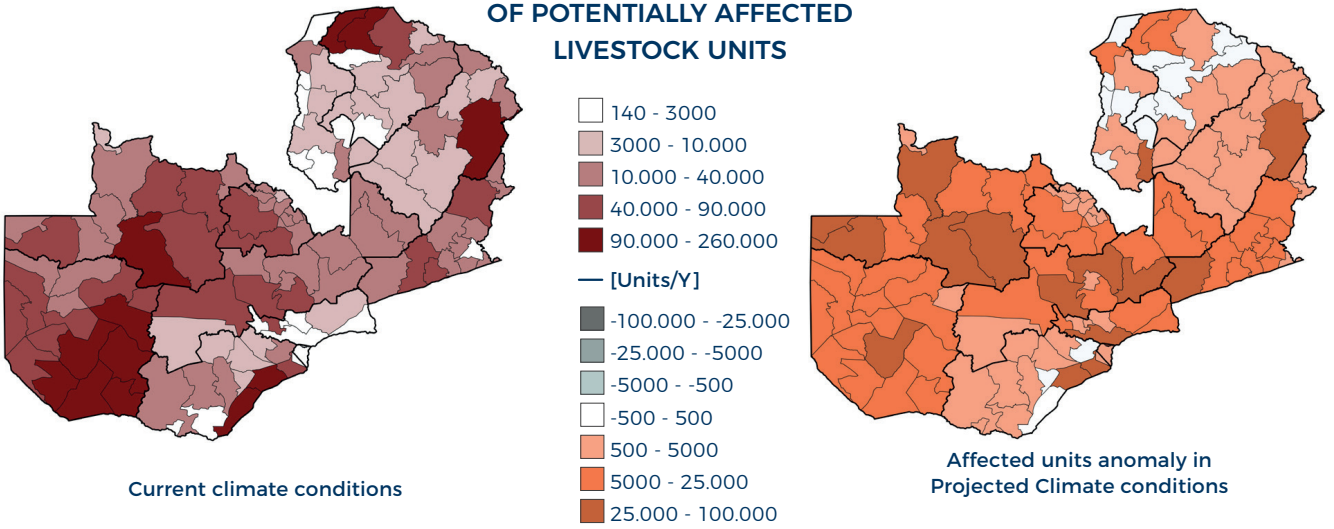
AGRICULTURE



Under present climate conditions direct economic crop losses are quite modest throughout the whole country (mostly less than 3, in two provinces less than 4 and in one province less than 8 Million$/Y). Under future climate conditions, increased droughts cause substantially higher direct economic crop losses in all provinces, but also much more variability within the country. Especially, the western part displays relatively high losses (28 - 38 Million $/Y), whereas in the eastern part losses remain relatively low at 3 - 8 Million$/Y. The increase in losses between present and future climates follows the same pattern: highest in western and lowest in eastern provinces.

Figure 3: Increase in Crop Losses (in USD) Between the Present and Projected Future Climate Conditions (CIMA, UNDRR et al., 2019)

LIVESTOCK



	Current Climate	Projected Climate
Million unit/Y	4.1	5.7
%	38.8%	54.3%

Under present climate conditions, affected livestock (i.e. animals living in areas hit by droughts) counts 406 million units (39%). Under future climate conditions, the number of affected livestock is projected to increase to more than 54% of the total livestock population (with increases in almost all regions, except in Luapula and the Northern province). Livestock units are calculated as the sum of all animals on a certain place, weighed by the water and food needs of the animals (FAO conversion factors).

Figure 4: Increase in Livestock Annually Potentially Affected by Drought Between the Present and Projected Future Climate Conditions (CIMA, UNDRR et al., 2019)

DIRECT LOSS ECONOMIC

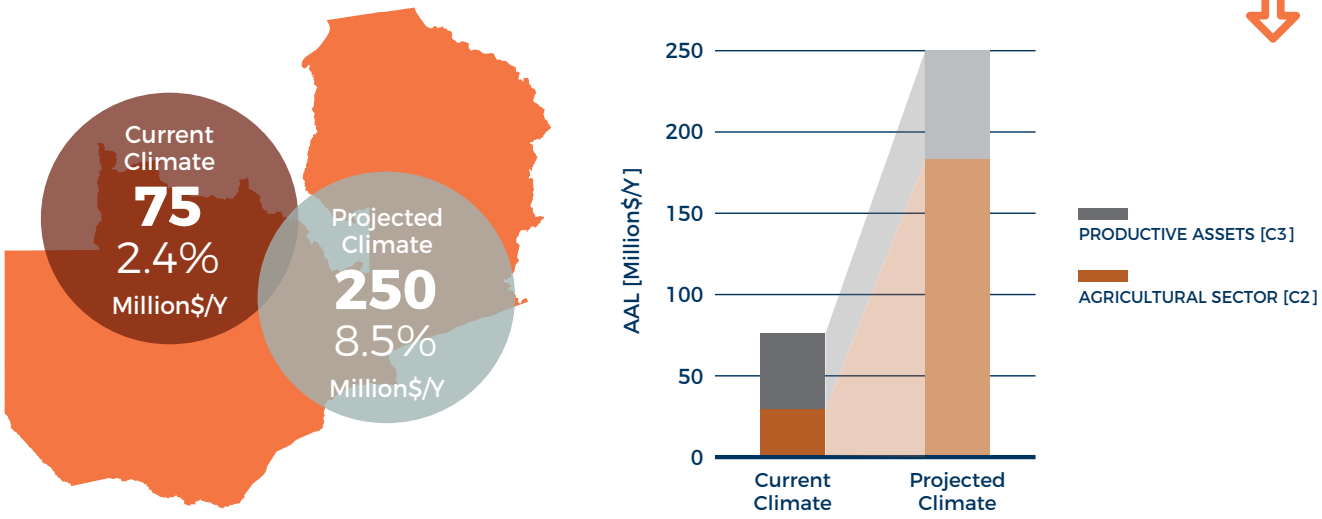


Figure 5: Increase in Losses in the Agricultural Sector Between the Present and Projected Future Climate Conditions (CIMA, UNDRR et al., 2019)

2.3 Application on National Adaptation Plans

2.3.1 Application Outline

Due to the importance of the impacts of climate change, national governments may opt for the elaboration of development plans that focus on Climate Change Adaptation (CCA), such as National Adaptation Plans (NAPs). NAPs provide a context for the identification of medium and long-term CCA needs. They then build strategies and implement programs to address these needs through an on-going, progressive and iterative process (UNFCCC, 2019).

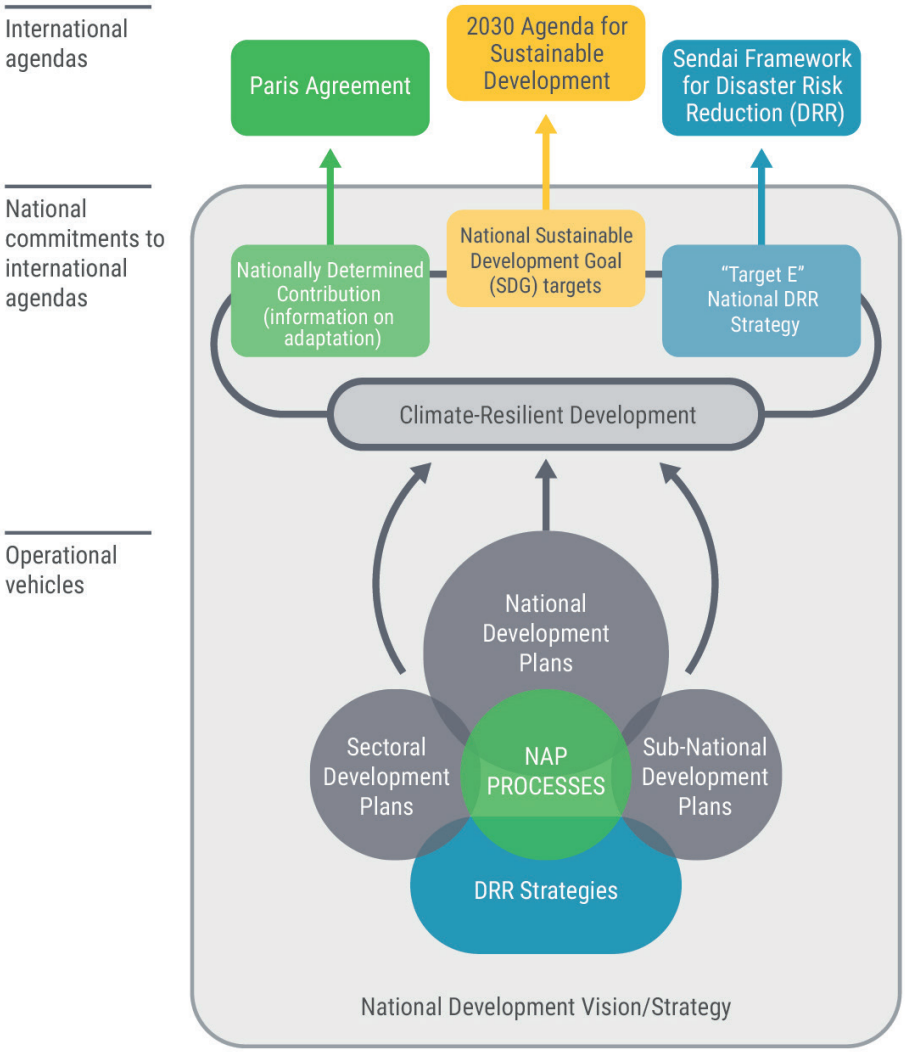


Figure 6: National Development Vision/Strategy (NAP Expo, 2019)

The complexity and all-encompassing nature of CCA requires that NAPs address every aspect of development. Doing so necessitates, of course, that they build on countries' existing climate change adaptation and disaster risk reduction activities. A complete integration of plans, goals, and strategies optimizes efficiency in the planning process and the allocation of resources. DRR, for example, should be mainstreamed into all development plans, but also in turn look to increase its focus and integration of other development priorities such as poverty eradication, climate change adaptation and mitigation, and sustainability (NAP Expo, 2019; UNDRR, 2013).

2.3.2 Potential Uses of the Probabilistic Country Risk Profile

The United Nations Framework Convention on Climate Change outlines four flexible implementation phases to guide countries in establishing National Adaptation Plans. These are meant to be broad in order to easily adapt to specific country contexts. A country risk profile can contribute to various aims within each of these phases, which are elaborated when applicable.

2.3.2.1 Implementation phases to establish National Adaptation Plans

1. *Laying the Groundwork and Addressing Gaps*
   The initial phase is meant to lay the groundwork for the establishment of the plan and address gaps that could hinder its launch. In this phase, information is gathered and exchanged, awareness is raised among policy makers and the general population, primary linkages between adaptation and development are examined, and a general vision for the NAP is discussed. By the end of this phase, the country should come out with a political mandate, an overview document of existing data, information and activities, an enabling environment for the NAP process (institutional arrangements, NAP strategy and roadmap, stakeholder analysis and engagement plan, M&E framework), and an approach to continually identify the interplay of adaptation and development (UNFCCC, 2013). In this phase, the country risk profile can be used to raise awareness among stakeholders. It can also provide an overview of the links between development and climate adaptation that should be considered. For example, the country risk profile highlights the economic sectors that will see a likely reduction in losses due to a changing climate and those that will see a large increase. This can help narrow the areas of focus within the NAPs. Finally, the country risk profiles can be used to enhance policy coherence, which is necessary for facilitating the exchange of data and information.

2. *Preparatory elements*
   The second phase is the preparation phase. Governments should analyse current and future climate scenarios, assess and rank climate vulnerabilities, identify, assess, and prioritize adaptation options, and compile an initial adaptation plan. This should result in credible current and future climate estimations, ranked climate change vulnerabilities, ranked adaptation options, an initial adaptation knowledge base, a national adaptation plan, and communication/education strategies for its implementation (UNFCCC, 2013). The country risk profile is best put to use in this phase because it provides a national overview of the major evolutions of risk in the coming decades. Furthermore, the country risk profile categorizes these risks by economic sector, which facilitates the integration of DRR and CCA with other development priorities. It also provides an initial indication of vulnerability rankings for which appropriate adaptation responses should be implemented.

3. *Implementation Strategies*
   The third phase is the implementation phase. Governments should prioritize adaptation options according to feasible implementation and previous prioritization measures, develop an implementation timescale, promote coordination between different sectors of government to facilitate implementation, strengthen institutional and regulatory frameworks, and begin the implementation of measures and activities. This should lead to long-term orientation for

stakeholders with regards to adaptation planning and the implementation and concrete activities or measures that can be feasibly funded (UNFCCC, 2013). Policy coherence is crucial throughout this phase, and the country risk profile can facilitate this process. Coordination ensures that the plan is implementable, as grouping the goals of multiple interest groups into one plan helps NAPs maintain strong political backing. It is also essential for developing an adaptation plan that properly prioritizes adaptation options, ensuring that these address the complexities of all the types of risk as they evolve in a changing climate and developing country. With regards to prioritization of risk options, the country risk profile can help with cost-benefit analysis calculations.

4. *Reporting, Monitoring and Review.*
   The last phase is the monitoring phase. Governments should continually monitor progress, evaluate, and update the NAP. The NAP should be transparent to all stakeholders and continually adjusted for effectiveness (UNFCCC, 2013). By this phase, new probabilistic risk assessments need to be made in order to take into account the changes in climate predictions and vulnerabilities, and the country risk profile acts more as a reference point (either for its methodology or past information). These new probabilistic risk assessments can then be used to correct previous data found in the plan and accordingly refine national adaptation strategies.

2.3.3 Case Study: Kenya

Kenya launched its National Adaptation Plan 2015-2030 in July 2016 in order to "consolidate the country's vision on adaptation supported by macro-level adaptation actions that relate to the economic sectors and country level vulnerabilities to enhance long term resilience and adaptive capacity" (Kenya National Adaptation Plan, 2016). The plan is anchored in the Kenyan Constitution and the country's Vision 2030, the country's blueprint for development. It also integrates the country's disaster risk reduction and medium-term development and expenditure plans, as well as the country's Climate Change Act, which was enacted into law in May 2016.

Kenya's NAP is very conscious of the need, not only to reduce risk with a multi-sector and multi-disciplinary approach, but also of the evolving nature of risk due to climate change. The introduction of the plan ends with a presentation of the estimates of future changes in temperature and precipitation in the country. When it comes to the vulnerability analysis however, Kenya's NAP does not calculate how this changing climate will directly shape risk, because the risk analyses are based on historical data losses. In drought risk calculations for example, the plan shows that both the number of people affected and the costs of losses has gradually increased between 1998 and 2011, and it estimates that the increase will be accentuated by a changing climate, but there is no estimation of what this increase might look like. (Kenya National Adaptation Plan, 2016).

The country risk profile can provide this missing information. It gives an estimation of the average annual losses and how they will change in a new climate, but they also provide an estimation of the probable maximum losses that will exist in the new climate. This shows the severity of the trend and allows for better planning as a result of the NAP. Thus the probabilistic profiles can be used both to elaborate new national adaptation plan and to complement the work done on previous ones.

2.4 Application on DRR Strategies and Mainstreaming

2.4.1 Application Outline

In line with the Sendai Framework, DRR strategies provide the basis for taking systematic action to reduce natural hazard-related disaster risk and establish a strategic direction for the strengthening of economic, social, health and environmental resilience (UNDRR 2019; UNDRR 2017). They define objectives across different timescales with concrete targets, indicators, and timeframes, while building on the country context (governance structure, political and economic priorities), an understanding of disaster risk (prevailing hazards, risk vulnerability, exposure, perception of risk and existing coping capacities of society), and an evaluation of current DRR systems and capacities at the country level (UNDRR, 2019). Strategies are ideally also closely linked with development plans, so that underlying factors of risk and resilience-building can be fully addressed (UNDRR, 2020). These key planning tools are usually decided by a high-level authority at the national or local level, or a multi-stakeholder mechanism with the appropriate authority.

The development of DRR strategies in and of itself is an essential process in the effort to reduce disaster risk, as they stimulate a coordination mechanism in the country, but it is through their implementation that they are truly effective in helping countries achieve the Sendai Framework targets. Countries face important difficulties in this regard. A UNDRR (2017) study for example, found that "many existing national DRR strategies and plans were not actionable due to weak disaster risk governance systems and a lack of dedicated financial resources, technical and institutional capacities and accountability measures" (UNDRR, 2017).

The development of DRR strategies should be supported by DRR mainstreaming into other government policies, development agendas, private sector initiatives or public consciousness, in order to produce observable reductions in disaster losses. Mainstreaming disaster risk reduction is the process of integrating considerations of risk emanating from natural hazards into strategies and policies in order to more effectively reduce these risks. It requires "analysing how potential hazard events could affect the performance of policies, programmes and projects and analysing the impact of those policies, programmes and projects on vulnerability to natural hazards" (IFRC, 2007). By adopting measures that reduce vulnerability and exposure as part of the development process, disaster risk reduction becomes an integral aspect of development rather than a separate end goal (IFRC, 2007).

Mainstreaming aims to radically expand and enhance DRR so that it is incorporated into normal practice, and fully institutionalized within an agency's relief and development agenda. Essentially, this process merges the key principles of DRR with development goals, governance arrangements, institutional policies and practices (Vargas et al. 2017). Mainstreaming efforts occur at all levels of governance, from its insertion into development plans, processes and initiatives at the local level (e.g. city master plans or individual infrastructure projects), to efforts at the sub-national and national levels (Vargas et al, 2017).

2.4.2 Potential Uses of the Probabilistic Country Risk Profile

2.4.2.1 Development of DRR Strategies

The country risk profiles can foundational to the development of DRR strategies as they provide of baseline of risk information. They can therefore be used to define the objectives and monitoring indicators of DRR strategies. One example of this was conducted during the national workshops that UNDRR and CIMA organized in 2018-2019, where the used of the probabilistic country risk profiles facilitated exchanges and the working out of common solutions. Workshop participants drafted DRR strategies with a few objectives and indicators, linking the results of the probabilistic country risk profiles to the elaborated strategies (e.g. reduce people effected in an identified area, or reduce the damages to an identified effected sector).

2.4.2.2 Mainstreaming of DRR Strategies

The probabilistic country risk profiles can be used to help with mainstreaming DRR, particularly in development. UNESCAP describes six principles (see below) that are important for the process of mainstreaming DRR, specifically into development, and with each of them, the country risk profiles have a role to play.

1. *Legal Mechanisms*
   For DRR strategies to be implemented and mainstreaming of DRR to be effective, it must be mandated by the legal and regulatory systems of a given country (ESCAP, 2017). The country risk profiles can be used as an impetus, an economic and political justification, to develop such legislation where it is lacking.

2. *Institutional Mechanisms*
   From an institutional perspective, DRR also needs to be accounted for at every level of government, following a "whole-of-government" approach. This requires having a coordinating agency to make sure national agencies do not operate in silos (ESCAP, 2017). The country risk profiles can be used as an impetus, an economic and political justification, for the creation of national and subnational DRR platforms, committees or councils and for the identification of focal points in various national agencies where there currently are none .
3. *Policies and Planning*
   Disaster management plans are often created separately from multi-sectoral development plans or long-term national strategy plans, creating gaps between intended and actual DRR outputs (ESCAP, 2017). As the country risk profiles provide a picture of the impacts of disasters on the projected development of the country (divided by economic sector or region), they can act as a synergy between these plans—encouraging more collaborative policymaking.

4. *Finance and Budget*
   Governments, particularly in developing countries, have cited the lack of resources as a major barrier for implementing DRR. For example, countries in sub-Saharan Africa show limited investment in disaster risk reduction and risk financing (Van Niekerk, Coetzee,

Kruger, & Shoroma, 2013; UNDRR, 2020). Most countries in sub-Saharan Africa do not have a dedicated DRR budget and lack domestic resources to implement their DRR strategy. The risk profiles can help advocate to increase funding for DRR from international and domestic sources (including within a country's own government budget) and enhancing synergies with investments allocated for development planning.

5. *Decentralization*
   Effective DRR needs to be the responsibility, not only of national authorities, but also of regional and local authorities, and include the participation of all important stakeholders. Decentralizing DRR improves the delivery of services at the local level, involves citizens, and in the process makes the system more open and transparent: improving efficiency, participation and accountability (ESCAP, 2017; UNDRR, 2017). The country risk profiles can be a tool in this decentralization by encouraging national authorities to engage regional and local authorities, particularly in the high-risk or future high-risk areas that they highlight.

6. *Capacity Building*
   Multi-hazard, multi-sectoral, and multi-level capacity development is a massive and crucial task. Risk needs to be understood, existing capacities assessed, gaps identified, and strategies for resolving these gaps developed (ESCAP, 2017). The country risk profile can be used to understand where the most high-risk areas lie, and therefore prioritize where capacity building in DRR should take place if resources are limited.

2.4.3 Case Study: South Africa

UNDRR has long advocated for the establishment of multi-stakeholder National Platforms for DRR as an important tool to mainstream DRR into government agendas. National Platforms serve as an advocate for DRR at different levels, providing coordination, analysis, and advice on areas of priority for concerted action. Their ultimate aim is to provide or mobilize the combined knowledge, skills and resources required for DRR and its mainstreaming into development policies, planning and programmes (UNDRR, 2017).

One of the main advantages of implementing National Platforms is their very low operational cost. Their initial implementation requires only a team dedicated to organizing its activities, and perhaps a permanent secretariat. As a body focused on implementing and mainstreaming DRR, National Platforms use existing resources to better allocate funds, conducting activities such as: coordinating policy dialogues, sharing information, formulating science-based guidance for policy, building partnerships and coordination across sectors and stakeholders, or increasing education and public awareness on DRR. National platforms can play an essential role in developing national strategies for DRR because they are an interdisciplinary body. Typically, the development of national DRR strategies consists of a multi-stakeholder process of meetings, workshops, and presentations, all receiving comments from relevant actors (UNDRR, 2013).

The National Disaster Management Advisory Forum (NDMAF) was established on January 26 2007 and acts as South Africa's National Platform. The NDMAF coordinates the actions of different spheres of government with other disaster management role-players such as NGOs, the private sector, or other welfare organizations. The forum includes an extensive list of members from all

of the necessary areas that deal with DRR: 20 national government departments, 20 national statutory bodies, four strategic state-owned enterprises, representatives from provincial and municipal departments of government, religious and welfare organizations, NGOs such as the SA Red Cross, agricultural unions and interest groups, business, mining, and insurance interest groups, the medical, paramedical, and hospital associations and representatives from the disaster management institute of South Africa. The coordination conducted by the forum takes place through the sharing of information amongst members and the discussion of certain topical issues. The forum has also set up fourteen smaller technical task teams that report back to it on various topics (IFRC, 2011).

While stakeholders have affirmed that the National Platform functions relatively well, one major challenged has blocked it from exerting further influence: attendance. Critical sector departments were "reluctant" to attend meetings, and many of the representatives that did attend tended to be people with low seniority. Stakeholders not considering DRR to be an agenda priority was one of the supposed underlying reasons for this absenteeism.

The country risk profiles can enable a big-picture discussion around the issues of risk, development and climate adaptation, helping bring stakeholders together in the mainstreaming process. The country risk profiles distribute data to different sectors and regions, showing common challenges. In this sense, they could provide an added support to national platforms to increase the implication of all the actors involved in disaster risk management.

2.5 Application on Preparedness and Emergency Response Planning

2.5.1 Application Outline

Preparedness is defined by UNDRR as "the knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters" (UNDRR, 2017). Within the context of disaster risk management, preparedness determines actions and delegates roles and responsibilities to various government departments, disaster management organizations, industry, civil society institutions, volunteer groups, in all sectors and at all government levels. It builds the capacities needed to efficiently manage all types of emergencies, augment self-protection capabilities and achieve orderly transitions from response to sustained recovery.

2.5.2 Potential Uses of the Probabilistic Country Risk Profile

Preparedness is based on a comprehensive analysis of disaster risks and early warning systems. It includes different activities, such as: risk assessment, contingency planning, set up of equipment and supplies, development of arrangements for coordination, evacuation and public information, associated training and field exercises. These must be supported by formal institutional, legal and budgetary capacities.

The following schematic shows how these processes are developed and implemented. Within the defined processes, where applicable, the potential uses of the risk profile are elaborated.

Figure 7: Framework for Preparedness and Emergency Response planning including the probabilistic risk assessment (Source: CIMA)

2.5.2.1 Coordinating

It is crucial to assist victims of disasters more rapidly with a robust coordination mechanism with multi-sectoral and multi-stakeholder participation. Coordination among all partners is an essential process for every aspect and enables community, local, national, cross-border and international actors (UN agencies, NGOs and other international organizations) to work towards common objectives under a joint planning process in order to combine resources effectively and efficiently (WHO, 2017).

2.5.2.2 Probabilistic Risk Assessment

The development of an emergency preparedness program and associated plans should be based on the more frequent events and their associated intensities and expected losses. The country risk profile can facilitate the development of credible timelines for scenarios with related exceeding specific levels of physical and direct financial losses, targeted measures to strengthen preparedness and response systems in a proactive manner, and the assessment of response capacities. The use of a probable risk assessment in defining thresholds of potential impacts and associated mitigation measures is particularly crucial for Early Warning systems.

2.5.2.3 Financing

Emergency preparedness planning takes into account the availability of resources (financial and in-kind) from local, national or international sources. The need to increase investments in emergency preparedness has been articulated as a need to improve the effectiveness of humanitarian response and reduce the cost of recovery. Yet funding for emergency preparedness continues to fall far short of needs. One solution is to align the demand in resources for preparedness with the priorities articulated in national development plans. To achieve this, countries must consider preparedness and contingency funding mechanisms during the development of the national action plans. In this case information on possible losses can serve to advocate for resources to be allocated to preparedness and can prioritize the sectors that may require greater investments in preparedness. For countries that are high-risk, low-capacity, these processes will require considerable international financial support (WHO, 2017).

2.5.2.4 Planning

The preparedness plan is the central phase of this process. It establishes measures to be taken in advance to enable successful responses to potential hazards. Countries and communities will use different frameworks and tools to develop this plan according to differences in risks and capacities. Panning should follow a participatory process that involves all of the actors who will be required to work together in the event of an emergency. To avoid unnecessary fragmentation or duplication, it is crucial that emergency preparedness plans are designed and aligned between sectors. The country risk profiles can contribute to the initial phase of this process by creating a common understanding of the impact within the sectors and different regions (WHO, 2017).

2.5.2.5 Implementing

There are a number of requirements for developing a preparedness planning activity and these can be articulated in standard operational procedures. These procedures are the link between plans and the actual operational response. A harmonization procedure, connecting different teams of stakeholders with defined responsibilities, should monitor and track the

progress in referring to the previous phase of the preparedness process. The involvement of the stakeholders should follow the roles defined in the planning phase in order to ensure the commitment to, and ownership of, emergency preparedness measures. The management of time is a crucial aspect that must be monitored in order to reduce the potential delay between the development and implementation of the plan, to maintain commitment to emergency preparedness (IFRC, 2012; WHO, 2017).

2.5.2.6 Reviewing and taking corrective action (review)

Emergency preparedness is an on-going process where the implementation of plans should be monitored and evaluated in line with pre-defined indicators, or simple processes, and should be reported accordingly. Those indicators can be pre-established according to the probabilistic risk assessment outcomes. For example, if there is a specific sector with an AAL that is particularly high in a specific region, target indicators can support the evaluation of the preparedness level achieved and eventually define corrective actions for its improvement. This type of evaluation should be conducted at pre-agreed times by the coordinating body (IFRC, 2012; WHO, 2017).

2.5.2.7 Exercising

It is the last phase that should reveal the strengths and weaknesses of a plan. Exercises are useful to help build individual competencies, allowing participants to learn and practice their roles in emergencies. Ideally, they should be system-wide and include all components that would be involved in an actual disaster situation. After exercises have been conducted, action should be taken to institute the recommendations for strengthening emergency preparedness (WHO, 2017).

This process must be tailored depending on the scale of the analysis. Sometimes risks or disasters are not restricted to one country, or may impact another due to factors such as proximity or historical links. In this case, in developing a preparedness plan, it is important to contact and involve National Society or Regional delegation of neighbouring countries. Plans should include cross-border analyses of political events and their potential impact on the population, as well as the identification of particular vulnerabilities in border areas considering various scenarios (deriving from the probabilistic risk assessment), and carrying out simulations for cross-border response.

2.6 Application on Recovery Planning

2.6.1 Application Outline

Recovery is defined by UNDRR as "the restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and "build back better", to avoid or reduce future disaster risk" (UNDRR, 2017).
Recovery reports all the critical needs of the affected population. The results of the recovery process are directly linked with the availability of the resources and on the adequate implementation capacity. However, especially at the start of the recovery process, both of these elements may be limited (GFDRR, 2011). This is why recovery should also assess the opportunities to use the available resources as effectively as possible through an accurate planning process.

2.6.2 Potential Uses of the Probabilistic Country Risk Profile

The recovery planning phases are summarized in the following schematic and are comprised of four main phases (GFDRR, 2018). Within the descriptions of each phase, the areas where the risk profile can provide a contribution has been elaborated on. Generally, the most useful component of the risk profile for recovery is the expected losses. This allows for the identification of future geographic areas or economic sectors where it can be expected that recovery interventions will be needed. In sum, the results provided in the country risk profile can guide recovery investments and resource allocation, especially for medium and long-term reconstruction.

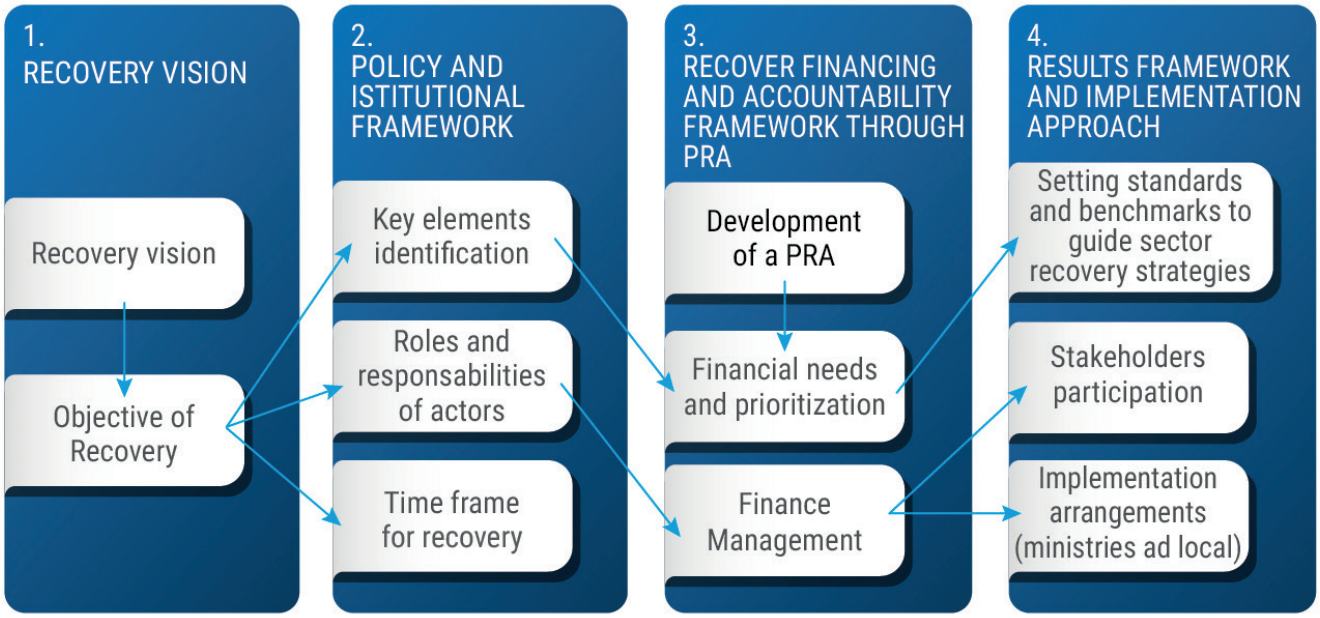


Figure 8: Framework for Recovery planning including the probabilistic risk assessment (Source: CIMA)

2.6.2.1 Recovery vision, principles and policies (GFDRR 2018)

a. A Recovery vision creates a common view for all relevant actors, in both public and private sectors, communities and government agencies are prepared by having disaster resilient infrastructure, all the while promoting inclusive and participatory reconstruction that can build back better. A recovery vision also coordinates the intentions of those involved in recovery to accomplish shared goals, looking to answer questions such as:

- What are the national sources of identity (e.g. natural and cultural heritage) that can motivate resilient recovery?
- What are the strategic development objectives that should guide the recovery process?
- How can the gap between recovery and development be bridged?

b. Objectives of Recovery generally reflect the areas of priorities for recovery, but the overall objectives mainly cluster around four areas:

- the sustainable improvement of the resilience of communities focusing on vulnerable groups, women, girls, children, elderly, and disabled. Here the country risk profiles can be useful by providing information on the number of potential people affected. Where disaggregated country data is available, useful information can be derived for the most vulnerable categories of people;
- the reconstruction of all critical infrastructure, urban facilities, services and houses. Here the country risk profiles with the specific Sendai indicators (C4, C5) can identify the objective of recovery for these sectors;
- the restoration of the economic production including the livelihoods of households and the establishment of new opportunities. Here, the country risk profiles with the specific Sendai indicators (C2, C3) can identify the objectives of recovery for these sectors;
- the strengthening of disaster risk reduction systems in the country.

In order to achieve the objectives defined, effective coordination and monitoring is needed. With a transparent monitoring effort, people can easily track the progress being made. Such a monitoring system also enhances accountability, reassuring the affected communities that they will be the ultimate beneficiaries.

2.6.2.2 Policy and Institutional framework (World Bank 2014, Malawi Government 2015)

a. Key elements identification have a central role in developing and recommending an enabling policy framework and revising policies to implement the recovery vision. Here the link with sectoral policies related to the objectives identified is evident. The risk profile, through estimated losses in terms of AAL, can guide the identification of sectors that have higher expected losses in order to better prioritize recovery measures (found in the next phase).

b. Roles and responsibilities of actors are closely linked with the identification of the key elements: to each key element must be associated a specific corresponding map of actors. For each actor a specific role must be assigned.

c. Time frame for recovery is related to the different sectors and actors considered. All recovery activities included in the sector plans are expected to be completed within this duration, contingent on the allocation of resources.

2.6.2.3 Recover financing and accountability framework through probabilistic risk assessment (GFDRR, 2011 – 2018)

a. Development of a probabilistic risk assessment: in order to have useful risk metrics, an appropriate model should be in place. This will provide users with the AAL values, the PML curves by sector, as well as the risk maps where for the different province/region of the country the AAL values are mapped. The probabilistic risk assessment conducted for the risk profile provide these values for the areas analysed.

b. Financial needs and prioritization: here a comprehensive prioritization plan is needed to guide planned and future recovery programs and projects, both within and across sectors. Here, the probabilistic risk assessment can support the inter-sectoral and intra-sectoral prioritization. Criteria for priority-setting should reflect geographic (different risk maps) and economic (AAL values) considerations.

c. Finance management: The cross-sectoral prioritization process supports the government in taking important decisions about where and how the available resources will be allocated during the first phase of the process. In this phase, economic planning plays a central role in conducting intersectoral prioritization, securing financial allocations, and developing a multiyear recovery financing plan. To achieve this, public spending data of past events can be fitted a parametric distribution and simulate possible future spending needs related to disasters. In particular, the risk metrics such as the AAL and the PML can provide useful information.

2.6.2.4 Results framework and Implementation approach (GFDRR, 2011 – 2018)

a. Setting standards and benchmarks to guide sector recovery strategies aims to create a central recovery program and governmental arrangements for coordination of monitoring and evaluation, budgeting resources and strategic initiatives.

b. Implementations arrangements (ministries and local) integrate the institutional framework, the recovery budget, and sector-specific implementation strategies. The implementation should identify the roles and the distribution of responsibilities of the different actors, but it should also present information on logistical and capacity limitations and how they will be moderated.

c. Stakeholders participation: the recovery will be implemented through multiple stakeholders across line ministries including the national and local government authorities involved in the coordination, funding, planning, and implementation of the national recovery and reconstruction programme. Other actors like NGOs and the private sector may also be engaged but a central mechanism will be needed to guarantee a good level of coordination.

Recovery planning starts at the national level, where the added value of the country risk profile has just been demonstrated. But when a downscaling process is needed, an appropriate probabilistic risk assessment can also support the recovery process by balancing local sector priorities or by addressing capacity assessment at local levels (local governments and other local actors) in order to establish arrangements for the recovery program.

2.6.3 Case Study: Indonesia

The Yogyakarta earthquake that struck in 2006 and caused losses estimated at 30% of the regional GDP is an example of funds allocation that met recovery needs in a timely fashion (GFDRR 2011). The experience coming from the consequence of the Tsunami in Aceh in December 2004 was Guidance note on Using Risk Profiles for Disaster Risk Management 26 the initial point for the definition of the recovery vision. Having defined the policy and institutional framework, a PRA was developed by using actuarial techniques to provide preliminary estimates of future possible public spending needs for post-disaster recovery operations. Using the AAL and the PML properly calculated, public spending data of past events estimated from the number of buildings destroyed and damaged, were used to fit a parametric distribution and simulate possible future spending needs considering the prioritizations made. Considering that the disaster occurred on May 29, the Parliament was able to implement the recovery plan by approving the revised budget in the mid-year budget (revision of June) in time to allow the financing of post-disaster emergency and recovery operations. In this way, by October 2006, thanks to the economic estimation of the PRA, US$270 million of the assessed needs for housing reconstruction were available for disbursement and all the funds were distributed by December.

2.7 Application on Risk Communication

2.7.1 Application Outline

Risk communication refers to the exchange of information, advice and opinions between experts and people facing threats to their health, economic or social well-being. (WHO, 2020). Risk Communication is central to disaster risk management in two ways: i) it makes it possible to feed information into decision making at the political level and ii) it increases citizen's risk awareness and behaviour change through a better understanding and ability to respond and to manage risk (Twigg, 2015).

2.7.2 Potential Uses of the Probabilistic Country Risk Profile

Risk communication makes use of interactive approaches that bring together risk managers, communication experts and the public, with messages that are consistently transmitted across sectors and through different channels and tools. Effective risk messages need to be tailored to specific audiences in ways that are adapted to both their values, interests and cultural norms, and to their specific exposures, vulnerabilities and coping capacity. Thus, by considering a wide range of audiences, such as politicians, communities and citizens, risk communication should ensure that inputs from the scientific and technical communities involved in risk management translate into effective risk-informed policymaking, risk awareness and behaviour change amongst societies and their organizations. It follows that country risk profiles can therefore be seen as a communication tool directed at DRR practitioners across multiple levels and high-level political makers to achieve such outcomes.

2.7.2.1 Communication for Risk-Informed Policymaking

By providing an evidence-based estimation of the country's disaster risk level through AAL and PML metrics, as well as affected GDP, affected sectors and population, country risk profiles can be used as a tool to promote inter-institutional communication and to pave the way for a common risk knowledge among practitioners and high-level policy makers. Such common knowledge can then set the basis not only for specific DRR strategies but, disaster risk being both a consequence and a driver of development, it can also promote the inclusion of risk reduction targets into national development plans. Key information contained in the risk profiles - such as hazard-prone geographic areas, most affected sectors and most vulnerable segments of the population (e.g. children, women, elderly persons) - can moreover guide political leaders to make coherent decisions targeting those being most affected. Possible examples include prioritizing provinces based on their level of risk and economic impacts, establishing building codes for the housing sector, building evacuation shelters and increasing risk awareness among target/vulnerable audiences.

2.7.2.2 Communication for Risk awareness and Behaviour Change

The link between a country risk profile and risk awareness is not a direct one. However, depending on the number of projected affected population, country risk profiles can highlight the need for increased awareness at citizen level and/ or in specific areas of the country. By identifying the most hazard-prone areas and the most vulnerable segments of the population, country risk profiles identify key topics (ex. floods, droughts) and main audiences (ex. children, women,

farmers, elderly) where to focus communication efforts. Risk profiles can moreover set the basis of overall communication goals and monitoring indicators for behavior change or for risk perception. However, implementing an effective communication campaign, requires further risk analysis at a local scale as well as an active engagement of the targeted population. This should ideally be achieved through participatory working groups in order to define the most suitable approaches, messages and means according to specific social and cultural contexts as illustrated by the case-study below: "Planning for Inclusive DRR Knowledge and Messaging in Nepal".

2.7.2.3 The Process of Changing Behaviours

Although there is no universal formula to ensure the success of risk communication initiatives and products, the image below describes the stages of change according to the transtheoretical model by Prochaska and DiClemente (1984) used by behavioral change communicators. The following exercise is an attempt to merge the Prochaska and DiClemente transtheoretical model with the information provided by the country risk profiles.

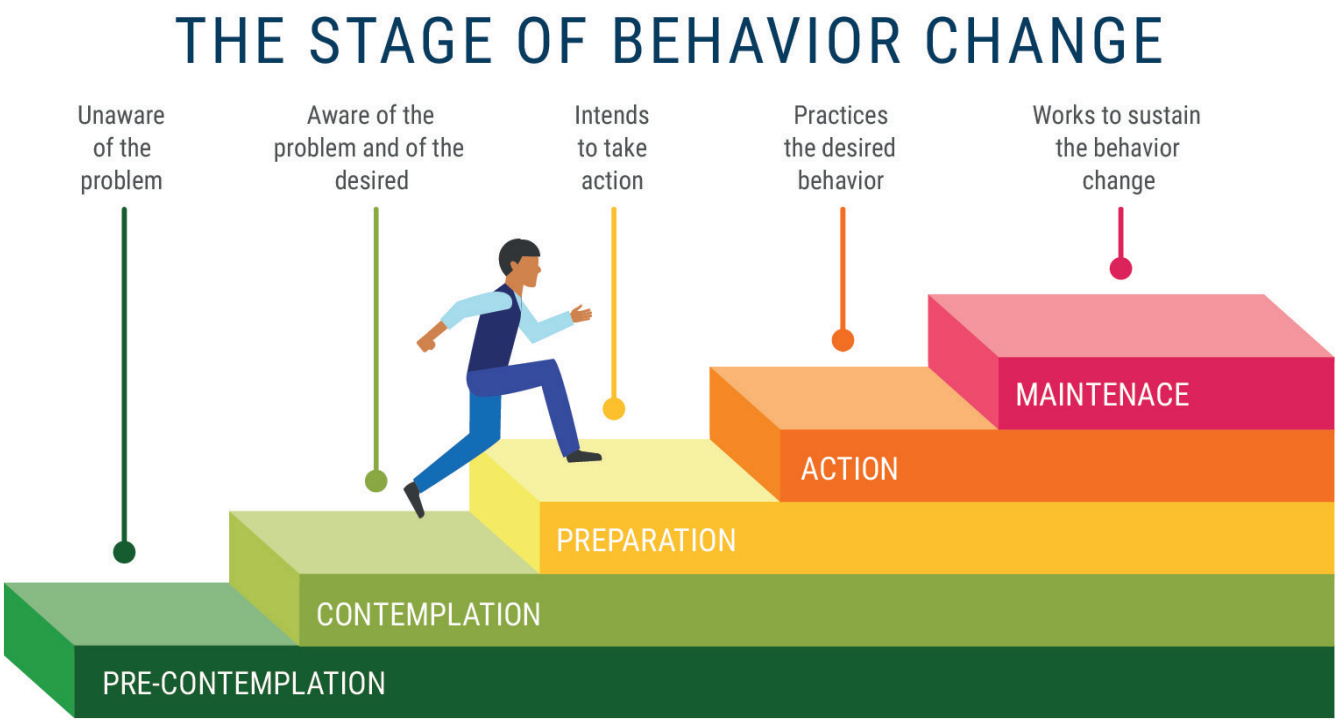


Figure 9: The stage of behavior change (Source: CIMA)

1) Pre-contemplation stage

At this stage, stakeholders are unaware of the problem and thus, do not intend to take action in the foreseeable future, underestimating, or not realizing at all, the pros of taking action. A clear presentation of the country risk profile, with a focus on disaster impact information such as segments of people affected and direct economic losses (total and per sector), can push the audience/stakeholders to become aware of the risks faced.

2) Contemplation stage

At this stage, the audience/stakeholders are aware of the problem and understand the advantages of producing change/improvements; there is a recognition that a certain situation such as hazard exposure, social vulnerability or the lack of policy and planning may be problematic; a more thoughtful and practical consideration of the pros and cons of taking action takes place. Here, the country risk profiles can reinforce determination towards developing specific policies by providing risk information on Annual Average Loss, Probable Maximum Loss and Return Period, in present and future projections, so as to foster the will to avoid the consequences of not taking action.

3) Preparation / Determination stage

At this stage, audiences/stakeholders are ready to take action and start to implement policies and steps towards the desired scenario. It is advisable that the scientific/communication team leading the country risk profile monitor and empower national authorities to take the necessary actions - mainstreaming risk information into national plans across sectors, advocating for specific disaster risk management measures and calling for the creation of inter-ministerial/ inter-sectoral working groups to ensure that DRR and resilience issues are well represented in development strategies.

4) Action stage

At this stage, audiences/stakeholders intend to keep moving forward. In the field of DRR this can be reflected in the alignment of national efforts with regional and international frameworks, such as the Sendai Framework for Disaster Risk Reduction, The Paris Agreement and the 2030 Agenda, which can optimize the efforts made by countries through finance, technology and capacity building. At this stage, risk profiles can be used as a common source of risk information among institutions, ensuring that all stakeholders involved have the same risk data and interpretation for awareness raising, policy making and monitoring purposes. It would be advisable, at this phase, to develop further and more specific risk assessments in order to identify cost-beneficial structural and non-structural DRR measures.

5) Maintenance stage

At this stage, audiences/stakeholders have sustained their change for a while and intend to maintain it to prevent relapse to earlier stages. A new disaster risk assessment could be considered in order to monitor the success of the measures already implemented. Risk communication interventions can be evaluated by assessing possible outcomes such as progress on knowledge and capacities, change in behaviours and incidence of outcomes; the continuous monitoring of such indicators is advisable in order to identify eventual incoherencies and adjust accordingly.

2.7.3 Case study: Planning for Inclusive DRR Knowledge and Messaging in Nepal (International Federation of Red Cross and Red Crescent Societies, 2017)

The Strengthening Urban Resilience and Engagement (SURE) programme was implemented by the Nepal Red Cross Society (NRCS) in partnership with the British Red Cross (BRC), in seven municipalities, targeting four groups vulnerable to disasters in each of the municipalities to increase awareness to risk and to possible mitigation measures. Learning from a previous programme which showed that disseminating general messages to entire populations was ineffective in creating behaviour change, the SURE programme developed the Participatory Campaign Planning (PCP) process to understand which messages and means of communication would be most effective within different target groups. The aim was to move away from a blanket approach in communicating messages, and to adopt an approach where messages and means of communicating were tailored to different target groups, according to their contexts and perceptions. The PCP methodology was applied through participatory and activity-based workshops and sought to establish:

- Hazards that target groups felt by being at the biggest risk;
- Test existing key messages to understand if target groups felt they were effective in changing behaviour;
- Map the main barriers to behaviour change;
- Understand participants' social networks and understand the best opportunities to share information;
- Understand the most effective means of communication;
- Understand how different target groups prefer to give feedback.

Key messages were changed based on the findings, tailoring them to the different target groups suggestions with the aim of increasing their effectiveness on promoting behaviour change. The overall learning was the confirmation that in order to lead to behaviour change, risk messages need to be adapted based on the target group and the geographic, cultural and social environment.

Further elements identified under the PCP that shall be considered when developing risk communications are:

- The income of the target group, the availability of human resources, equipment and materials;
- The existing knowledge of the target group;
- The availability of physical infrastructure;
- The availability of natural resources;
- The existence of laws and their enforcement;
- The social status of the target group;
- The literacy status of the target group;
- The physical and mental well-being of the target group.

Many PCP participants highlighted that they were poor and lacked resources to be resilient against disasters including property and equipment. As such, messages that promote the use of resources, for example, prepositioning rescue materials and constructing a house following a certain building code, will not lead to behaviour change. The participants also suggested the need

to account for available physical infrastructures while formulating messages: people who were living on riverbanks mentioned that messages suggesting people to move to temporary shelters during flooding were ineffective because they do not have access to shelters. Similarly, People with Disabilities objected that it is difficult to follow messages that request them to walk on footpaths because footpaths are not disabled-friendly. On the other hand, it was mentioned how flood warnings disseminated through sirens and radio are ineffective for people with hearing loss. Another factor to be considered while designing messages was the environmental setting. In Godawari municipality, unemployed youths suggested adapting messages that promoted the use of rafts during flooding as there are big stones in the river that would obstruct rafts, making rescue operations very difficult. The participants also raised concerns over messages that require the proper enforcement of laws. There was a message requesting pedestrians to use footpaths, but the participants mentioned that it was difficult to walk on footpaths because of street shops. According to them, such messages require an effective law enforcement which is beyond their capacity. Social status was also found to be an important factor. Dalit target groups said that they cannot follow the message that asks them to go to safe shelters during disasters because they are socially excluded and not allowed to access shelters with other so-called higher castes.

2.8. Application on Education for Disaster Risk Reduction

2.8.1 Application Outline

Education for disaster risk reduction is the formal inclusion in the basic school curriculum of issues and subjects related to the identification and understanding of risks, its linkages with sustainable development, and the learning of risk reduction measures and of disaster preparedness and response mechanisms (IFRC, 2013).

2.8.2 Potential Uses of the Probabilistic Country Risk Profile

In the last decade, 175 million children have been affected on average per year, by climate-related disasters (UNICEF, 2015). Moreover, areas experiencing extensive disasters often see decreased school enrolment rates and increased dropout rates (UNISDR, 2011). On the other hand, education is recognized as an essential element for disaster risk reduction, by helping communities located in hazard prone areas to better understand and manage the risks they face and, in this way, accelerating the progress of societies towards disaster resilience (De Silva, S. et al., 2008). By providing estimates of risk in terms of sectors and segments of affected population, the country risk profiles can contribute to a wider risk understanding regarding students' own country or province. Having a general evidence-based overview of one's national and provincial risk profile at a young age constitutes a solid starting point for a new generation of citizens and decision makers. Moreover, as children are often good communicators and influencers within their family environment, they can also be seen as agents of change, promoting awareness and correct practices of self protection learned at school.

By providing estimates of risk in terms of sectors and segments of affected population, the country risk profiles can also demonstrate how much the educational sector is projected to be impacted by disasters, both by assessing the number of children affected and by calculating the losses in educational infrastructures. Safe schools and educational buildings are described by the IFRC as potential "safe havens" and have proven effective in saving lives, thus making schools highly relevant for community based DRR. Ensuring that schools are safe, that DRR is integrated in school curricula and that children and youth are genuinely involved in DRR and in decision-making processes are vital steps to promote a global culture of safety, and to sustain the valuable gains made towards development goals.

Figure 10: Framework for Education for DRR (adapted from UNESCO)

2.8.2.1 Disaster Prevention Education

Teaching and learning about DRR and climate change is key to increasing individuals' and communities' knowledge about risk and its driving factors, and to creating a culture of self-protection. Based on information regarding the most risk prone areas and provinces, policymakers can decide to mandate DRR subjects in the curriculum and school-wide activities in those provinces. This might include multi-hazard awareness campaigns at school premises and/or conducting drills and establishing school-level disaster management plans, linked with provincial and national contingency plans. Other activities include supporting DRR community-led programs, ensuring the availability of learning materials and resources, and supporting the professionalization and research in the field of DRR in institutes of higher education. In this process, country risk profiles can also help identify national scientific knowledge gaps and thus, guide the design of educational and research programs in order to fill those gaps.

2.8.2.2 School Disaster Management

Based on the country risk profile results, policymakers may establish strategic decisions such as setting up school disaster management committees with participation from students, teachers, school administration and community members, and or to implement school Emergency Disaster Preparedness Plans. This might include warning systems, evacuation plans, conducting regular emergency drills and simulations and to provide operational guidance to schools before, during and immediately after an emergency.

2.8.2.3 Safe School Facilities

Policymakers have the responsibility to ensure that students are safe while at school and thus, must establish safety standards for school facilities. Based on future projections, the country risk profile allows decision makers at the national level to allocate resources for educational facilities in areas with large numbers of children potentially affected and/or in school facilities potentially affected. Disaster risk projections can also provide arguments for advocacy for higher building standards to ensure that schools are built to withstand multiple hazards. On the other hand, if an educational facility happens to be in a hazard prone area, policymakers might decide to prioritize the modification/ retrofitting of the existing building and to provide first-aid kits and safety/rescue equipment.

2.8.3 Case Study: Safer Schools Programme in Mozambique (Republic of Mozambique, 2015)

Due high vulnerability and recurrent negative impact of climate change in human settlements, UN-Habitat is promoting and piloting disaster adaptative solutions for schools and public construction in Mozambique since 2006 financed first by EU DG-ECHO through DIPECHO initiatives until 2013 to demonstrate how people and communities can learn living with natural hazards.

In 2012, The Government of Mozambique through the National Institute for Disaster Management (INGC), Ministry of Education and Human Development (MINEDH) and Ministry of Public Works, Housing and Water Resources (MOPHRH) funded by the World Bank requested assistance of UN-Habitat and Eduardo Mondlane University to provide technical assistance under safer school

framework "developing guidelines on school safety and resilient school building codes" which one of the most important outcomes was to create consensus on school infrastructure vulnerabilities among wide range of key players such government institutions at central, provincial and local levels, donors, academia, civil society, private sector and UN Agencies.

The Safer Schools Programme, included a comprehensive assessment of schools damaged or destroyed by natural hazards, hazard and zoning mapping at the national level, development of building guidelines and improved building codes to provide resilient school infrastructures to the impact of the most common natural hazards in Mozambique namely floods, cyclones, droughts and earthquake. The risk assessment showed that building 'Safe Schools' would cost, in the medium term, less than a traditional school which would need to be rebuilt whenever a severe event occurred. Thus, building Safe Schools was understood as being a strategic initiative not only to ensure children's safety but also economically. Benefits of avoided losses were estimated to be of $ 1,535,000 USD for every 500 classrooms. Considering that between late 2011 and early 2012, 1100 classrooms were destroyed, the benefits are potentially considerable. Moreover, the risk assessment showed that over the past 15 years, on average some 1,000 classrooms had been affected annually by floods or strong winds.

In 2016, based on a probabilistic risk forecast, the Ministry of Education and Human Development (MINEDH) contracted UN-Habitat to provide technical assistance to a World Bank-funded school reconstruction and retrofitting programme with resilient standards for conventional and non-conventional classrooms after large floods of 2015 to 2016 rainy season that affected central area of Mozambique.

The Safer Schools Programme was considered central to the community's resilience because often schools, health centres and other public buildings are the only structures built with improved/ conventional materials in remote areas. By rebuilding a damaged school in a safe and resilient manner, Mozambique is ensuring the continuity of education provision in the aftermath of future disasters as well as making sure isolated communities will have at least one resistant building to be used as "safe havens" during emergencies.

The Programme also included the enhancement of coordination among government, donors and other partners and the delivery of capacity building training to sub-contractors for building schools. The Programme resulted also in a strong partnership established between UNICEF and UN-Habitat with MINEDH since 2015, which expanded the project into the educational curricula, with risk awareness campaigns being designed specifically for students, through the distribution of information materials and scale up of resilient school infrastructures reconstruction. Continuous monitoring was ensured through checklists to assess school levels of vulnerability and risk indices.

The Government of Mozambique are strongly investing on safe schools approach at country level and UN-Habitat is providing a continuous and sustained advocacy on resilient school construction enabling long term achievements such adoption of resilient schools models, norms and further enlargement of Safer School approach with support of different partners as World Bank, EU, UNICEF, NGOs and Private Sector.

2.9 Application on Land-Use Planning

2.9.1 Application Outline

Land-use planning aims to harmonize different competing land uses in accordance with national, regional and local land policies. In guaranteeing that land-use planning guides the future use of space, planners face five important challenges: growing population, scarcity of suitable space, increasing inequality and risks deriving from disasters and climate change. Specifically, limited available space and rapid population growth tend to exacerbate inequalities, and all of these conditions are themselves exacerbated by climate change and the resulting increasing number of disasters (Resurreccion, et al, 2008). Land-use planning can be considered for legal and technical components, such as urban planning maps and zoning regulations, but it also offers a comprehensive approach that supports DRM by public land and housing policy formulation, land-use allocation, transparent investment, implementation of construction standards, social awareness and acceptance based on public participation (GIZ, 2011).

Within the Sendai Framework, land-use planning is highlighted as part of national and local actions to be taken under Priority 3 (Investing in disaster risk reduction for resilience), and to a lesser degree, under Priority 4 (Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction). It is also suggested that national and local level actions could include the mainstreaming of disaster risk assessments into land use policy development and implementation, including the areas of urban planning, as well as in the mapping and management of rural development planning.

2.9.2 Potential Uses of the Probabilistic Country Risk Profile

Specifically, the probabilistic country risk profile can support planners by identifying, at the national level, which provinces are likely to be exposed to disaster events with the highest impacts. They can guide decision making on strategic directions for the utilization of land at a large coverage, harmonizing different spatial plans and defining operational guidelines. The maps presenting the exposure distribution and the AAL, both for present and for future climates, are the main indicators that can be used to support planners. In sum, land-use planning can be used jointly with risk knowledge in order to reduce planning difficulties, reduce disaster risk and, consequently, improve a community's resilience.

2.9.3 Case Study: Indonesia

In Indonesia, a scientific study developed large-scale flood probabilistic risk analyses that assess the effectiveness of spatial planning based on future territorial projections. Researchers showed that land-use planning can be a key policy tool for reducing flood risk in rapidly developing countries. If no new cities were constructed in Indonesia's flood prone-areas between 2010 and 2030, annual expected losses from river and coastal floods would be 50–80% lower by the end of that time period than if cities were built. Without such limits on urban construction, it is estimated that flood risk may increase by as much as 166% (river floods) and 445% (coastal floods) over the three decades due to urbanization alone, with additional increases expected as a result of climate change and economic growth (Muis et al. 2015).

2.10 Application on Disaster Contingency Funds

2.10.1 Application Outline

There has been an increasing interest in recent years in using financial instruments to help countries cope with financial needs resulting from disasters (OECD, 2012). Governments are financially impacted by disasters, due for instance to the provision of emergency relief and post-disaster aid, the repair of government assets and infrastructure and macroeconomic impacts that affect revenues (GFDRR, 2012). Various financial instruments are available that enable governments to retain and transfer their risk in order to better manage budget volatility resulting from disasters. These instruments are known as Disaster Risk Financing Instruments (DRFIs). DRFI measures are commonly classified as ex-post or ex-ante (GIZ, 2017; World Bank 2010).

Ex-ante risk financing tools refer to financial pre-disaster commitments to shoulder specific disaster related costs, which can cover disaster related costs in the short-term (emergency response), mid-term (recovery) or long-term (reconstruction). When disasters strike, and there are no previous financial arrangements in place, governments finance disaster related expenditures ex-post. Governments interested in strengthening their response capacity will generally need to combine a number of complementary financial instruments and policies both ex-ante and ex-post. It is therefore key to understand how probabilistic risk assessment can better inform governments to balance between ex ante and ex post approaches to disaster risk financing.

2.10.2 Potential Uses of the Probabilistic Country Risk Profile

The probabilistic country risk profile can provide the required information for governments for given disaster scenarios or return periods, especially those that take the potential impact of climate change into account. Below, you will find a brief description of ex-post and ex-ante financing instruments, as well as where the probabilistic country risk profile can provide useful information.

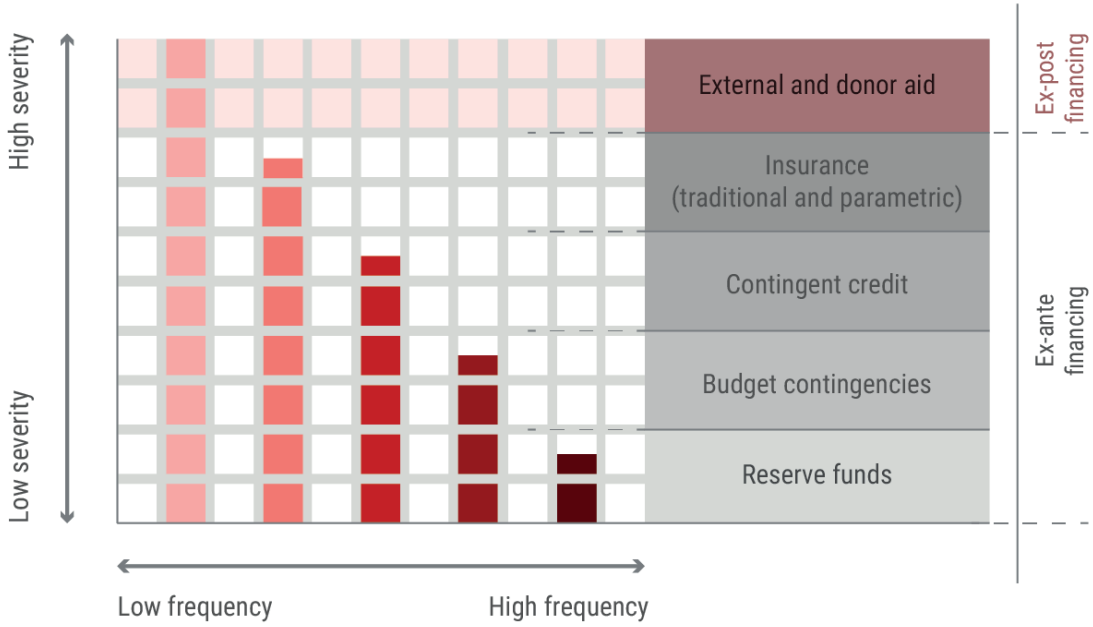


Figure 11: Catastrophe risk layering (Source: adapted from Ghesquiere F. and Mahul O., 2010)

2.10.2.1 Ex-ante financing

These financing instruments require proactive advanced planning; hence, the probabilistic country risk profile can be used to inform financial decision making with a better understanding of potential future disaster losses by the use of the different risk metrics (AAL and PML). The user can extrapolate the metric (differentiated by area and sector) needed to tailor his specific ex-ante tool.

As ex-ante funds are financed by annual appropriations and can be drawn down in the event of a disaster, they involve investing in national disaster risk management prior to a disaster occurring. Governments may use reserve funds as their primary means to finance disaster risks, for instance where they face frequent but low impact disasters. When they face the risk of high impact but low frequency disasters, they may use reserve funds as part of a broader, multi-layered financial strategy. The main advantage of ex-ante instruments is that they are secured before a disaster and thus allow for quick disbursement post-disaster. The main ex-ante risk financing instruments are:

- *Budget contingencies*: they usually represent about 2 to 5 percent of government expenditures and are not earmarked only for natural disasters. Budget contingencies together with reserves are the cheapest source of ex-ante risk financing and are generally used to cover the recurrent losses. To support the quantification of the recurrent losses, the risk profile is very useful (Ghesquiere F. and Mahul O., 2010). With this assessment, different governments and related bodies can choose which parameters to use to identify the right quantity of money to allocate: this can be based on the AAL.
- *Reserve fund*: DRFIs usually cover moderate but frequent losses caused by natural disasters. Normally, they are funded with annual budget allocations. Reserves are generally held in short-term assets; their cost is the difference between the returns on long term investments and on short-term investments (GFDRR, 2014). Similarly to budget contingencies, the reserve funds can be used to manage unidentified risks: for this reason, the country risk profile has a limited applicability. Most countries have annual reserves that provide flexibility to respond quickly in the immediate aftermath of a natural disaster.
- *Contingent credit*: available through various multilateral development banks, it provides a flexible mechanism to manage risk at relatively low cost. Contingent credits allow for immediate access to liquidity in the case of a disaster, combining the benefits of low interest rates provided by multilateral credit with rapid and flexible access to resources. In order to have access to contingent credit, countries must generally demonstrate that they have engaged in a comprehensive disaster management program. Under this aspect, the country risk profile can provide an initial added value. Contingent credit can provide governments with additional financial capacity in the aftermath of a disaster, but its amount is constrained by the borrowing capacity of the country. However, the risk profile can also enable quantitative analyses supporting the implementers in deciding on a set of rules that would trigger additional resources. In this specific case, the different AAL estimations for the different sectors can provide those trigger values.
- *Sovereign insurance*: for the sovereign insurance, risk takes the form of deductibles, sub limits or policy exclusions. Payment is made only after an actual loss assessment and investigation. With the goal to put the insured back in the position they were prior to the event, the reimbursement is equal to the actual loss sustained. In order to define the

amount of loss that the country wants to cover with the insurance, they need to have an accurate probabilistic risk assessment. For this reason, the country risk profile can be the first step. In this case the PML curve can be used to set this value in order to identify which losses are not covered by the insurance. On the other side, insurance companies have their own probabilistic risk assessments that are used to tailor the premium to offer the country and eventually identify a reinsurance policy that can allow them to cover all the different scenarios of losses.

- *Parametric insurance*: parametric insurance is not designed to replace, but to complement sovereign insurance programs. They insure a policyholder against the occurrence of a specific event by paying a set amount based on the magnitude of the event, as opposed to the magnitude of the losses in a traditional indemnity policy. This type of contract is appealing because payment can be made in a short period (in general weeks) verses months or years with a standard indemnity contract. Unlike sovereign insurance settlements that require an assessment of individual losses on the ground, parametric insurance relies on a payout disbursement contingent on the intensity of an event (e.g., wind speed, ground acceleration). The African Risk Capacity (ARC) functions similarly by pooling funds from various African Union member states to insure against climate risk, utilizing Africa Risk View, a satellite weather surveillance system, to determine the magnitude of the parameters. Despite the many benefits to parametric insurance, parametric products are exposed to basis risk, i.e., the possibility that calculated or modelled losses may be higher or lower than actual losses on the ground. The probabilistic risk assessment developed is different to the one developed within the country risk profiles and it would require the definition of a trigger product derivable from a specific probabilistic risk assessment that needs to be tailored to the payout function.
- *CAT-Bonds*: CAT bonds, a relatively new financial market product, are a high-yield debt instrument designed to raise money for companies in the insurance industry in the event of a devastating natural disaster. A CAT bond allows the issuer to receive funding from the bond only if specific natural hazards occur. However, if the special event protected by the bond triggers the payout to the insurance company, the obligation to pay interest and repay the principal is either deferred or completely forgiven. For the issuer (governments, insurers, and reinsurers) cat bonds signify financial protection in case of a major natural catastrophe. For the investor, buying the bonds means they may get high returns for their investment, not subject to financial market fluctuations.
-

2.10.2.2 Ex post financing

Ex-post financing instruments are sources that can be implemented without advance planning. Ex-post strategies provide emergency response, rescue and emergency relief services in the aftermath of natural disasters and is an example of a pure public good. Differently from the ex-ante financing, these instruments can derive limited useful information from the country risk profiles or any other type of probabilistic risk assessment. Ex post risk financing instruments are:

- *Budget reallocations*: used by most countries in cases in which a natural disaster causes significant damage that must be covered by the government. Countries' legal frameworks can provide some flexibility in terms of quick budget reallocation and all institutions can

transfer a percentage of any budget appropriation to any other budget line. However, larger-scale reallocation of funds requires a supplementary budget and regular parliamentary approval. This takes more time and is likely to be too late to provide the immediate resources needed during and just after a disaster.

- *Domestic credit*: the domestic credit can speed household and business recovery through provision of rapid financial liquidity following an event. Domestic credit reduces the burden on the fiscal budget in the aftermath of a disaster by reducing the need for state compensation of businesses and individuals.
- *External credit*: external credits derive from international insurance companies to whom developing countries' governments have transferred excess risk. Furthermore, this pool of capital has grown domestic insurance markets in developing countries by allowing accumulated catastrophe risk to be passed out of the country and into the international financial markets.
- *Donor assistance*: donors' assistance usually kicks in support of a government response to catastrophic but not frequent events. Donor financing is highly unpredictable and does not allow the government to plan for a fast disaster response.
- *Taxation*: any introduction of new taxes, especially in a period in which large parts of the population are directly or indirectly affected by a disaster, is not popular. Even though it can be a relatively easy way for the government to collect the necessary funds, it is not the most effective one. Increasing taxes does not require advance planning, but it can be almost impossible in countries without a well-organized system for defining tax policy and tax administration.

2.10.3 Case Study: Cambodia

Due to the lack of awareness and the limited availability of local risk information, Cambodia is still in the process of building effective risk management systems. Combining the information regarding fiscal resources and the probabilistic estimates of recovery and reconstruction funding needs, it is evaluated that Cambodia will likely face a fiscal resource gap following a 28-year return period event. A dynamic fiscal model analysis shows that over the next 5 years, the likelihood that the Cambodian government will face a fiscal resource gap is estimated to be approximately 50%. This relatively high probability is due to the fact that disaster occurrence is frequent in Cambodia, and the cumulative effect of frequent disaster events will likely stress the fiscal situation (Mochizuki et al. 2015).

2.10.4 Case Study: Caribbean

The Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company (CCRIF) is an effort to reduce financial vulnerability through allowing Caribbean countries to access natural catastrophe risk insurance at affordable rates. Insured countries pay an annual premium commensurate with their own specific risk exposure and receive compensation based on the level of coverage agreed upon in the insurance contract upon the occurrence of a major disaster. The CCRIF transfers the risks it cannot retain by purchasing reinsurance and catastrophe swaps. Coverage provided by the Facility is "parametric" in nature. In the case of CCRIF, payouts are

proportional to the estimated impact of an event on each country's budget, which is derived from a new probabilistic catastrophe risk model called SPHERA (System for Probabilistic Hazard Evaluation and Risk Assessment). SPHERA is a new state-of-the-art model, based on the latest scientific findings and the most updated hazard datasets. The new model features new, up-to-date ground motion, wind and storm surge models; a larger and more detailed stochastic catalogue of events; a more detailed exposure database, including infrastructure and facilities; and new, updated vulnerability functions (Insurance Development Forum, 2017).

2.11 Application on Cost Benefit Analyses

2.11.1 Application Outline

A Cost Benefit Analysis (CBA) is a tool used to determine the economic efficiency of development interventions. It compares project costs with their predicted benefits, resulting in an estimation of the net benefits (Kull, Mechler & Hochrainer-Stigler, 2013). This allows analysts to clearly and efficiently communicate benefits of different proposals to decision-makers. Direct benefits in development interventions could be economic gains due to improvements in physical or social infrastructure. In DRR on the other hand, these benefits usually revolve around reduced potential damages, which makes them more complicated to quantify (Shreve & Kelman, 2014).

Cost-benefit analyses could be applied on the use of different financial instruments explained in the previous section. This would have the benefits of informing policy makers on the best financial instruments and or combination of them to prepare for potential fiscal shocks arising from disasters.

Disaster risk reduction has been proven to be more cost-effective through preventative action, as is advocated by the Sendai Framework, than through post-disaster reaction approaches (Shreve & Kelman, 2014). Nonetheless, preparedness and risk reduction is continually underfunded in the developing world compared to response. A 2020a UNDRR study on sixteen Sub-Saharan African countries, for example, shows that on average over a three-year period between 2015 and 2017, 88% of humanitarian aid targeted post-emergency/disaster activities. While funds allocated towards disaster risk prevention have increased in the last decade, more work needs to be done to help donors understand the cost and benefits of disaster risk management specific to projects (Kull, Mechler & Hochrainer-Stigler, 2013). The same is true for decision-makers. As disaster costs continue to rise, it has become increasingly necessary to demonstrate the financial benefits of DRR to policymakers and decision-makers (Shreve & Kelman, 2014).

The difficulty of calculating costs and benefits is one of the main limitations of cost benefit analyses. Many costs and benefits have no market value. For example, calculating the impacts of a specific intervention on the mental health of a community, or calculating the cost of the loss of human lives so that these can be compared with other financial factors is almost impossible, and also morally questionable. The same issue arises when quantifying 'value' of natural environments. Economic considerations of marketable goods do not give justice to their actual worth, as these depend on non-marketable variables such as personal values, moral beliefs, etc. (Kull, Mechler & Hochrainer-Stigler, 2013).

Purely economic costs or benefits can also be difficult to estimate due to the inherent uncertainties that accompany predictions. Uncertainties are usually quantifiable for direct costs and benefits, but indirect costs and benefits can be so wide-ranging that it is almost impossible to put a precise number on them. Providing a qualitative assessment of indirect costs and benefits is one way to mitigate this limitation (Shreve & Kelman, 2014).

Another important limitation of primary importance to development planning is that CBAs

do not consider the distribution of benefits and costs throughout society. Interventions will necessarily create some 'winners' and 'losers', but because societal welfare is calculated as a whole, there is no way to assess these groups, and there is therefore no compensation between them. Even if one were to assess the outcomes post-intervention, compensation would be difficult to quantify. The perception of who 'won' and who 'lost' can be extremely subjective. This relates, once again, to the difficulty of quantifying the real value of benefits and costs (Kull, Mechler & Hochrainer-Stigler, 2013).
These limitations need to be understood by decision-makers so that they do not overextend the role of cost-benefit analyses in the decision-making process. CBAs provide approximations of the preferences of society, not the exact economic value of an investment. They should never be the sole criteria used for evaluating policies - they should be part of a larger decision-making process that incorporates cultural, economic and social factors. That being said, the advantage of conducting a CBA is clear: they support coherent and systematic decision-making by providing a common measure that uses money as a metric.

2.11.2 Potential Uses of the Probabilistic country risk profile

When determining whether or not to invest in a project, the Net Present Value (NPV) provides an indication as to the feasibility of the project. If its value is greater than zero, taking into account the effect of time on the value of money, the benefits outweigh the cost. The NPV is therefore determined by calculating the value of an income stream resulting from subtracting the costs to the benefits of the investment after converting all future costs and benefits to their present values. Within this calculation, the information provided in the probabilistic country risk profiles can be used to calculate the benefits component, in terms of "avoided losses" if a specific DRR measure is implemented.

Normally, the benefits in a CBA calculation are an estimation of the positive outcomes generated by the project or measure that is being considered. In disaster risk management, however, these benefits are the estimated reduced losses, avoided losses or transferred risk. The probabilistic country risk profiles use return periods to calculate the AAL and PML caused by floods. Both of these are loss indicators. The first represents the average yearly loss, the reduction of which can represent the average yearly gain caused by a certain measure. The second represents, at minimum for the given return period, the probable maximum, or total, loss (in USD) that the country will experience (figure 11). It is important to highlight that these indicators are based on probability. From a theoretical standpoint, values for a substantial number of points are required for accurate calculations of losses. However, It is not possible to simulate the infinite amount of data points into models to arrive at such precise calculations. Therefore, the values given for these indicators can be understood as an estimation (Kull, Mechler & Hochrainer-Stigler, 2013).

To conclude then, the probabilistic risk profiles already provide a present AAL scenario and a future AAL scenario with regards to the future climate, but without consideration of specific DRR measure. To calculate a CBA, it is possible to take this probabilistic analysis for the present curve, and then make a new probabilistic analysis that takes into account the changes brought by the DRR measure that is being considered (Kull, Mechler & Hochrainer-Stigler, 2013).

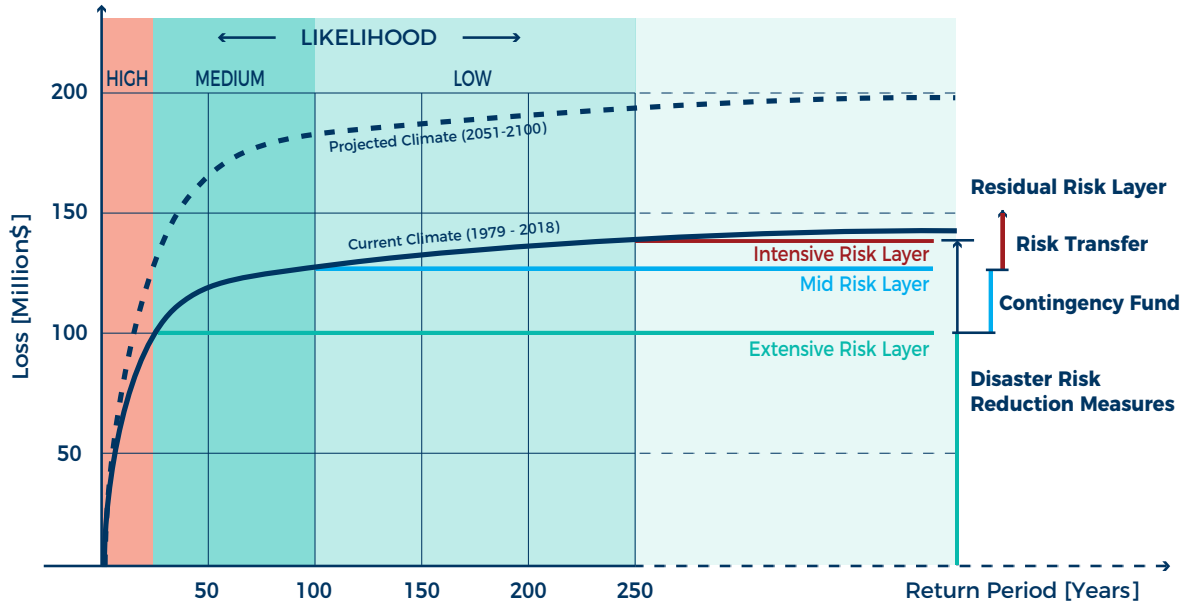


Figure 12: The PML (CIMA)

2.11.2.1 Potential Limitations

The AAL and PML only account for losses from direct risks (assets and structures). Indirect risks, such as assessing consequences on livelihoods, are much more difficult to calculate because they require conducting surveys, interviews or statistical and economic analyses. As a result, the 'real' impacts of disasters is not adequately represented. In the context of a cost-benefit analysis, this should be taken into account so as to better inform decision makers.

Certain disaster risk reduction measures may also lead to negative indirect consequences. These can easily be overlooked, but need to be considered into the 'cost' of a measure.
Finally, the distribution of losses is not given by the average annual losses. Kull, Mechler and Hochraner-Stingler provide an interesting comparison in this regard: "A loss of USD 250 has a different significance for a poor labourer in comparison to a large-scale farmer. In the case of the labourer, this loss would have severe follow-on effects, such as deprivation and malnutrition, whereas the farmer would be able to absorb this financial loss with few such indirect ramifications" (Kull, Mechler & Hochrainer-Stigler, 2013).

2.11.3 Case Study: Tanzania

In 2020, UNDRR conducted a study aiming at quantifying the multiple benefits of DRR investments and building a knowledge base for risk-informed decision-making on DRR investment in target countries including Tanzania.
The study describes the methods of direct and indirect benefit assessment and their application to flood and drought risk management and was released as part of the project 'Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities'. For the direct benefit assessment, a multi-model analysis showed that the existing multi-

purpose dams have flood regulating benefits, reducing the AAL of floods by approximately US$ 6 million in the country. When combined with the additional benefit of power generation, the indicative benefit-cost ratio (BCR) was estimated at 1.13 using a discount rate of 7%. Additional direct benefits included drought tolerant and shorter-cycle varieties of Maize, with the potential of reducing drought AAL from the original level of US$ 24.7 million to US$ 2.9 million and US$ 19.3 million, respectively. When combined with the yield enhancement potential due to the introduction of new seed varieties, the indicative BCR for these two DRR investment options are estimated at 2.04 (drought tolerant variety) and 1.90 (shorter-cycle variety), respectively, using a discount rate of 7% (UNDRR, 2020b).

Within the indirect benefit assessment, DRR investment implied multiple benefits beyond a mere reduction of disaster damage. When compared to the reference scenario, the DRR policy scenario (in which additional multi-purpose dams are constructed) reduced the damage to productive capital while fostering a safer environment that promoted savings and investment, leading to the creation of more productive capital such as buildings and machinery. When taking into account the co-benefits in terms of additional power production and better access to water, DRR investment is estimated to accelerate GDP growth. The Total Growth Effect (TGE) of this DRR investment is estimated at 8.8% of GDP in a period of 30 years. Similarly, the indirect benefit assessment of improved crop varieties underscored the potential for DRR investment to foster national economic growth. The TGE of drought risk reduction policy is estimated at 10 % in a period of 30 years for the drought resistant crop variety scenario and 18 % of GDP for the combined drought and flood policy scenario. The indirect benefit analysis provides substantial evidence that in addition to reducing the immediate impact of disasters (e.g., loss of lives and destruction of capital assets), DRR investment helps cultivate a safer environment where undamaged infrastructure and productive assets enable future earnings and promote further investment (UNDRR, 2020b).

2.11.4 Case Study: Netherlands

The Netherlands have always been highly vulnerable to sea and river flooding. Intensive flooding events in 1953 led to changes in how flooding was addressed by governments on all levels. In the words of Robert Slump (2012) from the Ministry of Infrastructure and the Environment: “The real reasons [for present successes] are [attributable to] the changes in legislation, organizational structures and policy. Without organizations with clear mandates and proper funding, reconstruction and maintenance [cannot be] carried out.”

The standards for flood protection that were introduced were partly based on economic optimization of costs and benefits of reducing flood damage. These standards were recently updated to take into account the most recent insights into flood probability, vulnerability of infrastructure and losses of life. These new standards were developed using a cost-benefit analysis to determine a strategy that would minimize the discounted investment cost and residual flood damages over a long period of time. The impacts of economic growth and

climate change were also taken into account. Even indirect damages, such as loss of life, were estimated. According to UNDRR (2017): "This was the first and most complete analysis to determine economically efficient flood protection standards in the world and included all areas in the Netherlands exposed to flooding. It provided policy makers not only with the expected economically efficient flood protection standards, but also with confidence intervals around those economically optimal standards."

The main conclusions of the cost-benefit analysis were that safety standards for coastal areas were sufficiently high, but that standards for dikes along major rivers should be increased. Parliament then approved these standards and they became law on 1 January 2017. The country will therefore invest an additional 5 billion euros by 2028 to bring the infrastructure up to the level required by the new regulations (UNDRR, 2017).

References

Policy Coherence for Disaster Risk Reduction

- *OECD (2015). Better Policies for Development 2015: Policy Coherence and Green Growth, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264236813-en*
- *Sandholz, S., et al. (2020). Costs and benefits of (in)coherence: Disaster Risk Reduction in the Post-2015-Agendas. Synthesis Report. Bonn: United Nations University – Institute for Environment and Human Security (UNU-EHS). [https://united-nations-university.foleon.com/ publications/costs-and-benefits-of-in-coherence/philippines/]*
- *UNDRR (2020). Disaster Risk Reduction and Climate Change Adaptation, Pathways for policy coherence in Sub-Saharan Africa.*
- *UNESCAP (2018). Policy coherence for disaster risk reduction and resilience: from evidence to implementation - a toolkit for practitioners.*

National Development Planning

- *Chimhowu, A., Hulme, D. & Munro, L. (2019) The 'New' National Development Planning and Global Development Goals: Processes and Partnerships, 76-89. World Development, vol. 120 (August).*
- *UNDP (2017, 24 November). National Development Plans. https://www.africa.undp.org/content/rba/en/home/blog/2017/national-development-plans.html*
- *UNPEI (2006). Guidelines for Integrating Sustainability Considerations in Sectoral Policies Using the Integrated Assessment and Planning Model.*
- *UNPEI (2017). Chapter 4: Mainstreaming into National Planning Processes. Mainstreaming Environment and Climate for Poverty Reduction and Sustainable Development: The Interactive Handbook to Strengthen Planning and Budgeting Processes.*
- *Zambia, Ministry of National Development Planning (2017) 7 National Development Plan: 2017-2021.*

National Adaptation Plans

- *CIMA, UNDRR (2019): Zambia Disaster Risk Profile, Nairobi: UNDRR and CIMA Research Foundation*
- *Kenya, Ministry of Environment and Natural Resources (2016). Kenya National Adaptation Plan: 2015-2030.*
- *NAPExpo (2019). NAP Expo 2019: Raising Adaptation Ambition by Advancing National Adaptation Plans, 4-8 April.*
- *UNFCCC (2013). Introduction to the Four Elements of the Technical Guidelines.*
- *UNFCCC (2019). National Adaptation Plans, October 29.*
- *UNDRR (2013). Findings of the Review of National Platforms for Disaster Risk Reduction.*

DRR Strategies and Mainstreaming

- *Comisión Nacional de Prevención de Riesgos y Atención de Emergencias (CNE). (2015). Política Nacional de Gestión del Riesgo 2016-2030. San José, C.R. : CNE.*
- *IFRC (2007). Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations.*
- *IFRC (2011). Analysis of Legislation Related to Disaster Risk Reduction in South Africa.*
- *Peters, K. et. al. (2019). Disaster Risk Reduction Strategies: Navigating Conflict Contexts. Federal Ministry for Economic Cooperation and Development (May).Comisión Nacional de Prevención de Riesgos y Atención de Emergencias (CNE). (2015). Política Nacional de Gestión del Riesgo 2016-2030. San José, C.R. : CNE.*
- *UNESCAP (2017). Mainstreaming Disaster Risk Reduction for Sustainable Development: A Guidebook for the Asia-Pacific.*
- *UNDRR (2013). Findings of the Review of National Platforms for Disaster Risk Reduction.*
- *UNDRR (2017). Words into Action Guidelines: National Focal Points for Disaster Risk Reduction, National Platforms for Disaster Risk Reduction, Local Platforms for Disaster Risk Reduction.*
- *UNDRR (2019). Developing National Disaster Risk Reduction Strategies: Words into Action: Engaging for resilience in support of the Sendai Framework for Disaster Risk Reduction 2015-2030.*
- *UNDRR (2020, July). Disaster Risk Reduction and Climate Change Adaptation: Pathways for Policy Coherence in Sub-Saharan Africa.*
- *Van Niekert, Dewald. Coetze, Christo. Kruger, Leandri. et al. (2013). Disaster Risk Reduction Investments in Africa. UNDRR: https://www.researchgate.net/publication/265586511_Disaster_risk_reduction_investments_in_Africa*
- *Vargas, J. C, Ponte, E. et al. 2017. An Effective Approach to Mainstreaming DRR and Resilience in La Paz, Mexico, M. Tiepolo et al. (eds.), Renewing Local Planning to Face Climate Change in the Tropics, Green Energy and Technology, Springer DOI 10.1007/978-3-319-59096-7_14.*

Preparedness and Emergency Response Planning

- *IFRC (2012). Contingency planning guide. International Federation of Red Cross and Red Crescent Societies, Geneva.*
- *UNDRR (2017), Words in Action Guidelines, National Disaster Risk Assessment. Geneva.*
- *WHO (2017), A Strategic Framework for Emergency Preparedness, WHO Document Production Services, Geneva, Switzerland.*
- *World Bank (2018). Turkey—Istanbul Seismic Risk Mitigation and Emergency Preparedness Project. Independent Evaluation Group, Project Performance Assessment Report 127522 Washington, DC: World Bank.*

Recovery Planning

- *GFDRR (2011), Indonesia, Advancing a National Disaster Risk Financing Strategy – Options for Consideration, Washington DC, World Bank.*
- *GFDRR (2018), Disaster Recovery Guidance Series Process for Preparing Disaster Recovery Frameworks, Washington DC, World Bank.*
- *Malawi Government (2015), National Disaster Recovery Framework Building Back a Disaster-Impacted Malawi Better and Safer, Department of Disaster Management Affairs, Lilongwe.*
- *World Bank (2014), Recovery and Reconstruction Planning in the Aftermath of Typhoon Haiyan, Washington DC, World Bank.*
- *UNDRR (2017), Build Back Better in recovery, rehabilitation and reconstruction, UNDRR, Geneva*

Risk Communication

- *Participatory Campaign Planning for Inclusive DRR Knowledge and Messaging in Nepal - International Federation of Red Cross and Red Crescent Societies, 2017 [http://media.ifrc.org/wp-content/uploads/sites/5/2018/06/CaseStudy3_Nepal-Gender-Inclusiveness-Final.pdf]*
- *Prochaska J.O., Diclemente C.C., (1986). Towards a Comprehensive Model of Change. In: Miller W.R., Heather N. (eds) Treating Addictive Behaviors. Applied Clinical Psychology, vol 13. Springer, Boston, MA.*
- *Twigg, J. (2015). Disaster Risk Reduction. Chapter 10.1: Communications, information, education. Humanitarian Practice Network. Overseas Development Institute.*

Education for Disaster Risk Reduction

- *De Silva, S. et al. (2008). Building resilient communities: risk management and response to natural disasters through social funds and community-driven development operations (English). Washington, DC: World Bank.*
- *Disaster risk reduction (DDR) comprehensive school safety: an imperative for education policymakers, Republic of Mozambique, 2015 [https://www.worldbank.org/en/news/feature/2014/06/12/mozambique-initiative-aims-to-build-safer-schools-protect-children-from-disasters]*
- *https://news.un.org/pt/story/2016/11/1569541-projeto-em-mocambique-promove-adaptacao-de-salas-de-aula-desastres*
- *IFRC (2013). International Federation of Red Cross and Red Crescent Societies. Public awareness and public education for disaster risk reduction: key messages.*
- *UNICEF (2015) Children's Vulnerability to Climate Change and Disaster Impacts in East Asia and the Pacific [https://www.unicef.org/UNICEF_Education-and-Resilience.pdf]*
- *UNISDR (2011). Global Assessment Report on disaster risk reduction. United Nations Office for Disaster Risk Reduction (UNISDR).*

Land-Use Planning

- *GIZ (2011). Land-use planning: Concepts, Tools, and Applications, Eschborn, DE: German Federal Ministry for Economic Cooperation and Development, 232 pp.*
- *Kidd, S. (2007). Towards a framework of integration in spatial planning: An exploration from a health perspective. Planning Theory & Practice, 8(2), 161–181. http://dx.doi.org/10.1080/14649350701324367.*
- *Larsson, G. (2006). Spatial planning systems in Western Europe: An overview. Amsterdam, Netherlands: IOS Press.*
- *Mochizuki J. et al. (2015), Operationalizing Iterative Risk Management under Limited Information: Fiscal and Economic Risks Due to Natural Disasters in Cambodia, International Journal of Disaster Risk Science, 6:321–334.*
- *Muis, S., B. Güneralp, B. Jongman, J. C. J. H. Aerts, and P. J. Ward. (2015). "Flood Risk and Adaptation Strategies under Climate Change and Urban Expansion: A Probabilistic Analysis Using Global Data." Science of the Total Environment 538: 445–57.*
- *Resurreccion, B. P., et al. (2008). Climate Adaptation in Asia: Knowledge Gaps and Research Issues in South East Asia, ISET-International and ISET- Nepal.*
- *Steiner, F. R., Butler, K. S., & American Planning Association (2012). Planning and urban design standards (Student ed.). Canada: John Wiley & Sons.*
- *UNDRR (2019). Words into Action Guidelines: Implementation guide for land use and urban planning. Geneva.*
- *White, I., & Richards, J. (2007). Planning policy and flood risk: The translation of national guidance into local policy. Planning Practice and Research, 22(4), 513–534. http://dx. doi.org/10.1080/02697450701770050.*

Disaster Contingency Funds

- *Clarke, D. J., and L. Wren-Lewis (2016). Solving Commitment Problems in Disaster Risk Finance. The World Bank Group, Washington, DC.*
- *Gamper, C., et al. (2017), "Managing disaster-related contingent liabilities in public finance frameworks", OECD Working Papers on Public Governance, No. 27, OECD Publishing, Paris, https://doi.org/10.1787/a6e0265a-en.*
- *GFDRR (2012). Sovereign Disaster Risk Financing. Disaster Risk Financing & Insurance Concept Note.*
- *GFDRR (2014). EAP DRM Knowledge Notes Disaster Risk Management in East Asia and the Pacific. Working Paper Series No. 23. Washington DC.*
- *GFDRR (2016). Disaster risk finance as a tool for development: A Summary of Findings from the Disaster Risk Finance Impact Analytics Project. Washington DC.*
- *Ghesquiere F. and Mahul O. (2010). Financial Protection of the State against Natural Disasters: A Primer. Policy Research working paper; no. WPS 5429. World Bank.*
- *GIZ (2017). Risk transfer and insurance for disaster risk management: evidence and lessons learned. Review paper for a special session on risk transfer and insurance at the 5th Global Platform for Disaster Risk Reduction.*
- *Hofman D. and P. Brukoff (2006). Insuring Public finances Against Natural Disaster: A Survey of options and Recent Initiatives, IMF Working Paper WP/06/199.*
- *Insurance Development Forum (2017). Guidelines for Risk Assessment to Support Sovereign Risk Financing and Risk Transfer. Published by The Geneva Association*
- *Mochizuki J. et al. (2015). Operationalizing Iterative Risk Management under Limited Information: Fiscal and Economic Risks Due to Natural Disasters in Cambodia. International Journal of Disaster Risk Science (2015) 6:321–334*
- *OECD (2012). Disaster Risk Assessment and Risk Financing. A G20/OECD methodological framework.*
- *OECD (2013). Disaster Risk Financing in APEC Economies, OECD Publishing, Paris.*
- *World Bank (2010). Financial Protection of the State against Natural Disasters. Policy Research Working Paper 5429. Washington DC.*

Cost-Benefit Analysis

- *Kull, D., Mechler, R., Horainer-Stigler, S. (2013). Probabilistic Cost-Benefit Analysis in a Development Context, 374-400. Disasters, vol. 37, no.3 (July).*
- *Shreve, C.M. and Kelman, I. (2014). Does Mitigation Save? Reviewing Cost-Benefit Analyses of Disaster Risk Reduction, 213-235. International Journal of Disaster Risk Reduction, vol. 10, part. A (December).*
- *Slump, R. (2012). Flood Risk and Water Management in the Netherlands. Ministry of Infrastructure and Environment.*
- *UNDRR (2020a). Disaster Risk Reduction Investments in Africa: Evidence from 16 Risk-sensitive Budget Reviews.*
- *UNDRR (2020b). Multiple benefits of DRR investment Reducing risk and building resilience in Sub-Saharan Africa. The case of the United Republic of Tanzania.*

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