Annex 3

Global Assessment Report on Disaster Risk Reduction

2015

ECONOMIC APPROACH TO SUPPORT PUBLIC INVESTMENT PLANNING AND FINANCING STRATEGY FOR DRR

UNISDR
The United Nations Office for Disaster Risk Reduction

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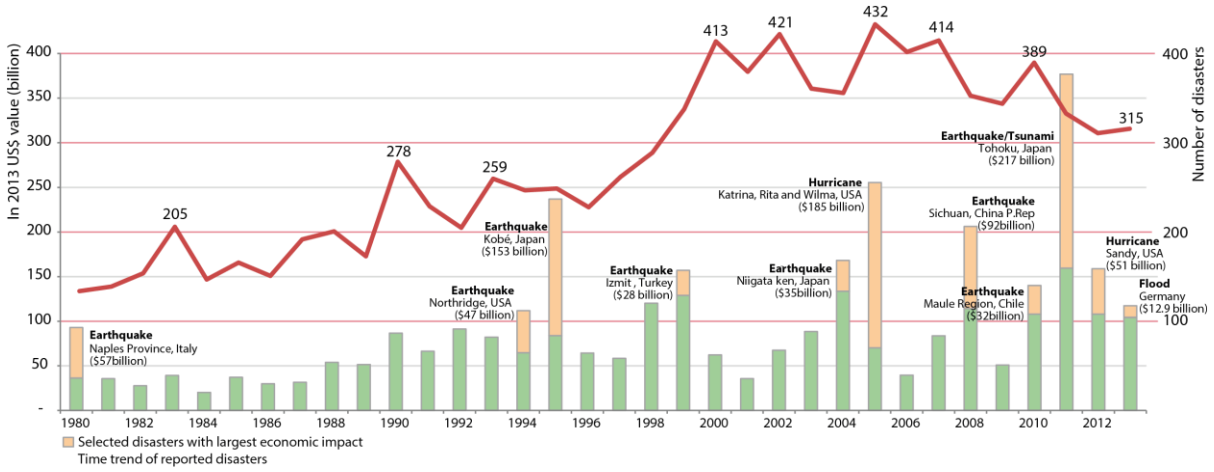
Chapter 1: What are challenges?

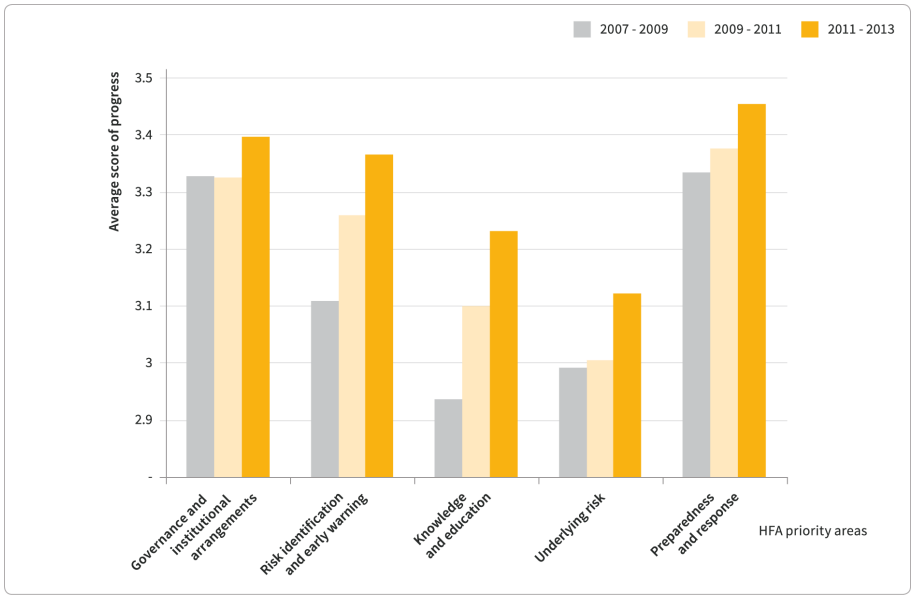
Why do we need to promote risk-sensitive public investment? Economic loss due to disasters has been increasing in spite of substantial progress in DRR policies promoted by Hyogo Framework of Action (HFA) (Figure 1 and Figure 2). HFA priorities have been progressing in all areas mainly due to the leadership of disaster management agencies and co-operation from related ministries/agencies and stakeholders. Especially during the past decade, capacity in monitoring and risk assessment has been developed in many countries.

Figure 1: Economic loss due to natural disasters, 1980-2013



Source: EM-DAT

Figure 2: HFA Progress

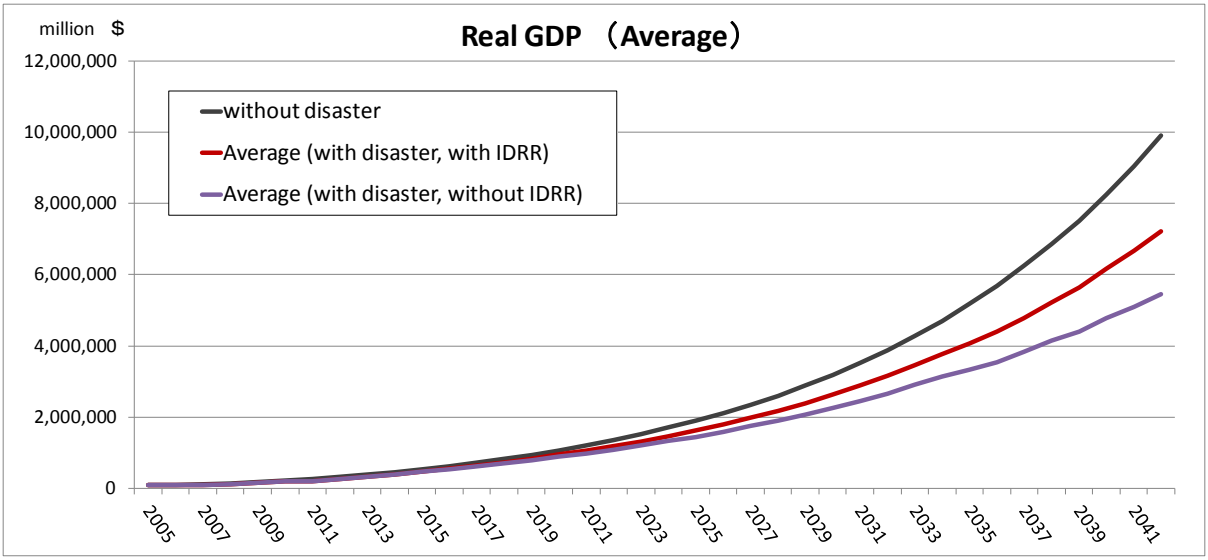


Source: UNISDR

Disaster interrupts or slows down economic growth by damaging public and private infrastructures and negatively affecting people and economic activities. Figure 3 portrays

the Pakistan GDP growth estimate calculated by JICA, clearly demonstrating that disasters will slow down economic growth and that DRR investment will mitigate the impact.

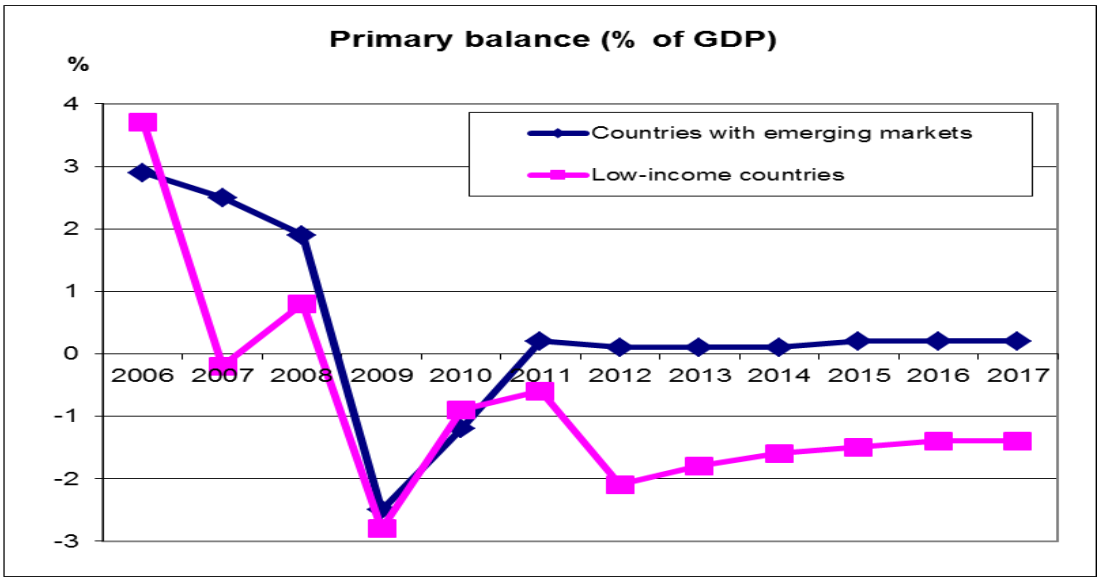
Figure 3: Pakistan GDP estimate, 2005-2041



Note: IDRR means DRR investment.
Source: Author based on the figure provided by JICA

Secondly, to reduce the impacts of disaster, governments need to invest in DRR. However, governments in most countries are suffering from tight budget constraints. Fiscal primary balance is expected to be negative in coming years (Figure 4). The financial situations of low-income countries are especially tight. If we consider the debt and interest payment of many developing countries, the budgetary situation would be even tighter than the graph portrays.

Figure 4: Primary balance (% of GDP), 2006-2017[1]

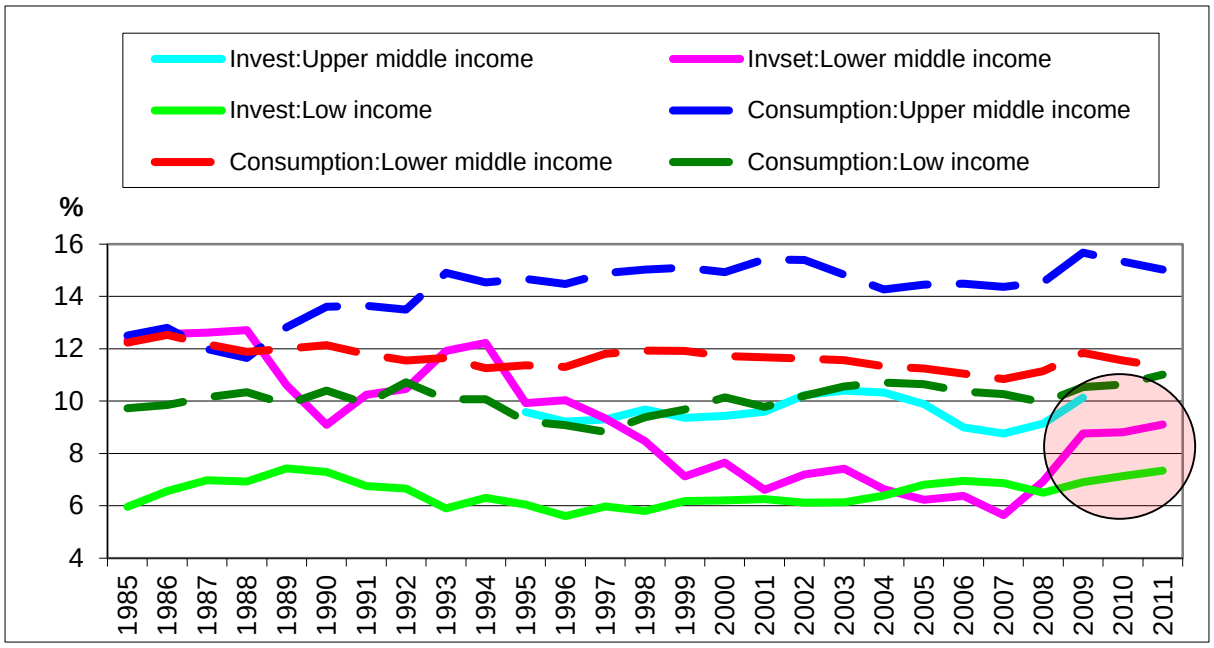


Source: Author based on IMF

Going deeper into the details of public finance, we can see the additional influence of budget constraints. Figure 5 portrays how public investment has been under pressure due to constant or increasing financial need for government consumption. Public investment, especially in low and lower middle-income countries, is very volatile. On the other hand, in spite of these constraints, public investment is significant, recently representing 6 to 10 % of GDP in developing countries. Governments must protect the hard-won fruits of these investments.

[1] The primary balance is the difference between a government's revenues and its non-interest expenditures; it is the most accurate reflection of government fiscal policy decisions. A country with a primary deficit, for example, spends more on roads, schools, defense, than it takes in from taxes and other revenues. Source: http://www.imf.org/external/np/fad/histdb/.

Figure 5: Government consumption and investment (% of GDP), 1985-2011



Source: Author based on the World Bank Development Indicators

Why does disaster risk matter in public finance? Although "risk as opportunity" has become an attractive political motto, on the ground, disaster risk simply represents costs for financial planners (both public and private) and society. While we often focus on disaster loss and impacts, the overall cost of disaster risk is a summation of a) ex-ante DRR investment and risk financing mechanisms, b) post-event response, recovery and reconstruction cost and c) disaster loss and impacts[2]. The cost of disaster risk management distracts financial resources from other priorities regardless of ex-ante or post event efforts. The impact of disaster risk on public finance should be considered based on the overview of these three categories of costs.

Recently there is increasing attention on risk-sensitive private investment (GAR2013). However, disaster risk management mechanisms should be first considered as an issue of public finance because national governments assume primary responsibility to protect people and assets from disasters, and the risk preventive infrastructure represents public goods to remedy the problem due to market failure.

In economics, **public goods** are characterized both as non-excludable and non-rivalrous in that individuals cannot be effectively excluded from use and use by one individual does not reduce availability to others. Classic examples of public goods include street lighting, police service, and fresh air and water. Paul A. Samuelson, in his seminal paper of 1954 entitled

[2] Some costs are duplicated. For example, contingency fund is regarded as both a) risk financing mechanism and b) expenditure for post-event response.

The Pure Theory of Public Expenditure, defined a public good (what he called "collective consumption good") as follows: "[goods] which all enjoy in common in the sense that each individual's consumption of such a good leads to no subtractions from any other individual's consumption of that good."

Disaster risk reduction mechanisms are also public goods satisfying conditions of non-excludability and no-rivalry. Sea walls and early warning system protect many people and assets at once and do not exclude anyone. The problem of public goods is that no one wants to pay for such goods and the goods are likely to be under-produced (*i.e.* free-rider problem[3]).

The argument of public goods is closely related to **market failure** in economic theory. Market failure is a situation in which the allocation of goods and services by free market is not efficient. Market failures are scenarios in which the individual pursuit of pure self-interest leads to results that are not efficient – that can be improved upon from the societal point of view[4]. The typical causes that lead to market failures include lack of information, externalities, or public goods.

When private sector does not properly assess the disaster risk, it tends to over-invest. While it is important for all members of society to properly recognize disaster risk, risk assessment is often costly and beyond the capacity of small and medium enterprises.

Furthermore, the impact of disasters can be felt beyond private sector investment and spill over to society (*e.g.* damaged factory interrupts traffic and prevents response activity or interrupts production causing income decrease of the employee). In this case, portions of disaster costs are transferred to others in society. This phenomenon is called negative **externality** in economics. When externality exists, private sector does not have incentives to decrease investment in hazard prone areas even if they properly understand the risk. Government needs to commit to disaster risk management mechanisms precisely to provide sufficient risk information to society and thereby remedy the lack of information and externality problem.

Assuring sufficient disaster risk management mechanisms transforms exposed and/or vulnerable areas and facilitates private investment in such areas. In this sense, disaster risk management mechanisms constitute important infrastructure supporting economic development of society. That is also a reason why government needs to commit to integrating disaster risk in public investment planning.

In spite of **decentralization** trends, the role of national government does not diminish. Disaster risk management infrastructure, such as sea walls, are often very costly and

[3] Typical examples of free rider problem include congestion in public roads and pollution of air and water.
[4] A socially desirable state is called Paleto Optimum in economic terms.

beyond the financial ability of local governments. Given the positive externality of such infrastructure, national governments are justified to financially commit in the investment. Catastrophes such as Indian Ocean tsunami in 2004 (just before HFA adoption) and Great East Japan Earthquake in 2011 (whose experience will influence post-2015 Framework for DRR informally called HFA-2) refocused the role of national government on their capability to prepare for and respond to intensive disaster risk. In the context of developing countries, accumulated impacts of low-to-mid scale disasters damage local level capacity and need systematic support from national governments.

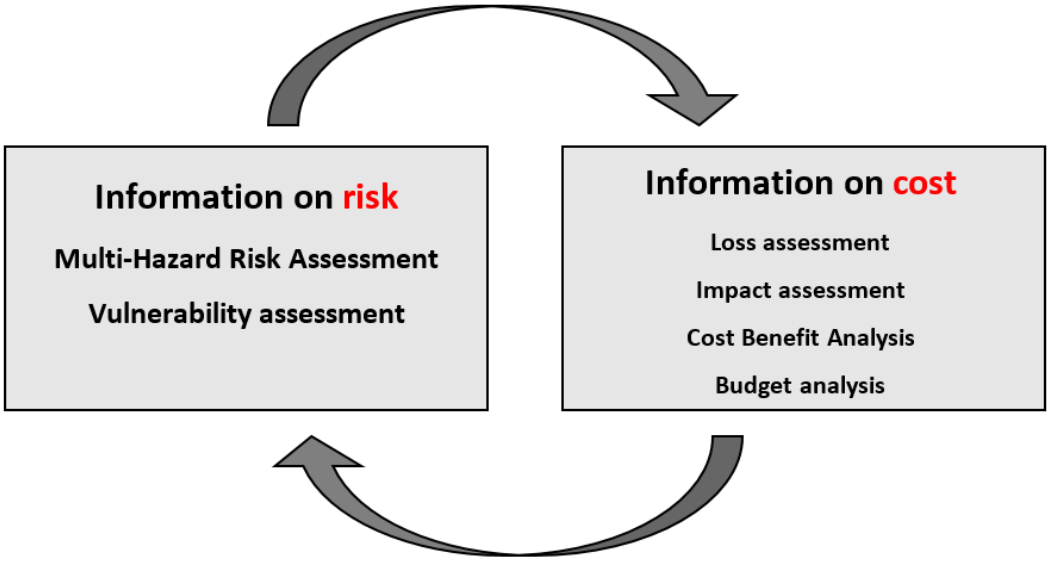
In case of catastrophe, horizontal risk transfer mechanisms such as insurance may often not be sufficient. DRR investment is, unlike risk transfer mechanism, considered inter-generational risk sharing. Following the definition of sustainable development by the Bruntland Committee, only development that addresses the existing risks without compromising the ability of future generations to address them should be promoted.

In summary, public investment in disaster risk management is theoretically justified and commitment of national level government is critical in spite of decentralization trends.

What are the gaps to be filled? It is important to focus on the lack of linkages between natural science and social science, especially in economics. Risk information produced by natural science is not well connected to cost information examined by social science. Even when risk information exists, if it is not linked to cost information, it is difficult to promote DRR Investment (Figure 6). For example, Solomon Islands states "If policies based on risk information would lead to increased project costs, *budget constraints may limit utilization of the risk information. Promoting cost benefit analysis is necessary in order to counteract this* "[5].

[5] HFA Report of Solomon Islands, 2013.

Figure 6: Required linkages between risk information and cost information



Source: Author

Related to the lack of cost information is an opportunity cost issue. Ministries of Finance are not concerned only about disaster risk. They need to respond to other competing country priorities. In many countries DRR is not a high priority and policymakers tend to allocate limited financial resources to other urgent needs such as poverty reduction, education and public health. It is also difficult to explain why there is *a sense of urgency surrounding DRR*, a challenge that often leads to problems securing financial resources. A classic dilemma for policy makers is whether they can justify giving up investment in other priorities with certain needs and in order to invest in DRR? In other words, risk needs to be examined through a socio-economic lens in each country.

In the DRM cycle, response, recovery and reconstruction also place pressure on the allocation of DRR budgets. Reconstruction and compensation for those affected is imminently needed in the majority of cases. In such situations, budget restructuring following a disaster often takes money away from DRR for use in reconstruction. To assure sufficient money for DRR investment, it is necessary to be able to justify the cost effectiveness of DRR investment –as compared to expenditure in response and reconstruction.

What exacerbates this difficult situation even more is that most countries do not have DRM labelling or dedicated budget lines for DRM in their public accounting system. So they don't know how much they spend on DRR, response and reconstruction. Sectorial DRR is especially hard to label, as it is often embedded in larger projects. For example, earthquake proof school building is included under the larger category of school building so that the

part of budget dedicated to strengthen the facility is not visible, making investment tracking almost impossible. Not having a DRM budget monitoring system results in the inefficient use of resources and an insufficiency of funds. Without knowing their current budget status, countries cannot properly evaluate the current level of DRM and estimate how much funding is required for further promoting DRM activities. Nepal claims "*The budget allocated for disaster preparedness and mitigation is spread among different projects which render it ineffective. There is a need to develop and implement a financial tracking system to monitor all DRR related expenditures for mitigation, preparedness and emergency response"*[6].

Considering all, the key questions that governments must tackle would be, "how much money should be allocated to DRM in total?" and "how to decide the most efficient and effective allocation of money between risk reduction and risk financing?" (Table 1). Subsequently, more specific issues need to be examined: the design of risk sensitive investment mechanisms and risk financing mechanisms.

Table 1: DRM structure for DRR

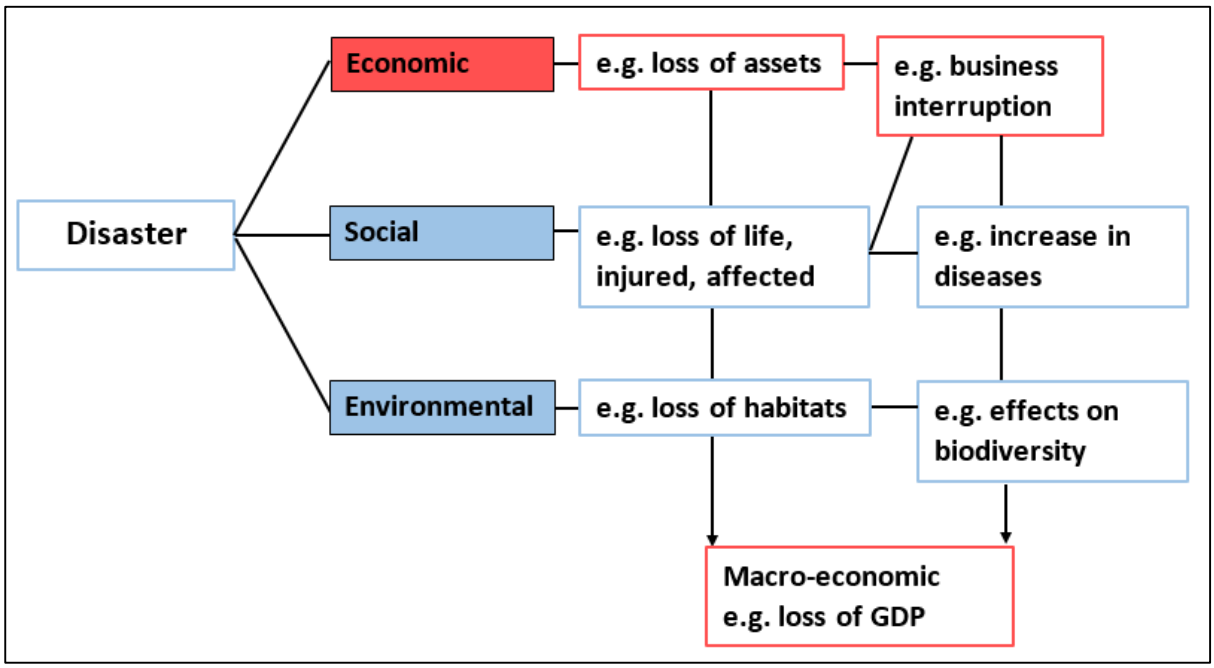
Disaster Risk Reduction (in broad sense)						
Risk reduction (in narrow sense)			**Risk financing**		**Disaster management**	
Prevention	**Mitigation**	**Preparedness**	**Transfer**	**Proactive retention**	**Response**	**Reconstruction**
e.g. **land use planning**	***e.g.*** **housing retrofitting**	***e.g.*** **contingency planning**	***e.g.*** **insurance**	***e.g.*** **contingency fund**	**Emergency management**	**Build back better**

[6] HFA Report of Nepal, 20xx

Chapter 2: Basic concept of economic loss: direct loss, indirect loss and macro-economic impact

Disasters have diverse impacts on society; they are often categorized into economic, social and environmental impacts (Figure 7). Economic impacts include, for example, loss of assets and business interruptions. Social impacts include death, injury and changes to the functioning of communities, to name a few. Some impacts are both economic and social. For example, increased poverty and unemployment would be interpreted from both perspectives. Environmental impacts are for example, loss of habitats for animals and deforestation due to natural fire. When these are all combined, disaster can have a macro-economic impact, for example, the reduction of GDP and trade balances. Economic analysis only focuses on the economic impacts of disaster.

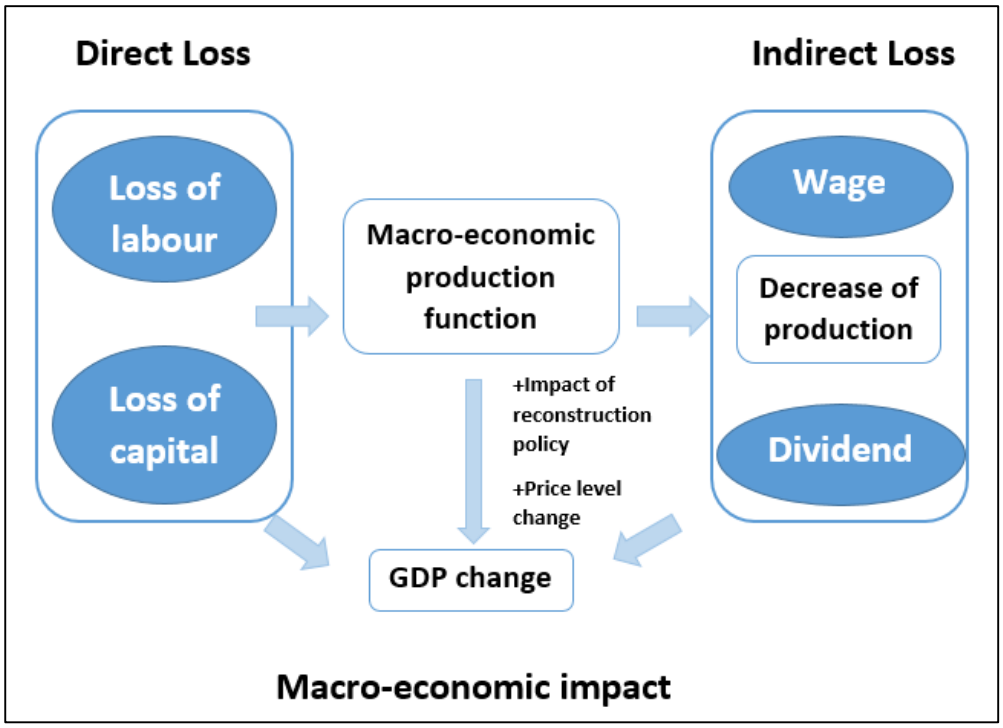
Figure 7: Impact of Disaster



Source: Author

It is important to clarify the difference between direct loss (physical loss centered), indirect loss and macro-economic impact at the start of analysis (Figure 8, Table 2). National disaster loss databases often focus only on direct loss. Probabilistic risk assessment is also often limited to physical impacts of disasters. In these cases, economic analysis based on available loss and risk data will also be limited to direct loss only.

Figure 8: Direct loss, indirect loss and macro-economic impact



Source: Author

Table 2: Direct loss, indirect loss and macro-economic impact

	Direct loss	Indirect loss	Macroeconomic impact
Typical examples	Loss of capital stock	Loss of economic activities (e.g. Business interruption) after the event	GDP Inflation trade balance
Time frame	Within the first few hours	Up to multiple years	Up to multiple years
Concept	stock	flow	flow
Estimate useful mainly for	Reconstruction	Recovery	Both
Main sectors affected	Infrastructure, housing	Productive sector (economic sector)	

Source: Author

Though there are several international databases registering economic loss, the methodology how to estimate the loss is often not fully clear. Systematic approach to record economic loss has been developed by UN-Economic Commission for Latin America and Caribbean (ECLAC). ECLAC standardized Damage and Loss Assessment (DALA) methodology and since 1972 economic loss assessment based on this methodology has

been accumulated In Latin American and other regions. Post-disaster needs assessment (PDNA) further developed the methodology by widening the scope of DALA. National disaster loss database that UNISDR promotes (explained in Chapter 4) focus on registering direct loss with much potential to widen the scope.

The development of methodology to estimate and register economic loss data will be the important first step to standardize methodology to estimate economic and financial impact of disaster *ex-ante*.

2.1. Direct loss

(Post-event estimate)

Direct loss is nearly equivalent to physical damage[7]. Examples include death and loss to physical assets such as damaged housings, factories and infrastructure. Direct losses usually happen within the first few hours after the event and are often assessed immediately after the event to estimate recovery cost and claim insurance payment. These are tangible and can be relatively easily measured. However, there are still technical challenges, for example, how to assign monetary value to such damage. Or, should direct losses be estimated as purchased value, book value or replacement cost[8]?

Though it is not directly related with economic loss, there is another important issue in measuring direct loss; "How to evaluate human loss?" There are some methodologies, for example, that evaluate human loss as lost income. However, this remains an on-going debate among economists because assigning monetary value to human life is an ethical issue, considered morally wrong. If we use the lost income approach, the life of a rich person is more valuable than a poor person. Though in very rare cases, monetary value is assigned to human loss, it is not common to monetize human loss[9]. Human loss is important factor to influence indirect loss in terms of both supply and demand side (production and consumption estimate).

(Ex-ante estimate)

In the case of earthquake impacts on building assets, if data on probabilistic distribution of earthquake hazards, building by structure and age, and the past disaster record are

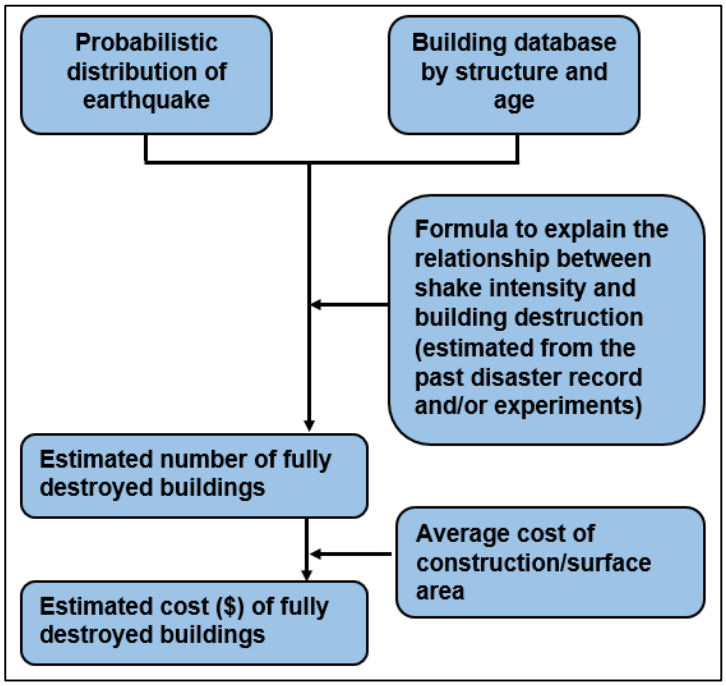
[7] In Damage and Loss Assessment (DALA) and Post-Disaster Needs Assessment (PDNA) approach, direct loss is termed as "damage" and indirect loss is simply called as "economic loss". Both constitute disaster "effect". Macro-economic impact and human development impact are disaster "impacts". (EC, UN and WB, 2013a, ECLAC, 2014)

[8] Book value means the current value of the asset on accounting book taking depreciation into consideration. Replacement cost can be cheaper than the price at which the asset was purchased. For example IT machines usually have become much cheaper during this decade. In this case, loss reported using purchased price means overestimation of the loss. Due to lack of data availability and urgent need to identify the recovery costs, replacement costs are often used in the world as a practical solution.

[9] This does not necessarily mean policy makers should not evaluate human loss. Most economists simply claim that human loss should not be evaluated at monetary value. Human loss should be counted as number of person killed, injured etc. Cost-effectiveness approach is developed for economic evaluation to determine options, for example, to reduce mortality. In a similar way to cost-benefit analysis, this approach compares several options and evaluates cost-efficiency given certain objective such as x % reduction of mortality.

availabe, we can estimate the value of expected building damage. If we multiply the number of houses destroyed by average cost of construction, then we can estimate monetary value of such building loss (Figure 9[10]).

Figure 9: impact of earthquake on building



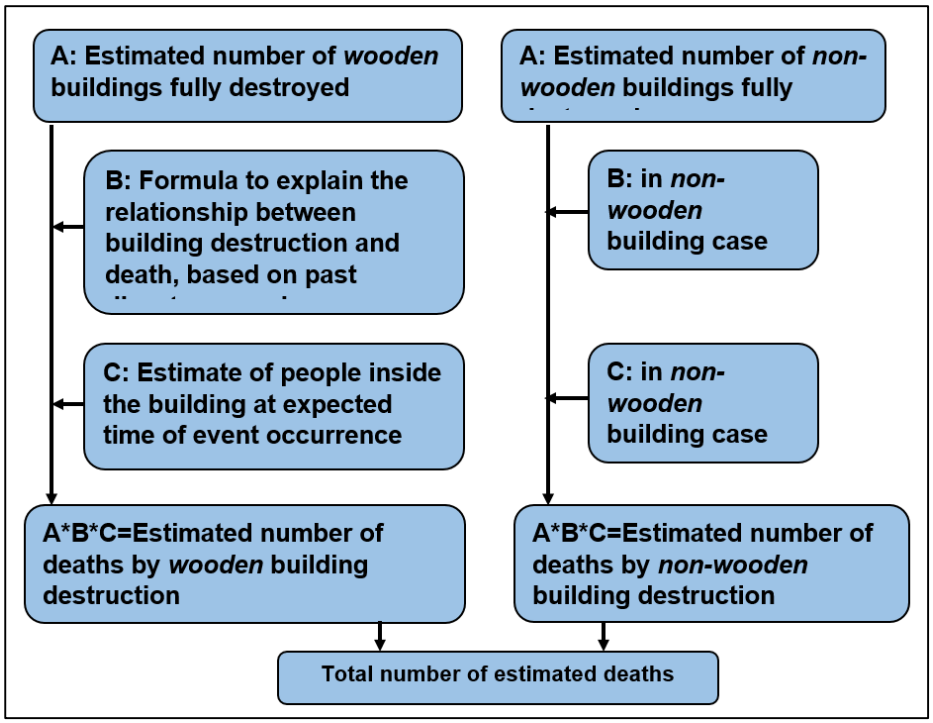
Source: Author

Regarding human loss due to earthquakes, if similar data such as probability, building structure and age, and past disaster records are available, then we can also estimate mortality.

Direct loss to physical assets is important estimate for reconstruction after disaster and also critical input data to prepare for contingency finance mechanism. Public assets are to be reconstructed by government and part of uninsured private assets is likely to need government support for reconstruction (implicit liability).

[10] The formula in the figure is often called “vulnerability function” in probabilistic risk assessment.

Figure 10: Mortality estimate process



Source: Author

It is clear from the examples that we need to have risk profiles, past loss data and baseline data, for example number of buildings by structure and age to estimate the loss.

2.2. Indirect loss and macro-economic impact

Indirect loss is more complicated. For example, a reduction in labour force and physical capital will cause business interruption and therefore a decrease in production. Interruption of basic service such as road and electricity infrastructures also hinders production process. The reduction of production might be instantly recovered but most often it lasts several years. Damage to economic activity, therefore, should be monitored over a longer period. Indirect losses are conventionally estimated within maximum of five years; it is reported that most loss occurs in the first two years after the disaster. Measurable impacts are often loss to production and income due to destruction of physical assets[11]. Though these indirect losses might be seemingly measurable, it is difficult to isolate the impact of disaster from others, for example, global financial crisis[12]. Technically speaking, to estimate indirect loss, it is necessary to have a "production function" linking labour and capital with production.

[11] Decrease of production will impact the wage level and dividend level.

[12] Another difficult issue would be for example, that lost product has two prices, which are producer price and consumer price. When measuring production sector's loss, then producer price would be more appropriate. On the other hand, if it is desirable to measure the loss from the interrupted service, consumer price would be better.

Macro-economic impact is much more complicated, because economic activity is interlinked. For example, production decreases are likely to push prices upward, if demand level remains stable. The rise of price level will increase interest rates[13]. High interest rates will bring private investment demand down. Reconstruction activity through public spending might produce effective demand for depressed economy but might crowd out private investment in growing economy. To estimate macro-economic impact, it is important to model the causal relationship of all these factors. Macro-economic impacts such as GDP, inflation and trade balances will often persist for several years and should also be monitored over time. They are conventionally estimated within maximum of five years after disaster events.

Indirect loss and macro-economic impacts are highly analytical and the results change depending on many factors. First, the result depends on geographic scale (e.g. municipality, region, or nation). For example, the impact of the Great East Japan Earthquake on the national economy is estimated to be negative (*i.e*. a loss in production). But if we look at the regional scale, while Miyagi prefecture including Sendai City-- severely affected by the tsunami-- had a negative impact, Tokyo had a positive impact --an increase in production to cover the loss in Miyagi prefecture.

Second, the result depends on the time an impact is estimated. As time passes, more information is gathered but some information will also be lost. For example, the estimate of one month after the event usually cannot integrate the impact of reconstruction activity on macro economy. In the case of intensive disasters, even after one year, the impact of reconstruction activity cannot be fully evaluated.

Third, the result also depends on the availability of baseline economic scenarios. The impact of a disaster on the macro economy should exclude other factors. For example, if the economy has been declining for the past decade and is likely to decline in coming five years, even if the GDP decreases after the disaster, that might be reflecting the general economic trend more than the event itself.

Forth, the results depend on the definition of impact, which is likely to be politically influenced by main concern for society and its policy makers. In case of 911, the Asia-Pacific Economic Cooperation (APEC) estimates included the increase of security costs. After Niigata earthquake of Japan --which also caused nuclear power plant problems, though much smaller scale than Fukushima, Niigata prefecture included an estimate of the impact of “reputation loss” due to the nuclear problem.

Indirect loss and macro-economic loss are useful estimate to support recovery planning while the direct loss estimate is more related with reconstruction of assets. Indirect loss

[13] The reason for this increase is because people want to withdraw money from the bank, and banks need to set high interest rates, as incentives to maintain deposit levels.

suggests the need for additional expenditure to service providers to restore basic services to contribute to economic activity. The analysis of DALA database shows that geological disasters normally cause more direct loss than indirect loss while hydro-meteorological disasters generally cause more indirect loss than direct loss (EC, UN and WB, 2013b). This evidence suggests the need for different approach to the events of different origin.

2.3. Macro-economic impact

In analysing macro-economic impact, it is very important to analyze the impact from supply and demand sides and short and long-term perspective (Table 3, Figure 11). From supply side, decrease of production due to capital loss can be observed as a negative impact in the short term. However, in the long term, replaced new and more productive factories can improve efficiency and produce positive impact. From the demand side, decline of income, asset value, and population can be all observed as negative impacts in the short term. However, reconstruction demand can have a positive impact, especially for depressed economies that lack effective demand. The total impacts can be evaluated as the balance of supply and demand side impacts. A macro-economic model is constructed based on many assumptions reflecting causal relationships that impact both the demand and supply sides.

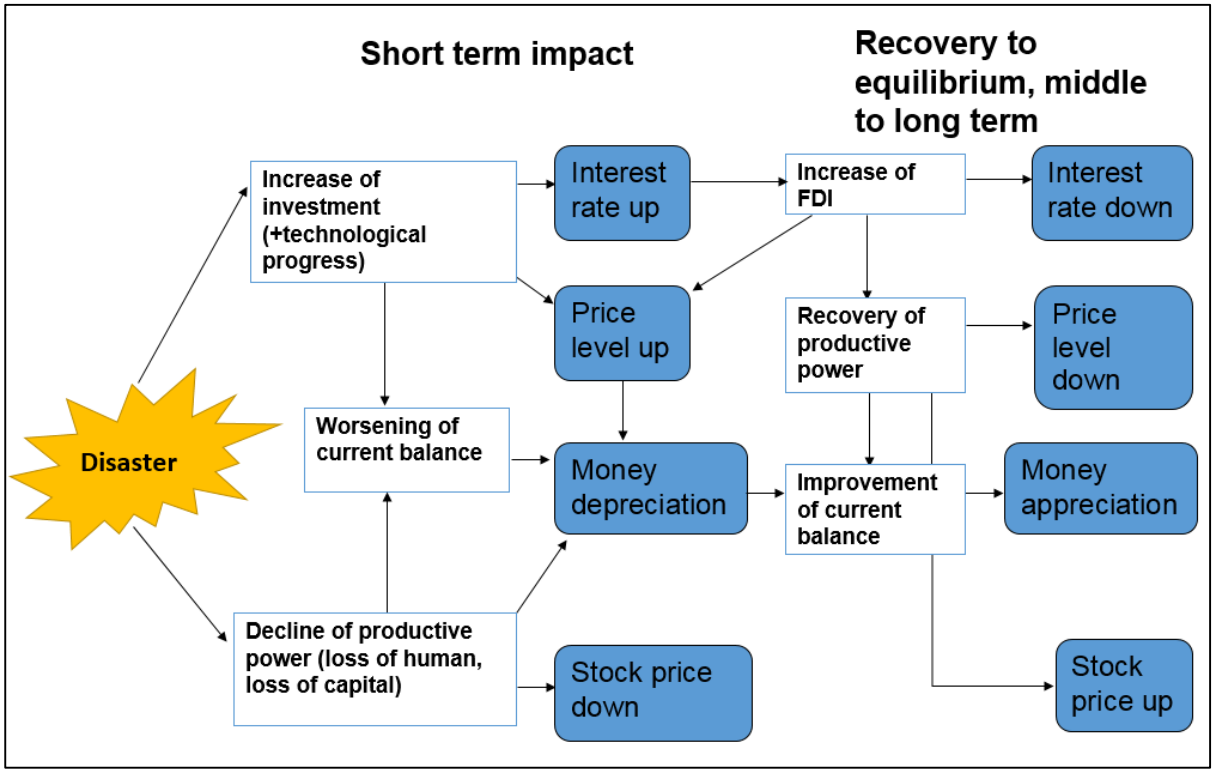
PDNA approach claims that "A distinction must be made of the impact caused by the disaster itself and the subsequent impact of post-disaster activities or interventions aimed at recovery, reconstruction and risk reduction" (EC, UN and WB, 2013b, p.3). This stance will end the debate on whether economic impact of disaster can be positive. Most research highlighting positive economic impact of disaster is measuring the impact of reconstruction activity, which financial resources could have been used for other development activities.

Table 3: Macro-economic impact

		Short Term Impact	Long Term Impact
Supply	Decline of production capacity due to capital loss	Negative	
	Technological progress (*e.g.* replacement of factory)	-	Positive
Demand	Decline of income	Negative	
	Decline of asset value	Negative	
	Population decrease	Negative	Negative
	Reconstruction demand	-	Positive

Source: Author

Figure 11: Example of economic modelling

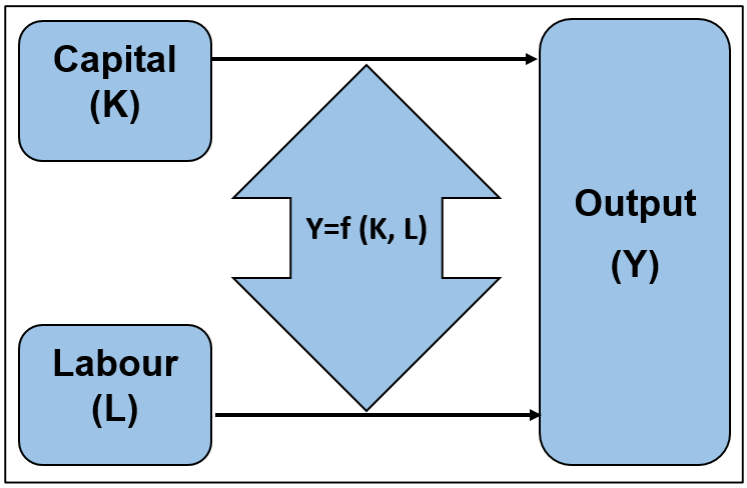


Source: Author

When macro-economic modelling is not available or a more micro-level approach is more practical, a sectoral-based approach might be preferable[14]. The essence of estimating economic impact is in how disasters impact labour and capital --the two most important factors for economic growth (Figure 12). If capital and/or labour decrease, *ceteris paribus,* production will decrease based on the production function. Each sector, or even each company, has a different production function. Those results will constitute GDP estimates (Figure 13). Sectors often assessed are infrastructure, schools, hospitals, energy etc. However, when summarizing them, we need to be careful about double-counting and the inter-relationship between sectors. When each sector is not well coordinated, double-counting often occurs. Inter-relationships between sectors should be checked using an input-output table, if possible. In the process of estimating macro-economic impact, the consistency with national account system should be considered and maximum utilization of data from national account system is also recommended.

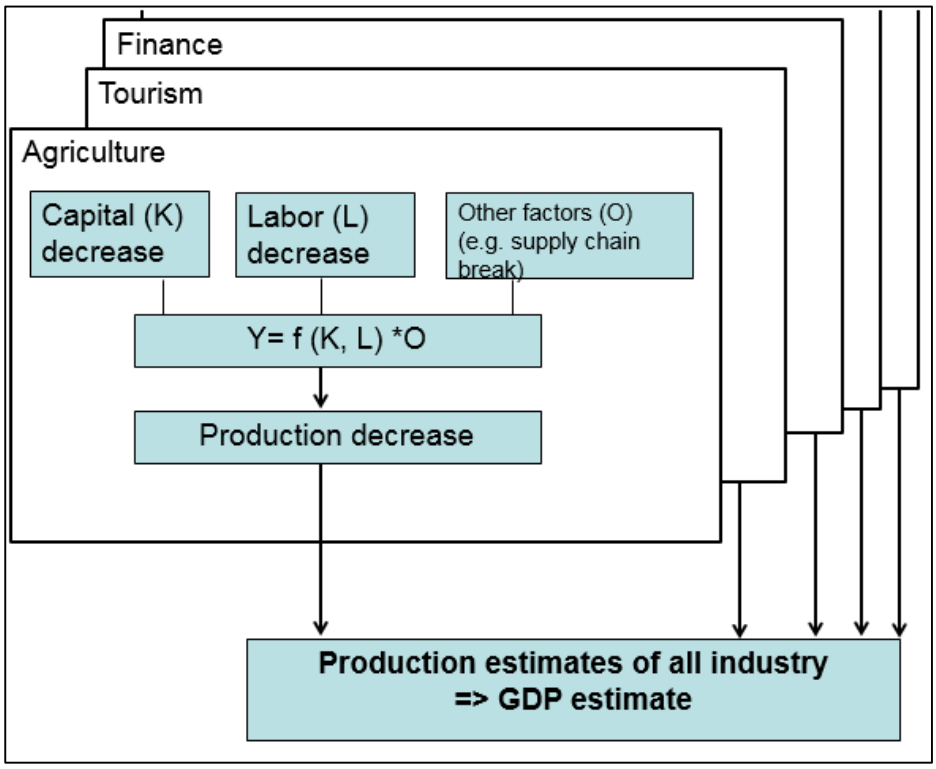
[14] Damage and Loss Assessment (DALA) methodology developed by UN-ECLAC (Economic Commission for Latina America and the Caribbean) and Post Disaster Needs Assessment (PDNA) methodology developed and coordinated by the EC, UN and WB take this sector-based approach (.EC, UN and WB, 2013a, ECLAC 2014)

Figure 12: Production function



Source: Author

Figure 13: Production function by sector



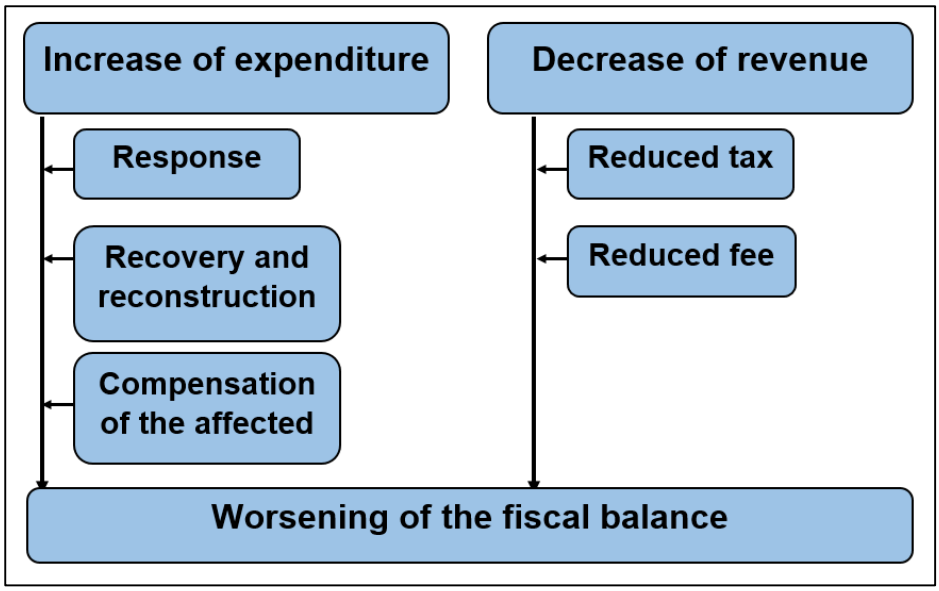
Source: Author

2.4. Impact on public finance

When considering the impact of disasters on public finance, similarly we need to explore the demand and supply sides of public finance. On the demand side, increased need for expenditure in response, recovery and reconstruction are always observed. On the supply

side, decrease of financial resources by reduced tax and fees can be also noted. Therefore, fiscal balances almost always worsen (Figure 14).

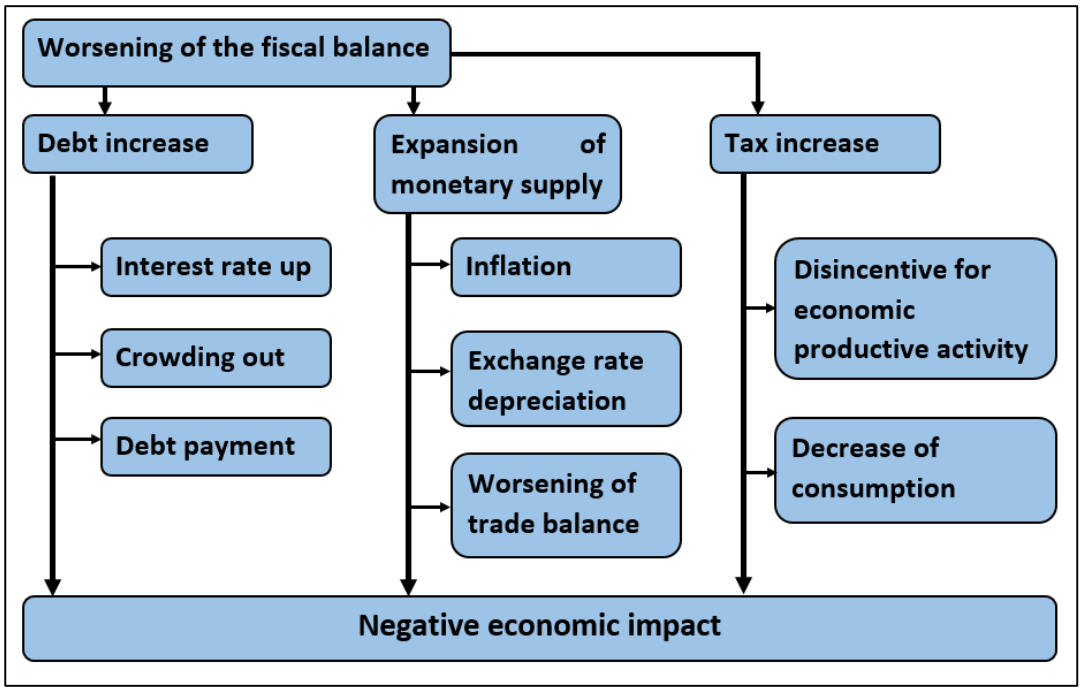
Figure 14: Fiscal impact of disasters



Source: Author

A worsened fiscal balance often has a negative impact on the macro economy. Figure 15 below presents three cases of a negative chain of fiscal impact: debt increase, expansion of monetary supply, tax increase. Whichever option a government takes, it will have a negative impact on macro-economy. IIASA's CATSIM model estimates the impact of public finance on macro-economy.

Figure 15: Relationship between fiscal impact and economic impact

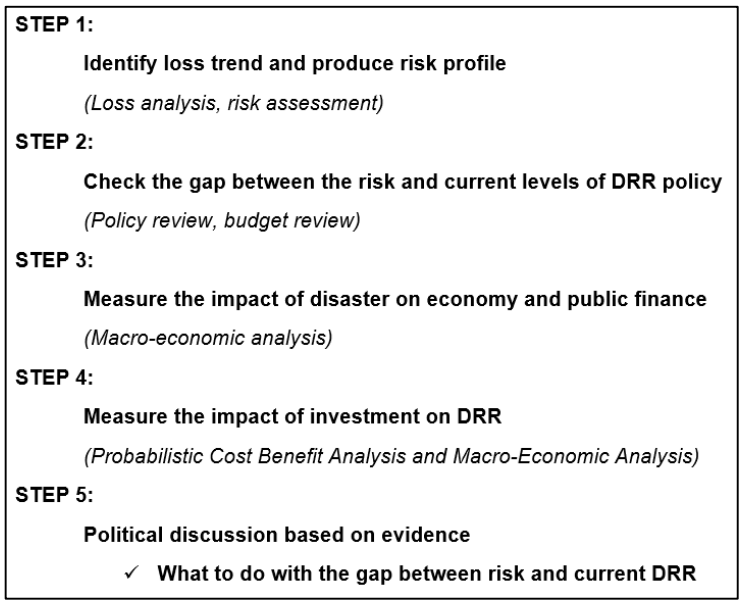


Source: Author

Chapter 3: Streamlined process for evidence based decision making

Given challenges identified in Chapter 1, how to streamline process of evidence based decision making, combining risk and cost information? UNIDR introduced a five-step process (Figure 16). The first step is to identify loss trends and produce risk. Subsequently, the current state of DRR policy, public investment policy and budget is examined to verify the gap between risk and DRR efforts. Expected impact on public finance was examined with more detail using the CATSIM model. Lastly, to examine the degree a DRR policy could mitigate the negative impact of a hazard, probabilistic cost benefit analysis is conducted. These analyses, combined, are expected to provide insights on and facilitate evidence-based decision making for risk-sensitive public investment planning.

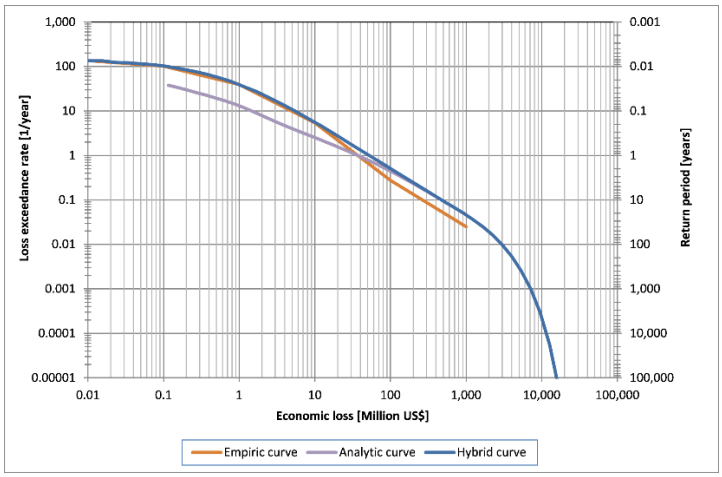
Figure 16: Overall design to support evidence based decision making



Source: Author

Understanding loss and risk in a country is the first step to evidence-based decision making. Loss and risk data present what has historically been lost and what is likely to be lost in future. Both loss and risk information contribute to produce hybrid curves portraying all possible combinations of probability of an event happening and the expected loss (Figure 17) in all risk layers including intensive (low frequency and high loss) and extensive (high frequency and small loss). However, as outlined above, this information alone cannot determine how much should be invested in DRR.

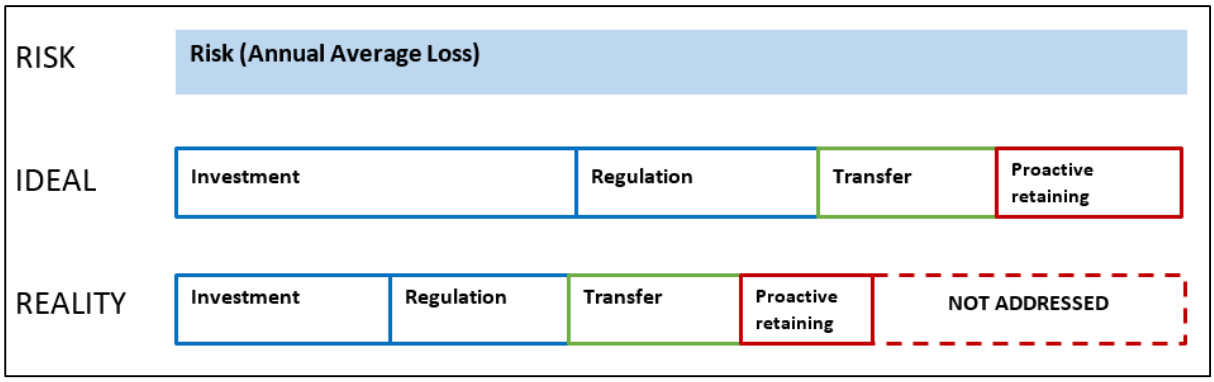
Figure 17: Hybrid loss exceedance curve



Source: UNISDR

Step 2 aims to determine the gap between risk and current levels of DRR policy. An examination of current DRR and investment policies and a comparison between risk levels and DRR investment will provide insights on how much investment in DRR is needed to fill the gap (Figure 18).

Figure 18: Gap identification, drawn from budget and policy analysis



Note: Impact of investment usually lasts for certain project periods and therefore reduces AAL the following year.

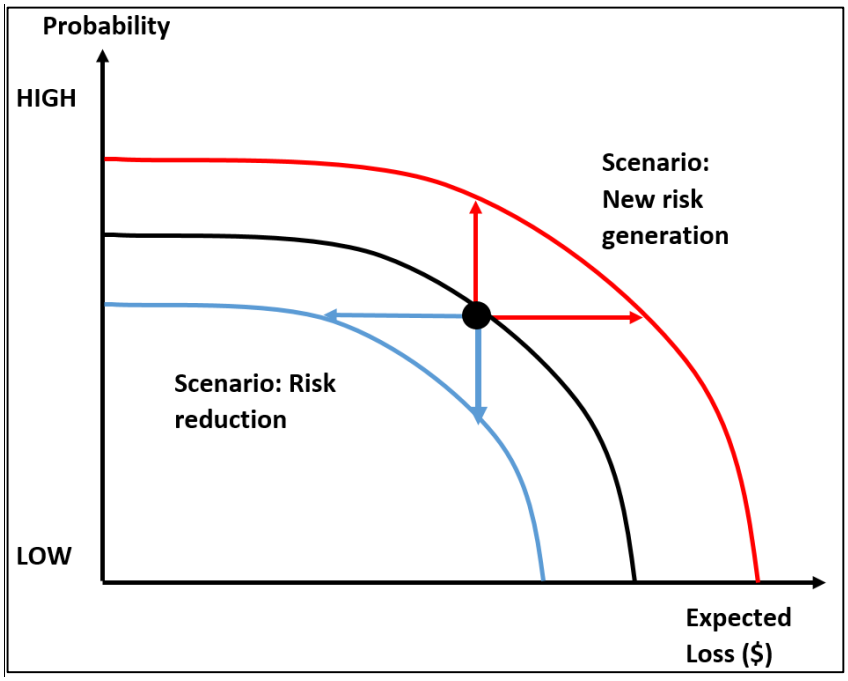
Source: Author

Step 3 measures the impact of disaster on economy and public finance, to further verify the expected impact of disasters on a country. The focus is not necessarily limited to direct loss and indirect loss, and macro-economic impacts are considered to a certain extent depending on the model. In the Indian Ocean Commission (IOC) region, the CATSIM model developed by IIASA and taking indirect loss to a certain degree was used to measure the impact of disasters on public finance.

Step 4 aims to measure the impact of policy on DRR to showcase the cost-effectiveness of DRR investment. Some policies are more cost efficient than others, meaning that such policies reduce risk more with less investment. Cost benefit analysis is implemented in this

step. DRR policy can shift the risk curve inward (i.e. lower frequency of event happening and/or decrease of expected loss) (Figure 19).

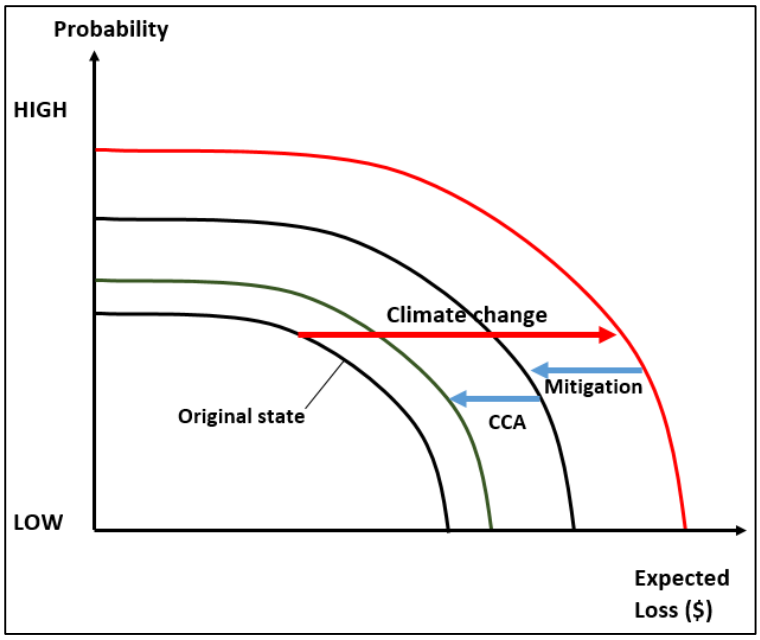
Figure 19: Shift of loss exceedance curve by DRR investment (blue) and new risk generation (red)



Source: Author

Climate change will also influence loss exceedance curve. However, investment in mitigation and adaptation can reduce the total cost. This is graphically expressed in Figure 20. Climate change will shift the curve upward while mitigation and CCA will work to shift the curve to original position. Climate change impact can be integrated into economic analysis of disaster risk applying the same methodological concept when disaster and climate change risk assessment are integrated.

Figure 20: Climate change impact

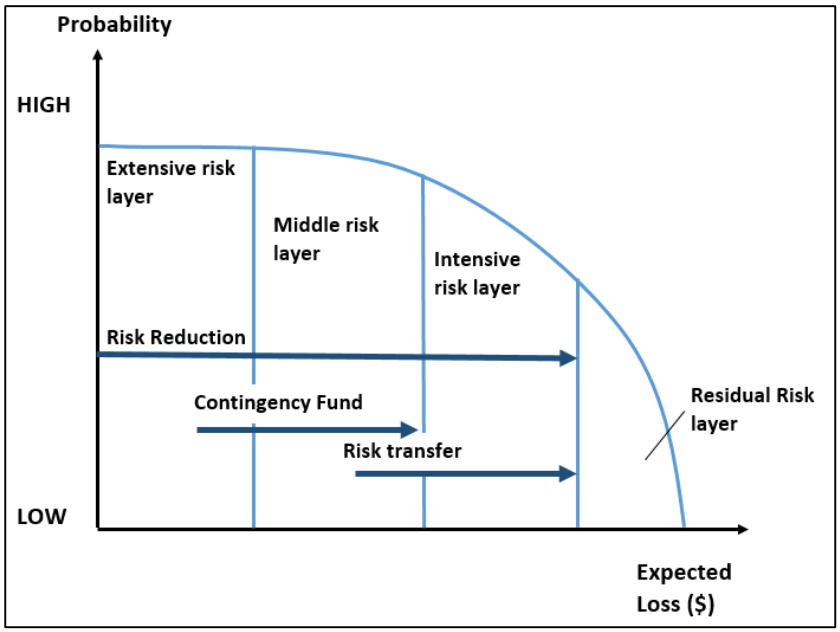


Source: Author

These analyses, in combination, suggest that a risk-layered approach is crucial to manage disaster risk (Figure 21). In the extensive risk layer (high probability and low expected loss), investment for risk reduction is basically the most cost-efficient. Some measures for risk reduction (*e.g.* emergency drills as preparedness) can be cost-efficient (and efforts should be devoted to) all risk layers. However, in the intensive layer (low probability and high expected loss), risk reduction is often an unaffordable and prohibitive option.

Regarding risk financing, contingency funds will be effective in middle risk layers. However, to prepare for intensive risk, risk transfer schemes, such as insurance, would be more cost-efficient. It is important to note that DRR efforts bring risk premiums down and make insurance more affordable. DRR investment and risk financing mechanisms, therefore, should be considered in synergy to identify the optimum mix in public finance policy.

Figure 21: Risk layered approach



Source: Author

Chapter 4: Loss, Risk and Economic Approach

4.1. Disaster Loss

The small-to-medium scale disasters are rarely registered in the international disaster databases, because their effects are considered to be less relevant from a macroeconomic perspective. However, such disasters usually impact the livelihoods of poor people, perpetuating their level of poverty and human insecurity, and eroding government budgets. They exacerbate local level sustainability and pose serious problems for the development of a country as a whole.

The analysis of disasters at all scales allows the identification of aggregated effects over time, regional areas and hazards targeted as high priority, and impacts on housing and livelihoods of local communities.

Loss information contributes to comprehensive risk assessment by providing an estimate of the risk of high frequency but small-scale risk. It also gives information on non-modelled hazards. Furthermore, it can be utilized as an input to economic analysis, for example cost benefit and economic impact analysis.

The key concepts in the loss data analysis which are important for DRR practitioners and financial planners are:

Intensive disasters: high-severity, mid to low frequency disasters, mainly but not exclusively associated with high profile fast-onset hazards. UNISDR classifies disasters as intensive when at least 30 people are killed, and/or a minimum of 600 houses are destroyed.

Extensive disasters: low severity, high frequency disasters, mainly but not exclusively associated with highly localized and often slower-onset hazards. All disasters with less than 30 people killed, and/or less than 600 houses destroyed, are classified as “extensive”. There is no minimum number of deaths or damaged houses to be considered extensive[15].

The distinction between intensive and extensive disasters is important because they have different impacts on socio-economy and therefore different policy implications.

In national disaster loss database on which UNISDR has been long supporting countries, the data are registered by sub-national region, which allows more detailed examination of loss distribution in the country. The current loss database basically registers direct physical loss data only. Indirect and socio-economic loss data are not registered in principle. Even if registered, it needs to be analysed with caution due to ambiguity of definitions.

[15] The most well-known international disaster loss database called EM-DAT registers disasters for a minimum of 10 deaths (see http://www.emdat.be/criteria-and-definition).

The disaster loss database takes into account the different disaster types and registers a series of indicators to classify loss such as:

- Damaged houses;
- Destroyed houses;
- Basic human loss (mortality, injured, affected).

The loss data were assigned monetary value by applying the methodology developed by UNISDR, which allows comparison across countries[16]. The disaster data not directly associated with natural hazards (*e.g.* traffic accident, marine accident, epidemic) are registered in the database but excluded for global analysis implemented for GAR[17].

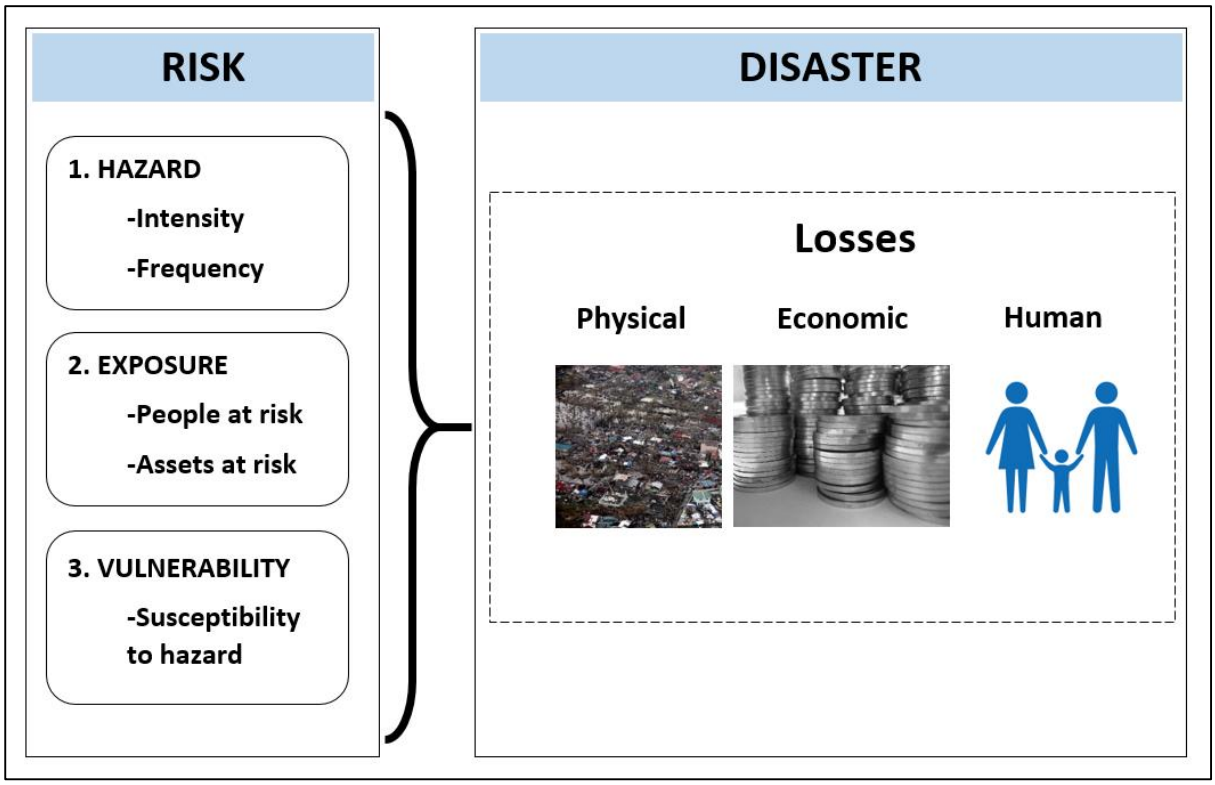
4.2. Disaster Risk

Probabilistic risk assessment differs from a "deterministic" risk assessment in that it attributes a probability to hazardous events. Probability indicates the likelihood of the event to occur during a given year; it is estimated using frequency and is expressed in terms of "return period" or "loss exceedance rate". Risk is expressed as a combination of the probability of the event occurring and the expected loss when such an event occurs.

In probabilistic risk assessment, risk is composed of three factors: hazard, exposure and vulnerability (Figure 22). **Hazard** data are basically calculated from a set of stochastic. **Exposure** data measures the degree to which people and assets will be at risk when a hazard hits, and often consists of inventories of buildings, population and infrastructure. **Vulnerability** indicates the susceptibility of exposed population or assets to suffer damages and loss. This is important because hazard affects exposed element in different ways. For example, a certain wind speed affects a wooden house more heavily than a concrete building. In other words, vulnerability data shows the relationship between hazard intensity and the expected values of damage.

[16] For methodology of assigning monetary value to loss, please see Annex 2
[17] Fire is included in the analysis, though.

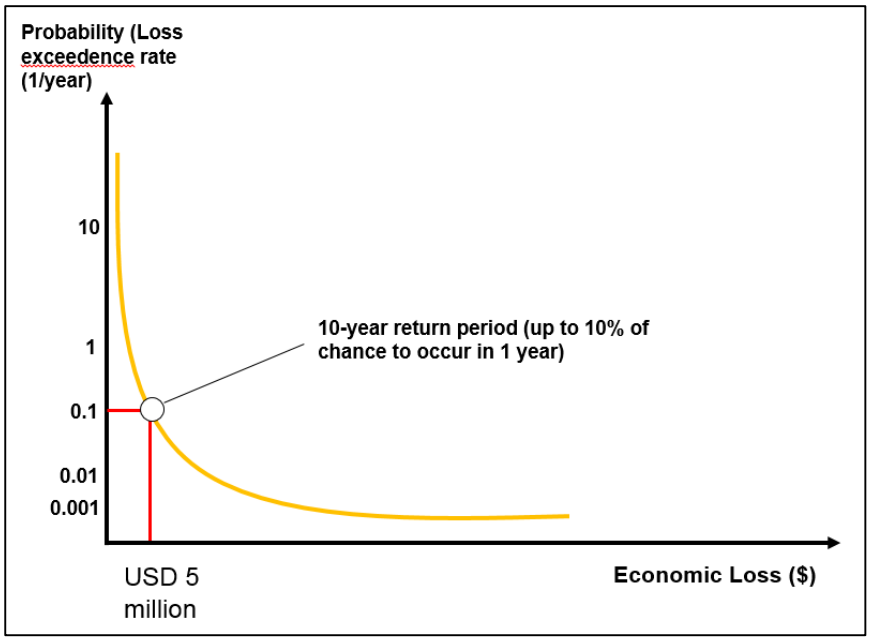
Figure 22: Key concepts of probabilistic risk assessment



Source: Author

Based on probabilistic risk assessment, a loss exceedance curve for each hazard is produced (Figure 23). The curve shows the relationship between each value of the losses and the likelihood (probability) of having such loss during one year. This curve will enable the scale estimate of extensive and intensive risks and opens avenue to risk- layer based approach.

Figure 23: Loss exceedance curve



Source: Author

This curve also enables the calculation of important national risk metrics called Annual Average Loss (AAL) and Probable Maximum Loss (PML). The AAL is basically the combination of all the potential losses that can occur every year due to a particular hazard, weighted according to their likelihood of occurrence. Simply said, the AAL is the loss that can be expected every year, regardless of whether it actually occurs or not. It gives insights into investment planning because the value shows how much risk should be reduced or transferred annually to prepare for all layers of risk. The PML is the loss associated to a specific, usually long return period. PML is a loss that is not frequent, therefore usually high, but still possible. PML is a useful reference value to draft a worst-case scenario and prepare for intensive events.

Probabilistic risk assessment can be utilized for diverse policy areas, from emergency management planning to land use planning and financial and investment planning. However, caution should be given to the limitation caused by scarce data that feed into probabilistic risk assessment, and simplified modelling of complex phenomena.

The challenge is that the current historic loss databases have time series that are often too short to produce high quality risk assessments. Achieving more detailed risk assessments requires continuity on capacity building processes, improvement of data/information and commitment of institutions, technical personnel and decision makers.

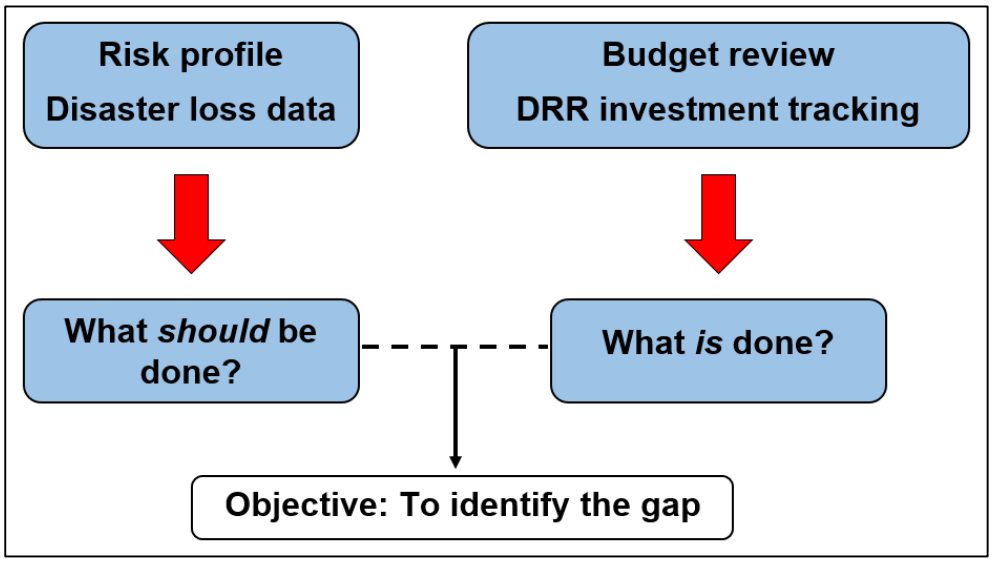
The probabilistic risk assessment based on global data does not have high resolution. Therefore it cannot be utilized for detailed cost benefit analysis, local planning and insurance premium calculation. The result is currently often limited to the assessment of

physical assets due to data availability. However, the result can be very useful to raise awareness of disaster risk and initiate dialogues on incorporating DRM into the country's public investment planning.

4.3. DRR/DRM Budget Monitoring

The objective of the Risk-Sensitive Budget Review (hereafter called budget review) is to explore the gap between risk level and DRR investment (Figure 24). The budget review aims to clarify what has already been done to reduce risk. It also checks the balance between disaster risk reduction/mitigation, preparedness, response and reconstruction. Understanding the costs of response and reconstruction is an opportunity to re-consider the importance of DRR investment.

Figure 24: Objective of budget review



Source: Author

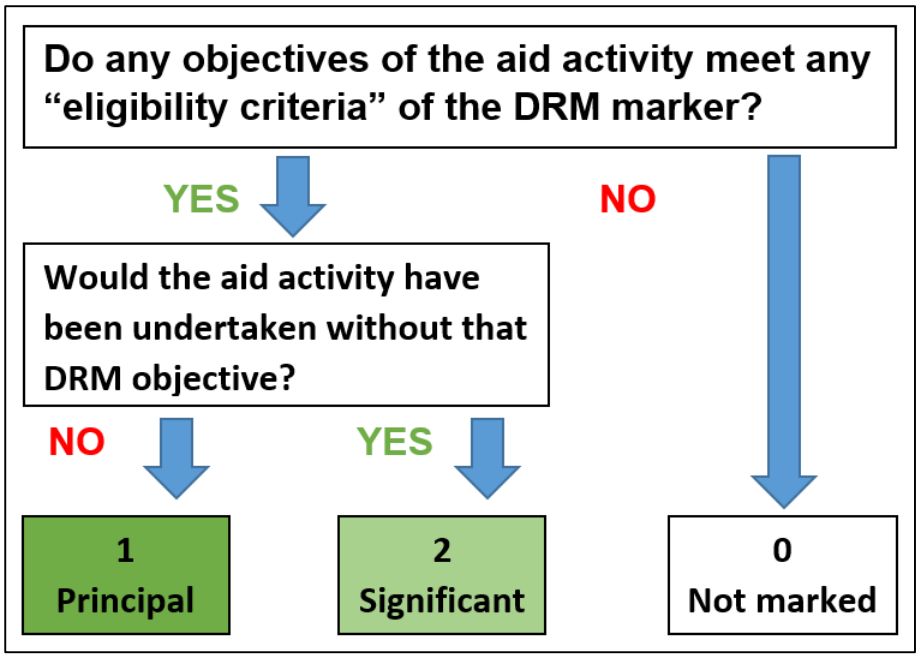
Budget review is expected to bring about improved efficiency and accountability. Systematic budget analysis requires the cooperation of all stakeholders, thereby improving budget coordination and leading to a more effective use of financial resources. Budget review clarifies the current level of DRR activities and enables a thorough analysis of the gap to explain how much funding is required for further DRR implementation.

The DRM marker allows (a) capturing "embedded" investment by distinguishing between stand-alone versus mainstreamed DRR investment (*e.g.* retrofitting in school renovation program), (b) strengthening the ability to analyse, measure and report activities in DRR, and (c) improving regulatory conditions to facilitate tracking of budgetary allocations and expenditure in DRR and even (d) tracking pre-disaster (DRR) versus post-disaster (relief/reconstruction) investments, with simple addition of a rule.

The first eligibility criterion for an element to be marked is that DRM must be included in "the programme objectives" (Figure 25). The DRM element is defined as any "strategy, policy, effort or measure that improves the understanding of disaster risk, fosters disaster risk reduction or transfer, and promotes continuous improvement in disaster preparedness, response and recovery practices" (OECD, 2014[18]). If a budgeted activity meets any of those elements, it becomes "marked" as DRM.

The second level criterion is to examine how important the DRM objective is to drive implementation of the activity. The exact question is "would the aid activity have been undertaken without that DRR objective?" If the answer is affirmative, then it is marked as "significant" and if negative, it is marked as "principal"[19].

Figure 25: DRM Marker process



Source: OECD (2014)

By applying this DRM Marker methodology across time and space, it is expected that data homogeneity and comparability will be assured. Furthermore, especially by introducing the "significant" category, incentives to mainstream DRM in development activities become visible. In the past, DRM has conventionally been delivered through stand-alone projects. However with progress achieved in implementing the HFA, more governments have been recognizing development mechanisms and instruments as important to reduce risks and strengthen resilience. It becomes more important to monitor a wide number of DRR related

[18] OECD, 2014. A Proposal to Establish a Policy Marker for Disaster Risk Management (DRM) in the OECD DAC Creditor Reporting System (CRS). http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DCD/DAC/STAT%282014%293&docLanguage=En

[19] Still certain level of ambiguity remains. For example, distinction between principal and significant is not clear and might require subjective judgment. However this is a notable progress for systematic monitoring.

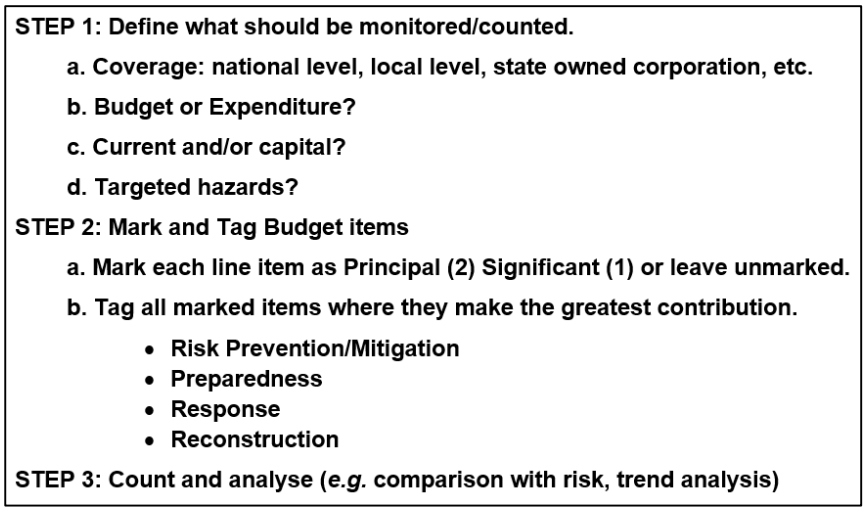
projects and investments embedded across different sectors either at central or local government levels in order to provide comprehensive overview of DRR policies.

In spite of such benefits, it is necessary to clarify the limitations of the DRM marker. The DRM marker cannot quantify the exact amount of DRM activity and only provides a best estimate. It is often impossible to extract a DRM element from overall programmes/projects, therefore overall programme/project budget are registered, leading to over-estimation of DRM budget. Furthermore, because the objective of the activity is the only criteria used to "mark" the budget item as DRM, if policy makers are unaware of DRM benefits, the activity will never be "marked". While it is clear to most that flood control and early warning are DRR policies, policy makers may not naturally recognize the contributions to reduce disaster vulnerability made, for example, by poverty reduction and ecosystem restoration. In this regard, a DRM Marker system may miss DRR elements embedded in all development activities. The DRR activities, which must have DRR elements but are not recognized as DRR, might underline an awareness gap of policy makers in the given sector.

In applying the methodology of the DRM Marker in a risk-sensitive budget review, the following three steps were taken (Figure 26, Annex A-1 for more details). The first step is to define what should be monitored, *i.e.* the scope of the budget review. In the DRM Marker, the target was ODA data stored in OECD Credit Reporting System. However, in budget review, the scope of review needs to be clarified in the given context.

Then, the second step is to mark budget line items as significant and principal using DRM Marker criteria, count the budget in each item and sum up the value. In this step, sub-categories based on DRM elements is added to the original DRM Marker to show the balance between DRR (including prevention and preparedness) and disaster management (response and recovery). The last step aims to assess the resulting gap by comparing budget with risk. This analysis enables the identification of lessons to feed into the following year's budget.

Figure 26: Risk sensitive budget review process



Source: Author

In defining the scope of budget review, the following four aspects need to be clarified. The first is the coverage of monitored entities. Public sector consists of general government and state corporations. General government consists of central and sub-national governments. In developing countries, donor finance is also a non-negligible component of budget.

The second is whether to monitor budget or expenditure. In the context of developing countries, very often expenditure is far below the budget especially in capital investment due to its disposal of donor relationship.

The third point is whether to monitor current or capital budget/expenditure. Most infrastructures are classified under capital budget/expenditure, with sometimes multi-year budget commitment. Considering the importance of DRR in public investment, monitoring capital budget/expenditure is necessary. At the same time, current budget/expenditure includes important items such as expenses for training and early warning. Ideally, both should be monitored.

Lastly, there is often no disagreement in including activities targeted at geological (*e.g.* earthquake, tsunami, landslide), meteorological (*e.g.* cyclone, heat wave) and hydrological hazards (*e.g.* flood, landslide, drought). However, depending on countries context, epidemics and other hazards may also be included.

In Step 2, while the marking process based on DRM Marker methodology highlights investments in DRM in monetary terms, a parallel “tagging” process categorizes each marked activity as one of four components of DRM: prevention/mitigation, preparedness,

response and reconstruction. Tagging is most easily represented as percentages in each category, the four categories summing to 100% of marked elements[20].

When each marked item is "tagged" in this way, we can start to understand how investments are distributed before and after a disaster. As countries can demonstrate more and more investment on the side of DRR (including prevention and preparedness), they can prove that they are accountable for risk reduction. As the value rises in components tagged as DRR, it will normally become evident that less funding is required in the post-disaster phase (response and reconstruction).

4.4. Macro-Economic and Financial Analysis

Generally regarded as the 'insurer of last resort,' national governments assume primary responsibility in providing response, recovery and reconstruction resources in times of disasters (Mechler, 2004). Governments play an important role in the post-disaster period, conducting timely and accurate damage assessments, devising rehabilitation plans, and financing and executing rehabilitation projects. Reconstruction is often very costly. Appropriate assessment of existing risk and contingency liability, and reducing risk and preparing for fiscal contingency as much as feasible before events occur is therefore of paramount importance for government's strategic decision-making, planning and resource allocation.

To respond to such needs in 2006 the International Institute for Applied Systems Analysis (IIASA) invented the "CATSIM" (Catastrophe Simulation), an interactive simulation tool to build capacity of policy makers to estimate and reduce public sector financial vulnerability. The CATSIM model consists of five-steps (See Table 4):

Table 4: 5 Step CATSIM Modules

Steps	Tasks
1. Direct Risk Assessment	To estimate **economic asset at risk and return periods** of natural hazards.
2. Fiscal Resilience Assessment	To assess the country's current **fiscal resources availability and preparedness**
3. Fiscal and Economic Vulnerability	To estimate a '**fiscal resources gap year**' combining step 1 & 2
4. Economic impact Assessment	To estimate **indirect impacts** in terms of potential risks to macroeconomic growth

[20] In reality, the four components overlap. For example, some elements of reconstruction may be devoted to future disaster risk prevention/mitigation. However, for simplification, items are classified and tagged for four components based on their greatest contribution.

5. Risk Management/Reduction Option Assessment	To evaluate the risk management options

Source: Author

In **the first step**, direct risk assessment is performed integrating information regarding the probability of natural hazard occurrence, the level of exposure and physical vulnerability (see Hochrainer-Stigler, 2012 for details). Direct risk is expressed in terms of economic value of asset at risk and return periods of natural hazards. The government is generally not responsible to provide all reconstruction needs because private households and businesses will assume responsibility of their own reconstruction needs. It is assumed that the governments assume the following responsibility in case of a disaster:

- The government will be responsible to finance reconstruction of public assets, including roads, bridges, schools and hospitals, etc. (Explicit liability).
- The government will extend partial support for private relief and recovery including provision of support to the poor (Implicit liability).

In **the second step**, public finance preparedness and vulnerability are determined by the national government's current ability to raise internal and external funds for disaster response and reconstruction ex-ante or ex-post. The government's ability to raise necessary fiscal means are typically constrained by a number of economic and institutional factors such as the country's current level of public deficit and cumulative debt, capacity to raise tax revenue and its ability to borrow from domestic and international credit markets.The below are some of the ways in which governments typically raise fund to finance reconstruction:

Ex-Ante Resources

- Preparing contingency budget line
- Establishing reserve fund
- Arranging contingent credit
- Obtaining insurance for public infrastructure
- Issuing catastrophe bonds

Ex-Post Resources

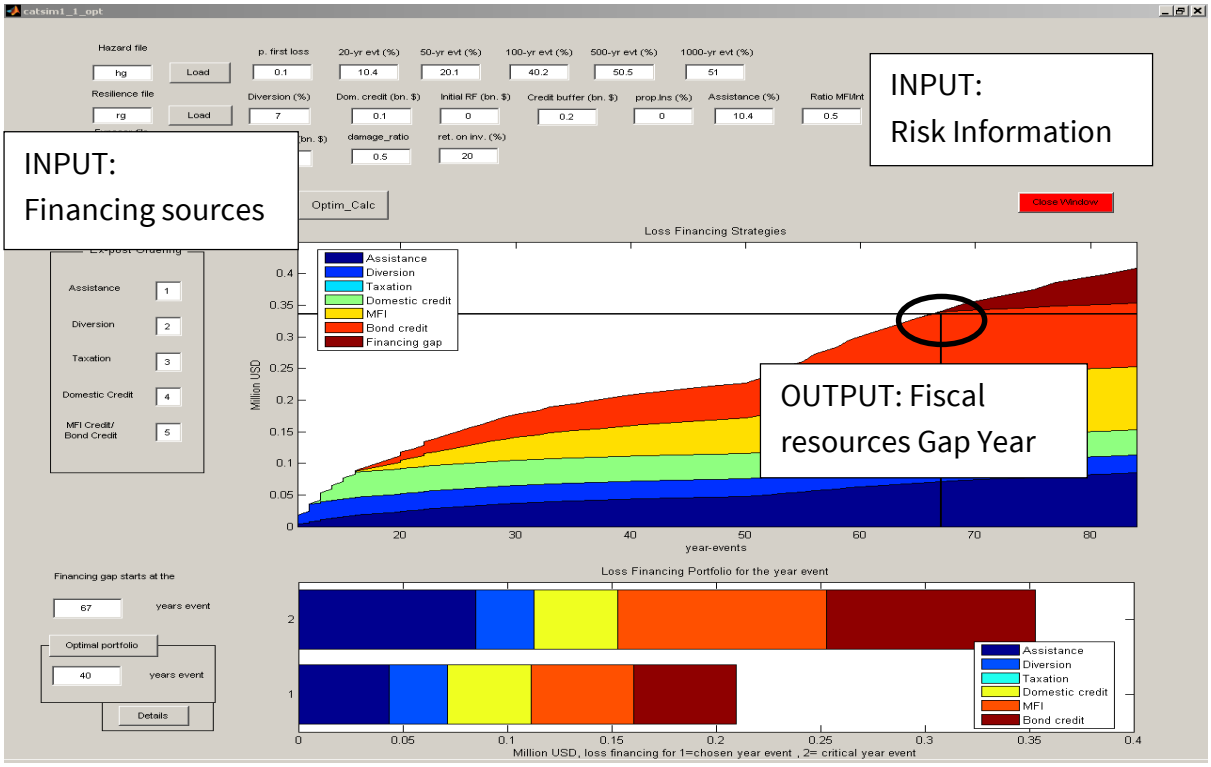
- Diverting funds from other budget expenditures
- Raising additional tax
- Obtaining credits from central bank
- Borrowing and issuing domestic bonds
- Receiving international assistance
- Borrowing from multilateral finance institutions
- Borrowing and issuing bonds in international market

In **the third step**, the government's current level of public finance preparedness is evaluated against the disaster risk. The model quantifies the notion of fiscal 'resource gap year'—*i.e.* the return period at which the national government's current level of fiscal preparedness will be insufficient against the risk it faces.

Combining direct risk and fiscal resources availability information obtained in previous steps, this section estimates the governments' potential fiscal resources gap year — the return period at which the government will face difficulty in raising sufficient funds for reconstruction (Figure 27).

While the concept of 'fiscal resources gap' illustrates the snapshot estimate of the country's resource availability, it is important to note that a large proportion of resources that will be used to meet this one-time disaster event is loan-based, suggesting that there will be a longer-term cost of repayment of these loans. While the precise fiscal and macroeconomic implications of such longer-term impacts must be analysed in a dynamic CATSIM framework, it is important to keep in mind that there are a number of costs associated with each option. In particular, the opportunity cost of diverting resources away from other development projects must be weighed carefully with the benefit of resources spent on disaster reconstruction and recovery.

Figure 27: Display of results of fiscal resources gap year



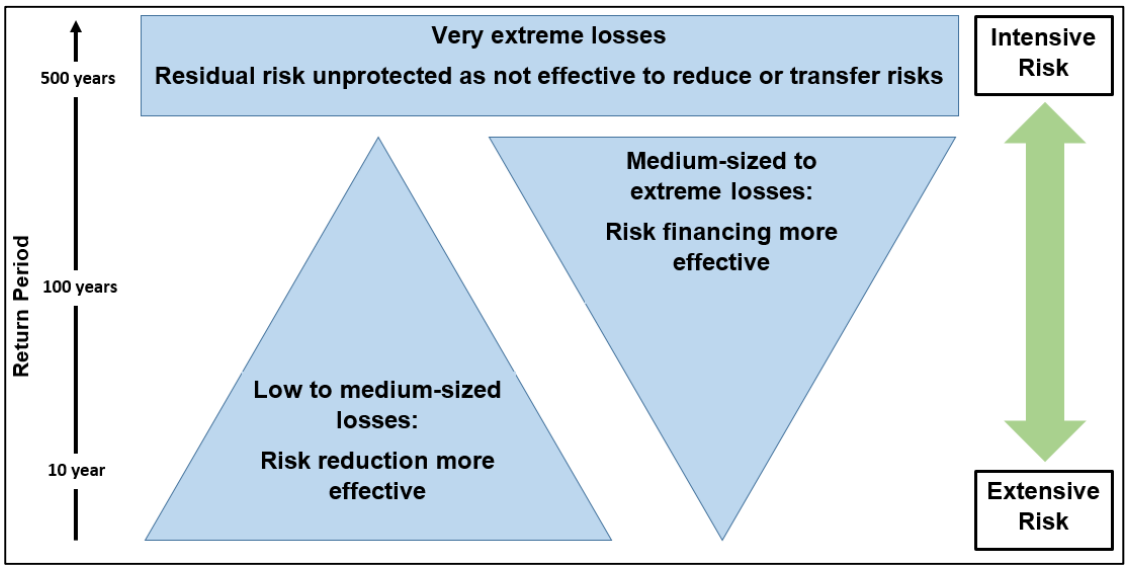
Source: Author based on inputs from IIASA.

The potential occurrence of a fiscal resource gap and its longer-term growth implications are appraised through macroeconomic modelling in **step four**. Using the Monte-Carlo simulation approach, the model quantifies probabilistic macroeconomic growth trajectories based on the existing degrees of natural disaster risk and public finance preparedness.

Finally, a range of risk management options is evaluated against the costs and benefits in **the fifth and final step**. Governments may adopt a number of ex-ante and ex-post measures to prepare for the disaster risk, including structural mitigation, contingency fund, catastrophe insurance, catastrophe bonds, and contingent credit arrangements.

By examining of CATSIM simulation results, the government is encouraged to take a 'risk layered management' approach where resources are allocated based on the varying levels of risk facing the country, with a priority given to reducing existing risk and preventing the creation of new risks in the extensive risk layer (Figure 28). The CATSIM analysis can illustrate the need for improved management of disaster risk.

Figure 28: Risk layering approach



Source: Author

4.5. Cost-Benefit Analysis

Cost benefit analysis (CBA) is an established tool in economics. This analysis can be used for both sectorial and project analysis. Many countries already adopt cost benefit analysis as a requirement of large-scale public investment projects. Although imperfect, CBA is one of the most important tools for financial decision making around the world.

There are two important general objectives in CBA. One is to improve efficiency of the project selection, because CBA facilitates the rational comparison of available options. The second objective is to improve accountability. In democratized countries, it is increasingly important that government explains why a given project is selected. This will also contribute to reduce corruption and in some cases, lessen inappropriate interference of politicians. In this regard, it is important to disclose the methodology and the original data for the analysis.

We can apply this methodology into public investment projects that contributes to DRR. However, there is a unique concern to be considered. For usual projects, the benefits can be tangible and visible. For example, in the case of a public transportation project, we can estimate the number of passengers and total fees paid by passengers. On the other hand, in a DRR project, the main benefit is avoided loss. In this case, we need to somehow estimate the benefit relating with an event not occurring. This introduces technical difficulty in DRR cost benefit analysis.

CBA can measure the impact of policy on DRR at sectorial or project level. While a budget review and macro-model provide overviews of the country and help raise awareness of the effectiveness of DRR investment, CBA can provide more detailed insight for decision-making.

Depending on precise objectives and the resolution of available data, different levels of CBA are possible (Table 5). If the objective is an informational study to provide overview over costs and benefits, resource requirements (*e.g.* data, time and human capacity) are relatively not so demanding. However, if the objective is project appraisal, the resource requirements can be enormous in terms of financial and time aspects.

Table 5: Cost benefit analysis at different scopes

Informational study	Provide a broad overview over costs and benefits	+
Pre-project appraisal	Singling out most effective measures	++
Project appraisal	Detailed evaluation of project	+++
Ex-post evaluation	Evaluation of project after completion	++

Source: Mechler (2008)

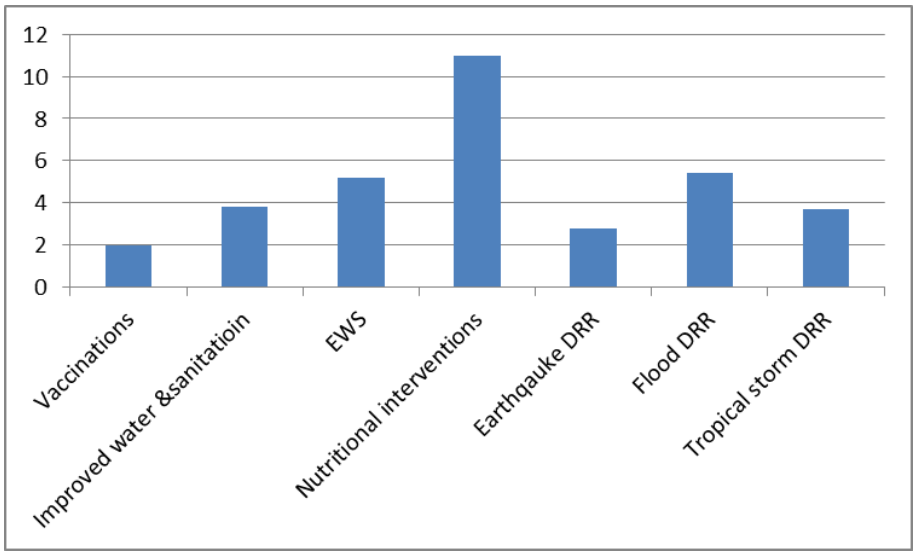
CBA is based on the following simple principle: If **the benefit-to-cost (B/C) ratio** (benefit divided by cost) is greater than one, invest. Comparing multiple projects, the higher the B/C ratio, the more preferable the project. Also, where the **net present value (NPV)** (benefit minus cost) is positive, invest. The larger the NPV, the more preferable the project.

However, there are complex methodological problems that survive to date with no consensus of even modern economists (*e.g.* how to set the discount rate? How to assign monetary value to immeasurable, intangible items?). Furthermore, there are concerns regarding who conducts the CBA in order to retain objectiveness and accountability. Administrative costs for implementing CBA are also a concern for government.

The strength of the CBA is its ability to compare several options. For example, in reducing flood loss, the practical issue that financially constrained governments often face is how to choose between competing options such as Early Warning Systems (EWS), evacuation planning, sea wall construction, building retrofitting etc. Or in countries that face several hazards, questions are whether to prioritize risk reduction for earthquakes, floods, or cyclones, etc. CBA is a useful tool to provide insight on such prioritization issues.

Figure **29** summarizes examples of CBA to DRR policy implemented in several studies. We need to interpret the figure with caution because it is based on several studies and different contexts, however the interesting point is that in all of the featured projects benefit exceeds cost.

Figure 29: Benefit to cost ratio of DRR policies



Source: Wethli 2013 cited by the World Bank

In DRR projects, probabilistic CBA should be applied. The most important difference between probabilistic and non-probabilistic CBA is that the former accounts for the probabilistic benefits of risk reduction. While non-probabilistic CBA answers the question "what is the cost and benefit of sea wall construction *if a cyclone of a 50-year return period occurs*?" probabilistic CBA answers the question "what is the cost and benefit of sea wall construction *given that cyclones of different sizes occur stochastically with different return*

periods?". Obviously, the results of probabilistic CBA would be more appropriate for DRR projects. The technique to estimate/quantify probabilistic benefits due to DRR can be also applied in projects which side benefits are disaster risk reduction (e.g. poverty reduction). Otherwise unattractive projects can be worth investment if DRR benefits are properly added in total benefits.

Probabilistic cost benefit analysis based on probabilistic risk assessment (forward looking probabilistic CBA) has been applied in several cases. When and where probabilistic risk assessment has not developed well, economists use historic disaster loss data (backward-looking probabilistic CBA) (Table 6). Now that more countries have risk profiles, more accurate forward-looking benefit estimation is increasingly possible.

Table 6: Forward-looking and backward-looking assessment

Type of assessment	Methodology	Data requirements	Cost and applicability
Forward looking assessment (*future risk* based)	Estimate risk as a function of hazard, exposure and vulnerability	Local and asset specific data on hazard, exposure and vulnerability	More accurate, but time and data intensive
Backward looking assessment (*past loss* based)	Use past losses as manifestations of past risk, then update to current risk	Data on past events and information on changes in hazard exposure and vulnerability Note: At least four credible data points of past loss are required	Rougher estimate, but more realistic for developing country contexts

Source: Mechler 2005, underlined by UNISDR.

CBA generally gets through five steps (Figure 30). CBA starts with setting project alternatives (**Step 1**). For example, when constructing dykes against flood, the government must choose the strength: how resilient should the dyke be? When planning dam building for river management, the government might need to decide between investing in two small dams or one big dam. It is also sometimes needed to compare investment and non-investment.

Step 2 is to estimate the benefit of policy. This is the most difficult step for DRR projects that will be explained below. **Step 3** is to calculate benefit to cost ratio or/and net present value. Once benefit is defined and estimated, this is very simple. **Step 4** is to carry out a sensitivity analysis to consider the possible variation in results due to the uncertainty of input variables (*e.g.* inflation costs).

Step 5 is distributional, or stakeholder analysis. CBA aims to measure the impact of a project on the society. Driven by strong economic assumption that the people who benefit will compensate for the loss to those who carry costs (Kaldor-Hicks Criterion), CBA does not consider distributional effects. However, reality is different. In making policy, distributional analysis is important to define stakeholders and care for those who may be negatively

impacted. Therefore, in some cases, this complements the CBA. When those who benefit and those who pay for a project cost (including explicit and implicit) are self-evident, the government may be able to quantify the distributional impact. When it is not clear, qualitative analysis is implemented.

Figure 30: 5 steps of CBA

STEP 1: Consider project alternatives

STEP 2: Expect the benefit of policy (what are the expected benefits)?

STEP 3: Calculate Benefit to Cost Ratio (and/or Net Present Value)

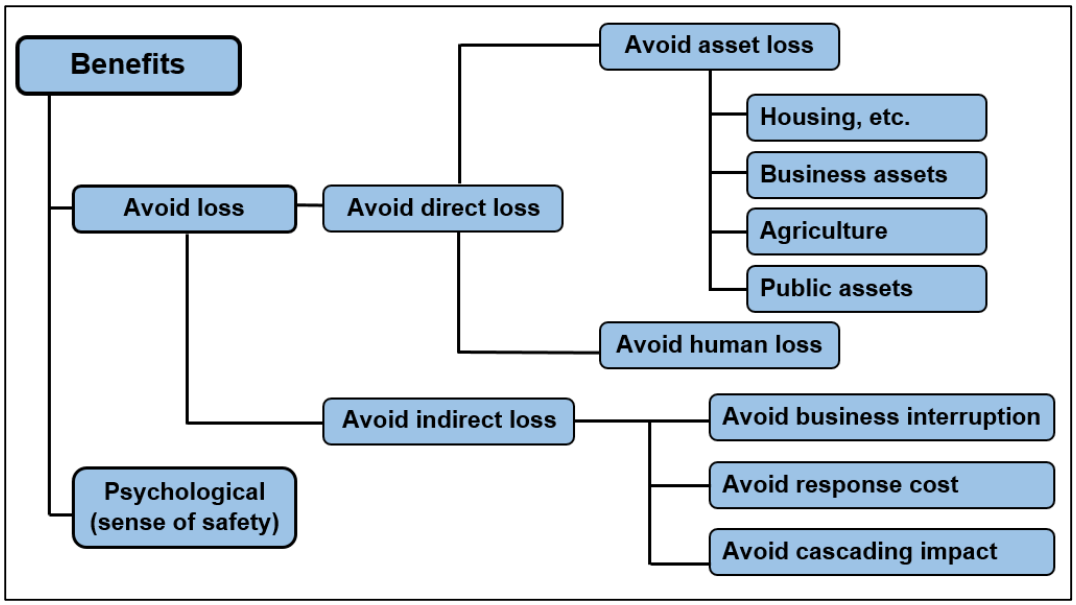
STEP 4: Sensitivity Analysis

STEP 5: Distributional Analysis, Stakeholder Analysis

Source: Author

The expected benefits from DRR investments are diverse. These might include avoided direct damage or loss to physical assets, avoided indirect loss (*e.g.* avoided business interruption), and even purely psychological benefits *(e.g.* sense of safety). Although listing benefits in a systematic way is important, we are not necessarily able to estimate or calculate all of the listed benefits (Figure 31).

Figure 31: Expected benefits from DRR investment



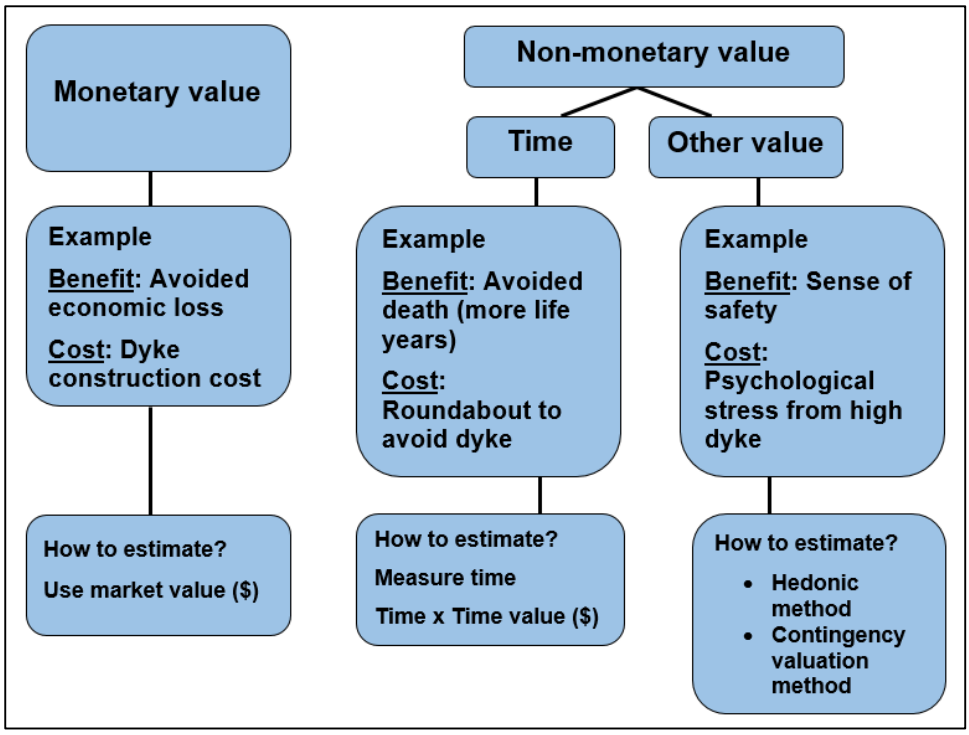
Source: Author

In estimating benefit, a main challenge is to assign monetary values to each expected benefit (Figure 32). If the benefits and costs have monetary values, the government can use

them[21]. If the benefit is expressed by time (*e.g.* reduction of commuting time due to road infrastructure), the government needs to estimate the time gained and multiply it by the value of time (*e.g.* the average wage or minimum wage per hour).

Environmental economists have long tackled the monetization of intangible benefits and developed many methods. For example, one method is directly asking people how much he/she is willing to pay if the project is implemented and estimating the monetary benefits from the answers to that question.

Figure 32: Expected benefit classification



Source: Author

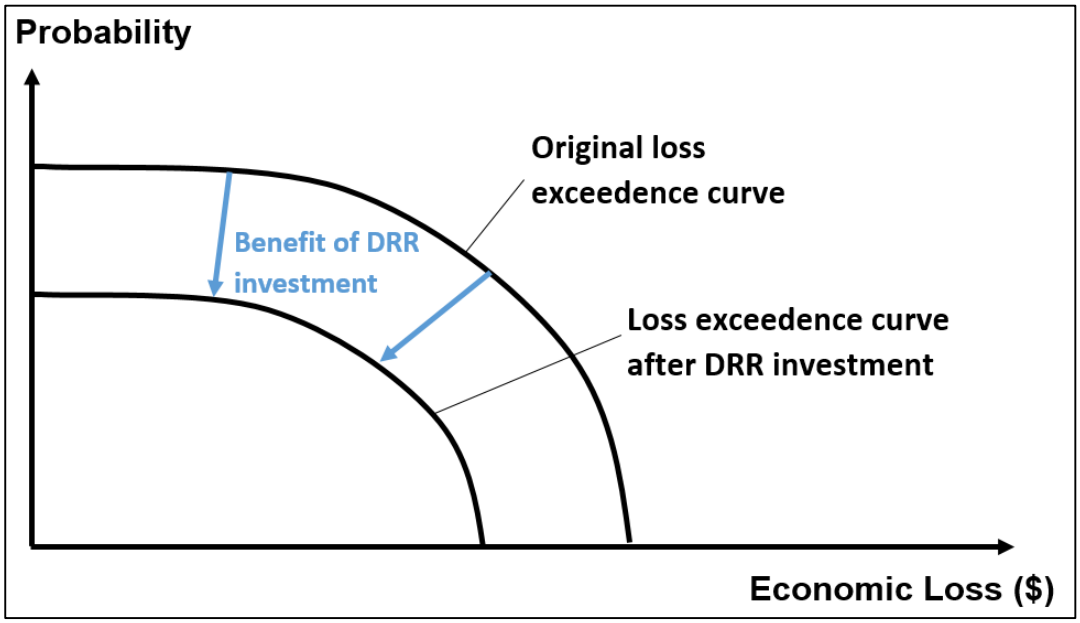
It is important to keep it in mind that this CBA often reflects only partial benefits. In probabilistic CBA, estimation of avoided loss is based on probabilistic risk assessment (forward-looking CBA) or historic loss database (backward-looking CBA). In that sense, the scope of CBA analysis is defined by the scope of risk and loss data. For the case study described below, the risk assessment was limited to direct loss. Therefore, the CBA study also focuses only on the direct loss (written in bold in Figure 57). However, this is nonetheless a meaningful first step, because physical loss often needs to be recovered by reconstruction, which is very costly.

The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment (Figure 33). In case of forward-looking CBA, the data can be input into

[21] More technically told, economists advocates using opportunity costs instead of the monetary value

software such as CAPRA to estimate the AAL before and after investment. In case of backward-looking CBA, AAL before and after investment is calculated by using statistical methods (Simpson rule[22]).

Figure 33: Benefits in terms of reduced AAL



Source: Author

Estimating cost is relatively simple. Project cost and maintenance cost will be listed. Intangible costs (*e.g.* negative environmental impact) are sometimes also estimated.

After having translated benefit and cost into monetary value, the discount rate will be a critical issue with a large impact on the result of a CBA[23]. Discount rates express time preferences within the society. Low discount rates will evaluate future benefit higher than the case applying high discount rate. For example the present value of USD 100 million in 100 years later is about USD 37 million in 1% discount rate, USD 2 million in 4% discount rate and only USD 0.1 million in 7% discount rate. The discount rate has more impact when the project sustains for a long time, which is often the case for big infrastructure.

[22] To estimate the AAL given probabilistic losses and return period data, the Simpson rule is applied. If we know several data points of (return period, PML), depending on the amount of data points available, we can create probabilistic ranges between two data points and multiply the range by the estimated midpoint of loss in this given range. This is expressed by

AAL for range p1, p2= (p2-p1)*((L1+L2)/2)

L1 and L2 represent the maximum loss associated with a given event. P1 and p2 are the probabilities associated with each event. By summing up the AAL for each interval, or range (p1 to p2, p2 to p3,..) we have a an estimate for the total AAL.

[23] When setting discount rate, it is important to consider the impact of expected inflation, if discount rate is 10%, but expected inflation rate is also 10%, the inflation rate will offset the discount rate.

In CBA for public project, social discount rates are often defined by government (Table 7). If the government considers opportunity cost of capital, with more market based consideration, then discount rate tends to be higher. However, if the government wants to politically reflect social time preference to balance the benefit of current and future generation, the rate tends to be set low. The International Panel for Climate Change (IPCC) recommends that governments adopt a low discount rate to recognize that benefits of future generations are equally important as those of current generation and future generation will be able to enjoy benefits from our actions today, in accordance with the concept of sustainable development (IPCC, 2012). It is important that government clarifies the rationale behind social discount rate setting; gaining accountability from the process is as important, or more, than the actual rate chosen.

Table 7: Discount rates in several countries

Country	Social discount rate	Rationale
USA	7%	Opportunity cost of capital
	3%	Social time preference
	4% (water)	Social time preference
New Zealand	7%	Opportunity cost of capital
Japan	4%	Opportunity cost of capital
EU	3.5%	Social time preference
UK	3.5%	Social time preference
France	4%	Social time preference

Source: Author based on Otani S. et al (n.d.)

The result of CBA is dependent on some critical variables. It is therefore always good to implement sensitivity analysis to observe how the result changes when we apply different values to those variables. For example, changing the social discount rate explained above will significantly change the result of the CBA. Construction periods and costs are also critical uncertain factors. Approving uncertainty and preparing several scenarios will strengthen the credibility of analysis instead of weakening it.

While CBA is an explicit and rigorous accounting framework for systematic cost-efficient decision making and common yardstick with a money metric against which to measure projects for social improvement, there are some limitations. CBA often does not assess non-market values and indirect impacts, lacks accounting for the distribution of benefits and

costs (due to Kaldor-Hicks Criterion), cannot resolve strong differences in value judgments, and is strongly influenced by discount rates. CBA should not be the sole criterion for evaluating policies and projects, but should be complemented by other, non-economic considerations.

Chapter 5: Policy challenges and good practices in public investment planning and financing strategies for DRR

5.1. Budget Monitoring

In the HFA Monitor, Indicator 1.2 aims to monitor the DRR budget. However, not many countries report their budgets due to lack of monitoring system for their DRR budget. Table 8 below, shows the reported value in selected countries. While we need to be cautious when comparing the values across countries, due to the application of different counting methods, this table shows that out of five countries, three invested significantly more in relief and reconstruction than in DRR and prevention.

Table 8: DRR Budget in selected countries (% of total budget)

Country	Year	DRR and prevention (%)	Relief and Reconstruction (%)	Total (%)
Belarus	2013	0.160	0.160	0.320
Ecuador	2013	0.300	1.600	1.900
Indonesia	2013	0.286	0.413	0.699
Mozambique	2013	4.610	0.350	4.960
Papua New Guinea	2012	0.100	1.000	1.100

Source: Author based on HFA Progress Report for each country

The lack of DRR financial monitoring stems from an inadequate understanding of *what DRR is* and *what constitutes DRR*. Creating a comprehensive DRM plan and/or clearly placing DRR in an economic development framework would help national stakeholders understand the concept and by default define what represents DRR and how much funding is allocated.

In response to the need for DRM budget monitoring, several initiatives have progressed to date. The first effort has been to create a consolidated budget line for DRM. This approach has mainly been taken in Latin American countries. For example, Columbia established the Adaptation Fund (2010). Mexico has been utilizing the Natural Disaster Prevention Fund (FOPREDEN), the Natural Disaster Fund (FONDEN) and the Fund for Assistance of the Affected Rural Populations by Climate Contingencies (FAPRAC). Peru has also established a

National Budgetary Programme for Vulnerability Reduction and Emergency Response (Box 1).

Box 1: Examples of consolidated budget line for DRM/DRR

Colombia: The Adaptation Fund was created in 2010 by the Ministry of Finance and is responsible for the budgetary analysis of disaster prevention and reconstruction. The Fund promotes mitigation and DRR measures and the Colombian government is now aware about how much money must be spent in each phase of the disaster risk management cycle.

Mexico: According to the Federal Budget and Fiscal Responsibility Law, the proposed annual expenditure budget of the federation has to include budget lines for the Natural Disaster Prevention Fund (FOPREDEN), the Natural Disaster Fund (FONDEN) and the Fund for Assistance of the Affected Rural Populations by Climate Contingencies (FAPRAC).

Peru: A National Budgetary Programme for Vulnerability Reduction and Emergency Response was created where roughly 1.1% of Peru's national budget is dedicated to DRM; an increase of 64% since 2009.

Source: UNISDR (2014)

The second effort is to assign codes to budgetary line items that indicate DRM measures. This is promoted by the World Bank and OECD in partnership with the UNISDR; they propose the "DRM marker" to monitor DRM elements in Official Development Assistances (ODAs) which are registered in OECD's Credit Reporting System. DRM marking allows the monitoring of donors' policy objectives in relation to DRM in each aid activity. Compared to consolidated budget lines, the DRM marker is a less drastic reform and has potential to be the first and simplest analytical step toward risk-sensitive public investment. For details of DRM Marker, please see Chapter 4-3.

Financial decentralization of DRR investment

There are two main sources of financing for local governments: financial transfers from national to local governments (e.g. subsidies) and locally produced financial resources (e.g. local taxes, bonds or fees). Compared to the number of countries where institutional arrangements are explained, fewer have reported their fiscal decentralization procedures. Legal arrangements for financial decentralization are inadequate in many countries, which prevents sufficient generation of funds at local levels.

The financial allocation for DRR or DRM at the level of local government is not satisfactory in many countries. Only Turkey reported having specific rules for local public financing. Local governments in most countries depend on financial transfers from upper tiers of government and face similar challenges to those of national governments (e.g. competing priorities).

Many countries do not have budget tracking systems for DRM, which leads to difficulties in tracking and estimating DRM allocations from the national to local levels. Local

governments rarely have budget tracking systems for DRM. Monitoring mechanisms are needed to identify how governments finance DRM activities at all levels of government, especially considering the increasing role of local government. A very small number of countries (Ecuador, Indonesia, Mozambique and Romania) reported concrete numbers for DRR activities at the local level.

5.2. DRR Integration into Public Investment Planning

Infrastructure for disaster avoidance and mitigation is one of the main tools for DRR. However, building, maintaining and upgrading infrastructure is costly, which hinders overall improvement. Climate change is another factor increasingly considered in infrastructure planning and development. Coordination between the DRM sector and infrastructure investment agencies (e.g. the Ministry of Public Works or the Ministry of Infrastructure) is essential for infrastructure to be made resilient.

Some infrastructure is not erected for the *sole* purpose of disaster risk reduction, but plays an important role in socio-economic development and disaster management. For example, school facilities are important infrastructure for economic growth and social development but it also functions as center for DRR knowledge awareness raising and temporary emergency shelter. Water irrigation infrastructure is critical for agricultural productivity but also works for mitigating risk against drought and flood.

Aa Public investment plans are, logically and practically, in alignment with economic development planning.[24] More countries in HFA Monitor addressed DRR integration, or lack thereof, in their public investment plans in the 2011-2013 period, reflecting the growing attention on this issue. Highlighting the need for DRR in public investment planning is critical for risk-proof public investments (Box 2).

[24] The current challenge of mainstreaming DRR into economic development planning is explained in Section 1.1.

Box 2: Good practice of DRR integration into public investment planning

Sri Lanka: A National Physical Plan and Policy have been developed that take DRR into consideration and serve as a major policy framework for national and sectoral development. During the last year a process has been initiated to incorporate disaster risk into development projects. Development stakeholders were consulted on the challenges and made aware of the importance of incorporating disaster risk into development planning. More concretely, the Department of National Planning of the Ministry of Finance agreed to consider disaster impacts when recommending projects for funding, if a mechanism is established to certify disaster impact assessments. A simplified tool/checklist is required to assess disaster risks.

Japan: The purpose of the Infrastructure Improvement Priority Programme is to carry out infrastructure improvement projects in an efficient manner. Revised in 2008 the programme promoted prioritized, effective and efficient infrastructure improvement projects. Some of the aims include "building disaster proof territory against huge earthquakes," supporting activities at the time of disaster, and developing social capital to secure peoples' livelihoods. The priority programme identifies DRR as one of the four key issues to be addressed. The Ministry of Land, Infrastructure, Transport and Tourism conducts an evaluation of public works that includes a disaster risk reduction lens, when projects are initiated, implemented and completed.

New Zealand: The National Infrastructure Unit, established within the Treasury in 2009, focuses on the performance of the physical assets that underpin the functioning of the economy, such as transport, water, communications, energy and public facilities like schools, hospitals and prisons. The unit prepared the 2011 National Infrastructure Plan with the aim of including resilience as a guiding principle, so that national infrastructure networks are able to deal with significant disruption and can adapt to changing circumstances.

Source: UNISDR (2014)

On a project basis, it is critical to introduce disaster risk and cost benefit analyses in project evaluations. When we assess from HFA Monitor the current status of CBA applications to DRR related projects, two issues arise. The first is that disaster risk is very often not accounted for in CBA for public investments, for example investment in infrastructure for transportation, education and health. The second issue is that direct risk preventive projects such as flood control infrastructure are often implemented without the routine grounding of a CBA framework. However, several countries reported that disaster impacts are a part of their public investment decision-making processes (Box 3).

Box 3: Systematic approaches to the integration of disaster risk assessments in the decision-making processes of public investment projects

India: The Government of India has introduced a system of Disaster Resilient Audits on a self-certification basis that will be applicable from the inception and planning stage of all centrally sponsored schemes. The Ministry of Finance has issued instructions to all ministries to include disaster risk reduction features in their projects and include a systematic checking mechanism at the project formulation, appraisal and approval stages. The major challenge lies in ensuring compliance to the certification process.

British Virgin Islands: Since 2008, the building review/application process has made provisions for hazard assessments within high-risk areas. This enables the public/private sectors to develop appropriate hazard mitigation strategies and measures to prevent or reduce the occurrence of disasters. Further integration of DRR concepts in various sectors continues through the incorporation of Hazard Risk Assessments in the Impact Assessment Process, and the integration of hazard data into the National GIS Database.

Trinidad and Tobago: Disaster risk has been considered in public investment decisions through consultations, as well as via the review of plans and policies by the Office of Disaster Preparedness and Management (ODPM). The CBA is taken into account in the design and operation of major development projects by national and sub-national authorities and institutions, as well as international development actors, through technical consultation with ODPM. The problem is that methodologies for the development of these projects differ across the public sector.

Vanuatu: According to Vanuatu's National Disaster Risk Management Arrangements, all national development programmes and projects are subject to the formal process of risk identification, analysis and evaluation. Appropriate risk treatments must be applied to ensure that identified risks are either eliminated (prevented) or reduced (mitigated).

United States of America: Public assistance and hazard mitigation grant projects of Federal Emergency Management Agency (FEMA) must meet eligibility requirements (such as positive benefits/cost ratios) and be assessed for potential impacts on citizens and the natural environment under the US 1969 National Environment Policy Act. By Executive Order of the President, federal agencies are required to avoid long and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a feasible alternative. FEMA ensures that projects that have the potential to affect flood plains, wetlands or their inhabitants living in these areas, or which are subject to potential harm by their proximity to wetlands or floodplains are analyzed and assessed prior to implementation. FEMA also provides technical assistance to other federal agencies, guidance on specific actions, and assistance on flood risk identification, flood hazard mitigation techniques and floodplain management.

Source: UNISDR (2014)

Public investment is often bankrolled by the Ministry of Finance and implemented by diverse sectoral ministries, meaning that cooperation is needed between the various stakeholders. Strong governance arrangements that include guidance from the focal DRM

agency, Ministry of Finance and sectoral ministries is imperative for mainstreaming DRR in public investment decision making. Especially commitment of DRM agency in public investment decision making is critical (Box 4).

Box 4: Engagement of DRM Agencies in Project Evaluation Committees

Turks and Caicos Islands: With the inclusion of the Department of Disaster Management and Emergencies on the Physical Planning Board, some aspects of DRR are taken into account when deliberating planning applications.

Sri Lanka: The Disaster Management Centre is involved as a member of the Technical Evaluation Committee for development projects in disaster prone areas.

Korea: To mainstream DRR in development, a pre-disaster impact analysis is needed to be undertaken by disaster management experts who sit on a development committee, as specified in the Natural Disasters Countermeasures Act.

Source: UNISDR (2014)

The biggest challenge is overcoming capacity issues with regards to skills, methodology and data availability[25]. Strong leadership and guidance from national governments are required. In Panama, the Ministry of Economy and Finance is aware of the importance of cost-benefit analyses and incorporates risk criteria in the evaluation of public investment projects. The National Civil Protection System promoted training courses on the "Inclusion of Risk in Public Investment Projects" where nearly 60 officials from different institutions were trained. Over 50 participants from civil society and institutions received training and manuals that contained information on integrating risk in construction, bridge and road maintenance (UNISDR, 2014).

The second challenge is how to ensure the enforcement of assessment directives. Even if disaster impact assessments are implemented, projects might not comply with recommendations due to financial reasons. Innovative and cost effective approaches for risk proof investment will facilitate implementation. Monitoring and evaluation at the implementation and post-implementation stages will also remedy any setbacks, however weak regulation and insufficient resources for monitoring are likely to hamper progress.

[25] The main methodologies used to understand and quantify how development projects impact on risk (and inversely, how the exposure of development projects to disaster risk might evolve over time and affect the sustainability and impact of development projects) involve a combination of probabilistic risk assessment and cost benefit analysis. Current challenges in risk assessments are explained in Section 2.1. For cost benefit analysis and economic impact analysis see Section 3.3.

DRR integration in Environment Impact Analysis: Potential for CCA and DRR integration into public investment planning project evaluation

In HFA Monitor, many countries underscored the importance of disaster risk assessments in relation to environmental impact assessments (EIA). Incorporating disaster risk assessments into EIA is one of the most popular tools for achieving indicator 4.6 (Box 5). Though EIAs are a well-established scheme in many countries, disaster risk assessment is relatively new, and consequently, disaster risk assessment is often inadequately integrated in EIA.

Box 5: DRR integration into the EIA process

British Virgin Islands: As part of the environmental review process, the Department of Disaster Management (DDM) reviews and comments on proposed projects where an EIA is required. Hazard and vulnerability assessments are incorporated into the EIA process and developments within designated hazardous areas must undergo a hazard assessment. Additionally, the Director of the DDM sits on the Planning Authority and the Environmental Management Committee. This membership calls for monitoring and inspection of development applications and the revision of EIA reports. The challenges include the incorporation of EIA and hazard and vulnerability assessments in all major development projects and the inclusion of climate change factors in project planning processes. There is also a need for stronger monitoring mechanisms to ensure that appropriate components are addressed, recommendations are fully carried out, and long-term impacts are monitored.

Colombia: The EIA was traditionally used to integrate risk assessments in development projects (mainly infrastructure), although carrying out a risk assessment was an optional component of the EIA process. The National Planning Department made risk analysis an obligation. All projects now have to address the issue of DRR and a new law passed in 2012 (Law 1523) states that all public investment projects that have an impact on the territory – whether at the national, provincial, district or municipal levels – should properly incorporate disaster risk analyses, the details of which are defined according to the complexity and nature of the project. The analysis should be considered from the early stages of development in order to prevent future risk associated with public investment projects.

The National Planning Department is formulating a methodology to analyze the exposure of projects to hazards, as well as the negative impact of projects on the environment and local communities. It is essential to generate guidelines for incorporating risk in project assessment, as well as determine what technical and financial resources are required for improving risk assessment and analysis.

Source: UNISDR (2014)

Some countries detailed how better governance arrangements can mitigate technical constraints. Cementing the commitment of disaster risk management authorities in the EIA

process improves the quality of disaster risk assessments. Cooperation between environment management agencies and DRM institutions will upgrade the effectiveness of EIA by facilitating the smooth exchange of information. Because many investment projects are designed and implemented by sectoral agencies, a better understanding and awareness of DRM by the sectoral agencies is also required.

The first challenge in integrating DRR into EIA processes is determining if there are any technical capacity problems. Disaster impact assessments require technical skills and a sound methodology. Capacity building is required not only for environment ministries but also for other related institutions and private sector entities. To ensure consistency in the application of EIA, a standardized methodology is required; this can be developed by related experts and stakeholders. Many countries lack such a standard assessment methodology (Box 6).

Box 6: Need for standardized methodology

Indonesia: Experts and DRR practitioners have not reached an agreement on the specific methodology to be used for disaster risk impact assessments for development projects. The National Agency for Disaster Management needs to collaborate with the Ministry of the Environment, the Ministry of Public Works and the Ministry of Energy and Mineral Resources to formulate appropriate risk assessment instruments.

Fiji: A weakness in the EIA process is the absence of guidelines on accepted standards for impact assessments. A related issue is the non-regulated assessment methodology applied by various agencies carrying out EIA studies. The application of EIA principles for outlining cost benefit analyses in new development proposals must be improved significantly. A framework on the acceptable standards of assessment should be developed following consultations with resource owners, EIA practitioners, scientists and academics. In practice, assessing the impact of disaster risks varies because assessments are not guided by an agreed standard. The lack of information on hazard and the potential economic impacts on projects is preventing agencies from routinely incorporating DRM considerations into their planning processes.

Trinidad and Tobago: Procedures for the assessment of disaster risk impacts in EIAs are not completely aligned with national standards. Every EIA is not vested for DRR due to capacity constraints and because standards for risk assessments are not aligned with international best practices.

Source: UNISR (2014)

Second, the integration of disaster risk assessments in EIA should be implemented in efficient way. Developers have often criticized the EIA for having long procedures that delay the entire process and decrease project efficiency. EIA also places an administrative burden on government officials, which is a reason for limiting the application of EIA to projects over a certain threshold. Finding a balance between risk concerns and economic and

administrative efficiency should be the goal of stakeholders. Streamlining and clarifying the entire process should help mitigate additional requirements.

Third, many countries mentioned weak enforcement as challenge. Insufficient financial and human resources and poor monitoring procedures in implementation and post-development phases lead to the weak enforcement of EIA recommendations.

Sectoral agencies and private sector entities taking part in EIA process often have little awareness and understanding about the risks and are thus disinclined to follow recommendations. EIA reports and recommendations need to be easily understood by developers and the general public. Boosting the capacity and resources of implementation agencies and raising the awareness of developers are necessities. In Laos PDR, for example, The Water Resources and Environment Administration (WREA) nominated a committee, consisting of WREA staff and officials from concerned ministries, to assess the report submitted by project owners/investors. If the environmental and social impact assessment meets all requirements, the committee will issue an authorization letter for the project to commence. Furthermore, during the construction period, the committee will monitor the project's environmental and social aspects and if the undertaking is found to conflict with the WREA initial assessment, the committee can halt the project.

Lastly, EIA has potential for extended coverage and deeper analysis. The Indonesian government has required more comprehensive Strategic Environmental Analysis (SEA) to complement EIA in areas that have many development projects and where the environment is at risk. Disaster risk considerations, if properly integrated into the SEA, have the potential to be applied to any area at the policy, plan and programme levels (as opposed to the project level alone).

Critical infrastructure protection

Many countries emphasized the importance of critical infrastructure protection as it ensures the business continuity of government and the private sector. Critical infrastructure is important for the speedy roll-out of emergency activities and contributes to improving resiliency in society. Sectors like energy, transport, communication and water are seen as critical infrastructure. Often network based, a disruption in one part of the infrastructure raises the possibility for damage across entire networks. Countries like Australia, Canada and Germany show a high level of institutionalization and have established strategic documents for the protection of critical infrastructure (Table 9). Public and private partnerships have been observed in such initiatives reflecting the increasing share of infrastructure that is privately owned (Box 7).

Table 9: Examples of critical infrastructure protection strategies

Country	Strategy
Australia	Critical Infrastructure Resilience Strategy (2010)
Canada	National Strategy for Critical Infrastructure
Germany	Guide "Critical Infrastructure Protection: Risk and Crisis Management"
New Zealand	Civil Defense Emergency Management Act (2002) Lifeline Engineering Project
United Kingdom	National Security Strategy Sectoral Resilience Plan
United States of America	National Infrastructure Protection Plan (2009)

Source: HFA Progress Report for each country.

Critical infrastructure protection is a relatively new policy area that has attracted more attention following the September 11th attacks in 2001 in the United States of America, and in the wake of recent disasters such as the Great East Japan Earthquake and Thai Floods of 2011. It has been recognized that damage to key infrastructure, such as energy and transport, will prolong deleterious economic impacts. Developing countries can learn a lot from critical infrastructure planning to identify what constitutes critical infrastructure and improve their own resilience.

Box 7: Strategic approaches for critical infrastructure protection in Australia

In 2010, the Attorney General launched the Australian Government Critical Infrastructure Resilience (CIR) Strategy, which aims to achieve the continued operation of critical infrastructure in the face of hazards. This critical infrastructure supports Australia's national defense and security and underpins the country's economic prosperity, and social and community wellbeing.

The Trusted Information Sharing Network for CIR is one avenue of engagement for the business-government partnership and is a forum in which the owners and operators of critical infrastructure can work together by sharing information on security and resilience issues. The network is made up of groups representing different critical infrastructure sectors including energy, water, transport, health, food chain, communications, banking and finance.

The Australian Government's Critical Infrastructure Program for Modeling and Analysis Capability (CIPMA) examines the impacts of extreme weather events and provides strategic analysis on disruptions to essential services. CIMPA has completed a range of scenarios on natural disasters to help enhance Australia's emergency management planning, preparedness, recovery and resilience in a range of locations. For example, if infrastructure were damaged due to a natural disaster within an area that falls under CIPMA, the programme would run a scenario and determine the estimated recovery time of the infrastructure damaged or destroyed, the estimated recovery cost and the flow-on effects of a critical infrastructure service disruption within/across sectors.

Source: UNISDR (2014)

In promoting critical infrastructure protection, some points should be considered. First, several countries commented on privately owned infrastructure protection. The privatization of government infrastructure and services has progressed since the 1980s and critical infrastructure providing public goods are increasingly owned and/or managed by private sector. Protection of private infrastructure should be also improved. All initiatives listed in the table 4.6 include public private partnerships.

Second, the interdependence of critical infrastructure should be analyzed. Discussions need to take place across all related sectors for critical infrastructure protection. For example, the disruption of the energy sector affects all other sectors. Links between sectors should be considered to prevent cascading effects from occurring.

Third, information on critical infrastructures is often sensitive for security reasons (e.g. exact location of nuclear storage sites). However, for response purposes, certain pieces of information must be shared between responders. Countries need to design information

management processes for protecting critical infrastructures, not only from disasters but also from man-made events such as terrorism.

Fourth, critical infrastructure protection is often focused on risk reduction. However, cooperation of critical infrastructure operators in emergency management and smooth recovery is also important. The role and responsibility of critical infrastructure providers should be considered in all phases of DRM.

5.3. Contingency Finance Mechanism

Contingency Funds

Under indicator 5.3, many countries cited having contingency fund mechanisms in place – including semi-contingency funds that do not carry over to the next fiscal year (see Table 10). Contingency funds are the most important tools for achieving the aims of indicator 5.3. Because of the wording, it was often difficult to differentiate between contingency funds and annual allocations for contingency without carry over; consequently, both schemes are analyzed together in this section. However, differences should be clarified in order to understand which schemes countries should adopt and to understand the implications for public finance programmes and entities. Aside from the above mechanism, there are countries that decide the percentage of the budget that will be set aside for contingency planning (e.g. Chile, Mozambique and Samoa).

Table 10: National Contingency Fund Mechanisms

Country	Name of Scheme	Scale
Bangladesh	Disaster Response Fund	USD 300 million
British Virgin Islands	Disaster/Emergency Fund	$0.5-1 million annually
Cook Islands	Disaster Emergency Trust Fund	NZD 200,000 Target: NZD 500,000
Haiti	National Emergency Fund	USD 23 million
Marshall Islands	Disaster Assistance Emergency Fund	USD 400,000 annually USD 1.2 million as of 2012
Mozambique	Contingency Plan Funds	USD 3-4 million
Nepal	Prime Minister's Disaster Relief Fund, Central National Disaster Relief Fund	NPR 50 million annually
Pakistan	National Disaster Management Fund (NDMF), President's Relief Fund, Prime Minister's Disaster Relief Fund	NDMF: PKR one billion
Peru	National Contingency Fund	PEN 50 million
Vanuatu	Disaster Management Fund	VUV 25 million

Source: HFA Progress Report from each country.

Many countries cited the lack of financial resources as a challenge, preventing the creation of contingency mechanisms. In other instances, no funds have been set aside even though a mechanism exists. The main reasons for insufficient funds include competing priorities, increased demand for response and recovery, and general economic conditions

Some countries reported they do not receive enough finances from the fund and they needed to complement DRM financing using budgetary reallocations and loans. Countries struggling with financial constraints need to find complementary mechanisms to respond to large-scale disasters.

Several countries noted the importance of timely fund release. One objective of contingency funds is to provide immediate finances without having to engage in the time-consuming process of budgetary reallocation. The speed of government response influences the scale of a disaster, especially in the immediate response phase. Attention to speed is therefore crucial for disaster management agencies, as is the transparency of contingency fund design. The balance between the need for speed and ensuring democratic accountability protocols must be pursued.

Discussions on contingency funding often take place at the central level within the Ministry of Finance (Box 85). This has led to concerns about the role of sectoral agencies/ministries. Some countries have local level contingency fund mechanisms in place, which have proved to be useful in many cases (Box 8).

Box 8: Local contingency mechanisms

Colombia: Law 1523, passed in 2012, identified a new financing mechanism for risk management. The law renamed the National Calamity Fund as the National Fund for Disaster Risk Management and created an independent account for the fund, to ensure flexibility and statutory procedures. In addition, the law led to the creation of five sub-accounts for risk knowledge, risk reduction, disaster management, recovery and financial protection. The law also established the departmental, district and municipal risk management funds, in order to strengthen response capacities at all levels.

New Zealand: The Local Authority Protection Programme Disaster Fund (LAPP) is a cash accumulation pool to help local authorities pay their share of infrastructure replacement costs for water, sewage and other uninsurable essential services damaged by natural disaster. The LAPP covers up to 40% of a local authority's share above the threshold set by central government for recovery assistance. Of the 85 local authorities, 59 are currently LAPP members. The Fund equity is approximately NZD 40 million, supplemented with reinsurance to enhance this balance.

Ghana: A 1999 Presidential decree mandated that all districts must set aside a percentage (~5%) of the district assembly funds for emergency response. The exact percentage has yet to be legalized and the management of the fund is not explicitly defined.

Pakistan: At the provincial level, the Chief Minister's Relief Funds and provincial disaster management funds are being maintained under respective Relief Commissions, to cater for contingency needs of the provinces.

Source: UNISDR (2014)

Few of the country reports were explicit about the use of a contingency fund; however, concerns did surface regarding the use of contingency funds to finance immediate response only. Some countries discussed the need to make financing available for DRR (and reconstruction).

Budget reallocation and expectation for donors

Several countries highlighted that they do not have contingency funds in place and instead respond to relief needs by regrouping existing budget lines. While two countries (Germany and Switzerland) intentionally chose this option, many others were obliged to adopt this approach, in part due to their inability to establish contingency financing mechanisms. Fundamentally, budget reallocation takes time and can affect the smooth delivery of relief efforts. In the long run, it can also affect economic growth by depleting funds allocated to other development projects.

Several countries addressed the possibility of acquiring external financial resources such as aid from international organizations and INGOs. External financing has been important in complementing (often meagre) resources in developing countries, however the expectation of acquiring resources in this way risks hindering national efforts to establish contingency mechanisms.

Catastrophe insurance and bonds

Several countries have dedicated catastrophe insurance, others in need of such insurance to protect public finances, subscribe to a regional facility (the Caribbean Catastrophe Risk Insurance Facility for example). The expectations for having a regional insurance mechanism in place are high in some regions (e.g. Pacific, Africa and southeastern Europe). The need for catastrophic insurance and bonds comes from the inadequacy of funds for recovery efforts, especially after large-scale, intensive disasters. The problem is that insurance is often costly, and a regional mechanism is required to spread the risk and decrease premiums to a reasonable level. Catastrophe bonds are not prevalent and Mexico is the only country that reports having them.

In Mexico, comprehensive risk financing strategy is developed. The Ministry of Finance and Public Credit has developed insurance to cover the losses from high frequency or high impact events. Insurance covers infrastructure for communication and transportation, water, education, sports and health, facilities for urban municipal solid waste, electricity, marine and tourism facilities, fishing and primary aquaculture, forestry and nurseries, protected natural areas, as well as rivers and lakes, patrimonial low-income housing, and archaeological and historic monuments. Of these assets, water, roads, education, health centres and social housing must be highlighted, as they have been earmarked for over 90% of all disbursements by the FONDEN (National Fund for Natural Disasters) since 1996.

The Mexican government, with support from the World Bank, successfully completed the second edition of the Catastrophic Bond, which transfers the risks of hurricane and earthquakes from investors and provides attractive returns if events do not occur within established parameters. Should the event occur, resources are deposited in the trust and transferred to Agroasemex SA (insurance company) that pays out to FONDEN. Furthermore, the Reconstruction Fund for Federal Entities, established in 2011, provides 20-year loans to affected federal states.

Contingency loans are another mechanism for risk financing. Latin American countries including Panama, Ecuador and Costa Rica mentioned their contracts with development banks. In the case of Panama, in March 2012 the Cabinet Council approved a contract for a Contingent Loan for Emergencies to Natural Disasters (for up to the USD 100 million), which was signed between the Ministry of Economy and Finance and the Inter-American

Development Bank. There is also a contingency loan with the World Bank that can be activated in case of disaster.

Crop Insurance

Crop insurance is especially important for countries dependent on agriculture. More and more governments have introduced or are developing schemes for crop insurance and some countries link crop insurance with credit programmes. Doing this will give farmers the incentive to purchase crop insurance and make them more resilient. While crop insurance involves an aspect of social policy to support vulnerable farmers and ensure food security, the cost of insurance premiums is often beyond the reach of farmers. The challenge is determining how to develop the private market by gradually decreasing the involvement of government.

Risk financing in private sector

Contingency finance mechanism in private sector is important because it will mitigate the burden on public finance. Information relating to risk financing in the private sector, especially insurance, is scattered across HFA progress reports. For simplicity's sake, information has been compiled under this section. Most of countries provide inputs about insurance, which is the most important contingency mechanism in the private sector. The type of insurance provided (the risks they must respond to and items that are being insured) is dependent on each country.

Some countries reported a lack of private insurance markets, and even when there is a market, the penetration rate is too low or at an undesirable level. One reason for such low penetration rates is an absent insurance culture. Raising awareness regarding the importance of insurance is one necessary step, as is mobilizing the insurance sector in the national platform, which may facilitate awareness amongst stakeholders and the public.

Second, insurance premium payments are out of reach for poor households and communities. Governments need to support access to insurance for low-income groups or communities through the use of subsidies on premiums. Public private partnerships can be useful in establishing such mechanism.

Other factors that empower private insurers are the existence of reinsurers, enabling laws and regulations, and capacity building of public and private sectors. The strong involvement of government is necessary to support the development of the private insurance market, and public private partnerships (PPP) can be a promising avenue for increasing penetration rates (Box 9).

Box 9: PPP schemes to combine public DRR with support for private insurers

United Kingdom: The government has an agreement with the insurance industry that the latter will insure property at risk so long as the Environment Agency has announced plans to defend the property against flooding. This ensures those vulnerable to flooding have enough insurance to protect themselves.

United States of America: The National Flood Insurance Program offers flood insurance to homeowners, renters and business owners if their community participates in the programme. Participating communities adopt and enforce ordinances that meet or exceed Federal Emergency Management Agency's requirements to reduce the risks of flooding.

Source: UNISDR (2014)

Some countries make insurance a legal requirement (see New Zealand below), while others debate whether to make insurance compulsory by law. Even if insurance is not legally mandatory, loan conditions required by banks sometimes render insurance obligatory.

In New Zealand, A levy for loss or damage (to residential property, land and personal possessions) from earthquakes, landslides, volcanic eruptions, hydrothermal/geothermal activity, tsunamis or fires is a compulsory component of all home and/or contents fire insurance policies (Earthquake Commission (EQC) Act 1993). A national natural disaster insurance scheme (through the EQC) provides automatic coverage – with a maximum cap – for property and goods, through a levy attached to private household insurance. Asset insurance and, in some cases, income protection are generally required as part of a lender's mortgage and loan agreements

By international standards, New Zealand has a high percentage of coverage for property (structures and content) damaged by floods simply because it is a standard part of insurance policies. While household insurance is high (approximately 95% nationwide) it is likely that some are still under-insured for total losses. Small to medium businesses in particular do not have the capacity to withstand an extended period of trading disruption. Further education is needed to raise awareness of hazard risks, individuals' responsibility in addressing them and reasonable expectations for state support following an event.

EQC's fund reserves and reinsurance has underpinned much of the losses incurred by households following the Canterbury earthquake. As a result of this experience, a review of the EQC funding model, to better reflect current risk and operational needs, is been undertaken. A significant increase in national insurance premiums, after the Canterbury earthquakes, suggests that the insurance/reinsurance market is reassessing risks in New Zealand. This has had significant financial implications for owners of highly earthquake prone buildings. There is also a shift in the form on insurance offered from full replacement to that of sum insured. This reflects a market rebalancing in the short to mid-term and

further incentivizes building upgrades. While further reinsurance has been attained initially, it has been at a higher cost and the Commission's reserves also require rebuilding.

Savings or establishing reserves is also a way to finance risk in private sector, however this seems to be restricted to large companies (with the capacity to establish reserves) and formal sectors under an institutionalized savings framework. Cooperatives will close the gap by opening avenues for the vulnerable communities. For example, in Malaysia, The establishment of a cooperative (the Endeavor Trust of Malaysia) in 1987 has improved the resilience of communities previously vulnerable to disasters. It has provided services to more than 180,000 families in Malaysia, including making micro-finance contributions, compulsory savings and welfare funds available for poor and marginalized groups.

5.4. Disaster Loss and Economic Analysis: Development of evidence base

Post-event assessment on economic loss:

Countries commented on two kinds of assessments under the HFA indicator 5.4. The first is a rapid assessment of damage, loss and needs, which is urgently required for estimating recovery costs immediately after a disaster. The second is a more detailed analysis that includes economic and social factors and measures the impact of a disaster more accurately and comprehensively. There are five challenges for both kinds of assessments.

The first is the need to establish and improve standardized methodologies for rapid assessments and socio-economic impact analyses. In rapid loss and needs assessments, many countries stated that they had adopted internationally or regionally established methodologies. While standardized methodologies are available at the regional and international levels for rapid assessments, this is less the case for socio-economic impact analyses.

Second, governments need to offer training to researchers and users on how to carry out assessments and analyses. Human capital is important, as speedy needs assessments are essential for the release of emergency funds and applying for international aid. Countries that have well developed insurance markets and (sector) mechanisms responsible for implementing rapid assessments, can complement the human capital provided by the public sector. Public and private partnerships are important in such cases.

Third, un-systematic data collection and assessment across sectors can mislead response and reconstruction activities. Coordination across sectors (e.g. developing common data collection templates and adopting a universal methodology) is required.

Fourth, baseline data (pre-disaster information) is necessary to accurately estimate losses and impacts. It is important to prepare baseline information in times of calm to facilitate post-disaster assessments and analyses.

Fifth, assessments are rarely carried out in remote and geographically inaccessible areas because of limited human resources and the inability of experts to visit such areas. Transportation and communication infrastructure development contributes to the full territorial coverage of assessments.

Fewer countries commented on the use of economic and social impact analyses, than did on rapid loss and needs assessments. An economic and social impact analysis is important for promoting smooth reconstruction and preparing for future events. Analyzing disasters that have occurred will contribute to the cost benefit analysis and the economic and social impact modeling of probable disasters, as explained in Section 3.3. Different skills are required for rapid assessment as opposed to comprehensive socio-economic impact analyses implemented at a prescribed time after the disaster.

The biggest challenge in carrying out economic and social impact analyses is the lack of common definitions regarding impacts. This leads to ambiguity about the type of data that should be collected.

When it comes to social impact analyses – usually implemented to measure the impact of disasters on vulnerable populations –more detailed and disaggregated data based on population groups is required. The more detailed an analysis is, the more human resources that are needed. In Mexico, since 1998, the country uses the ECLAC methodology for carrying out post-disaster impact analyses with social, economic and environmental considerations. The National Centre for Disaster Prevention developed the *SAVER* tool (System for Analysis and Visualization of Risk Scenarios) that allows users to develop a spatial analysis of affected territory and gather information about the economic and social impacts of disasters. Within *SAVER* there is a module with indicators disaggregated by gender, allowing for a differentiated analysis of the social and economic impact of disasters. Each year, an analysis is published, detailing the socioe-conomic impact of major disasters in Mexico.

Estimating the economic and social impact of disasters and storing such information in a database is a precondition for estimating future disaster impacts.

Disaster loss databases

Some countries reported having a centrally managed “disaster database” to store data of past events, a useful step towards the central management of all DRR related information. The challenge is securing financial resources that can boost efforts in data collection, collation and synthesis. The usefulness of disaster databases will be improved if loss data can be added to the catalogue.

To fill the gap between assessing losses and projecting future impacts, data needs to be stored for several years so it can be analyzed. In this regard, *DesInventar* (a conceptual and

methodological tool for the construction of databases of losses, damages or effects from disasters) contributed to the construction of disaster loss databases in many countries.

If data is going to be used for policy-making purposes, it is imperative that disaster loss databases store up to date and accurate data. Databases should be systematically and regularly reviewed and updated and any technical issues (including collection methods, data definition and coverage) should be minimized.

Second, because the coordination of loss assessments across sectors is rare, assessment results are often stored within individual government ministries/agencies. This has led to challenges in creating comprehensive and consistent national disaster loss databases.

Third, how disaster loss data is used is a challenge. Disaster loss databases can provide useful information, such as how to assess the vulnerability of building structures, but even if a country has developed a disaster loss database, the capacities required to analyze data and use it for effective policy making may be lacking. Appropriate measures for database use should be researched and communicated to stakeholders and the capacity of potential users needs to be strengthened.

Cost Benefit Analysis

Many countries commented on cost benefit analysis (CBA) of DRR. CBA is an important tool for stakeholders to integrate DRR into development and public investment planning. The use of CBA is also expected to raise the awareness of policy makers, including financial officers. However, existing CBA research is often sporadic or inadequate and most countries cited a strong and urgent need for enhanced, integrated CBA.

A major reason for the insufficient level of CBA is the lack of awareness and technical capacity to perform CBA (in terms of methodology and tools) at the macro and micro levels. Financial constraints are also addressed as challenges in some countries.

In implementing a CBA for DRR policies, the most difficult methodological issue to deal with is how to estimate the benefits of DRR investment. In probabilistic CBA, avoided damage is assumed to be a "benefit" of DRR policies – as seen in the case of France. The dearth of basic socio-economic data hinders stakeholders' ability to estimate "benefits." This is especially true when tracking past damage (outlined in Section 5.4) in order to estimate future losses, as seen in the cases of Colombia and Nepal.

The sharing of research results will improve the quality and standardization of the CBA, however, Algeria and Costa Rica have identified that information sharing is a challenge. Beyond information sharing, Switzerland established a standardized CBA methodology and an e-tool to extend the tool's wider application (Box 33). Other examples – such as Barbados and the Solomon Islands – highlight the missing link between scientists and

financial officials. Strengthening the link between natural science research and the economic elements of the CBA will help facilitate DRR policy implementation.

Ex-ante Economic and social impact analysis

Fewer country reports provided comments on economic impact analysis. While the cost benefit analysis tends to take place at the micro-level, the economic impact analysis is generally macro in scope. Assessing the economic impact of disasters is important for mid to long term economic planning. This analysis however, presents several methodological challenges. These include how to define the impact (not only direct losses, but also indirect losses and macro-economic impacts) and how to deal with inter-sectoral linkages. Little research has been carried out in this field and more methodological courses of action should be pursued. Inputs from the private sector are also required to have good quality economic impact analyses.

Fewer countries addressed the need for a social impact analysis (SIA) even though SIA is important because the scale of disasters differ depending on the vulnerability of the community. Poor people, children, the elderly and the disabled are more vulnerable to hazards. SIA is an important tool for supporting social policy planning and requires disaggregated data (e.g. age and gender) to identify the vulnerable segments of society that need support.

Chapter 6: Case studies: Application of methodology in South West Indian Ocean Region

In 2012, the UNISDR started a project called "Building capacities for increased public investment in integrated climate change adaptation and disaster risk reduction: 2012-2015" under the financial sponsorship of EC- Development and Cooperation (EC-DEVCO). The initiative supports approximately 30 countries in Asia, Pacific, Africa, Latin America and the Caribbean to systematically account for disaster loss and to develop probabilistic estimations of future risk. It provides a baseline for an economic approach toward better public investment planning.

The initiative has three components:

- Component 1: disaster loss
- Component 2: probabilistic disaster risk assessment
- Component 3: economic analysis to support public investment planning

Component 3 of this initiative considers disaster risks in economic analysis to support and facilitate risk-proof public investment decision-making. It especially aims to contribute to the progress of HFA priority areas monitored through core indicator 4.6 "procedures are in place to assess the disaster risk impacts of major development projects, especially infrastructure" and 3.3 "Research methods and tools for multi-risk assessments and cost benefit analysis are developed and strengthened".

In designing methodologies for Component 3, UNISDR considered how natural science can be linked to social science to contribute to better decision making in public investment planning.

We introduced tools a) to monitor DRM budgets to analyse the current state of public investment (called the "risk sensitive budget review"), b) to measure the impact of disasters on public finance and on the economy at the macro scale (CATSIM analysis), and c) to measure the impact of DRR investment on society (probabilistic cost-benefit analysis).

Recommendations for policy makers are discussed in each country drawing from the analyses implemented. The project was first completed in South West Indian Ocean Region and the results are explained briefly in this chapter. For details, please see the UNISDR Working Paper for Public Investment Planning and Financing Strategy for DRR.

Brief explanation of country structure in South West Indian Ocean

The project was implemented in five islands situated in the Indian Ocean (hereafter called IOC Region), namely: Madagascar, Mauritius, Seychelles, Union des Comores and Zanzibar.

These five islands in the Indian Ocean are home to 25.8 million people sitting on 594,331 km2 of land. The population density of the islands ranges from 35 (in Madagascar) to 618 (in Mauritius) (Table 11). The five entities have a combined total of 20 inhabited islands.

Table 11: Population in the IOC Region

	Population	Area (km^2)	Pop. Density
Madagascar	22.3 million (2012)	587,040	35
Mauritius	1.26 million (2014)	2,040	618
Seychelles	88,300 (2012)	455	198
Union des Comores	734,900 (2013)	2,236	278
Zanzibar	1,303,569 (2012)	2,560	530
IOC REGION	**25.6 million**	**594,331**	**43**

Source: UNISDR (2015a, 2015b, 2015c, 2015e), and World Bank for Union des Comores.

The Indian Ocean Commission (IOC) is an intergovernmental organization that was created in 1982 in Port Louis (Mauritius) and later institutionalized by the Victoria Agreement (Seychelles) in 1984. It brings together five countries from the Indian Ocean region: Comoros, Madagascar, Mauritius, Seychelles and Reunion (France).

As a tool for regional cooperation, across all sectors - political and diplomatic, economic and ecological, cultural and health - the IOC enables its members to respond to the common challenges of sustainable development. Indeed, the IOC as an external vehicle for collective and concerted action, leads cooperation projects that cover a wide range of fields including: maritime security, health monitoring, the management and control of fisheries, disaster risk reduction, the promotion of political stability and improved air, maritime and digital connectivity. As the only African regional organization made up entirely of islands, the IOC defends the common interests of its island states on the regional and international scene.

Box 10: Mission of the IOC

The IOC has a mission to actively contribute to the construction of a regional platform for sustainable development by strengthening the ties of solidarity among its Member States on the basis of a smart growth strategy and concerted actions.

More specifically, the IOC's mission has two complementary components:

the development and implementation of regional cooperation projects designed to protect the populations of Indianoceanic region, improve their lives and preserve the natural resources upon which they are heavily reliant; the defence of common interests of its Member States on the regional and international scene and emphasis of their specific characteristics with development partners and in multilateral fora.

In doing so, the IOC has become the preferred interlocutor of development partners, which it mobilises around cross border issues of common interest.

This is in the context of its mission that the island of Zanzibar of the United Republic of Tanzania, has been added to the beneficiary territories of the ISLANDS programme.

IOC operates wherever its action brings a strong added value to those of its members and / or initiatives of broader regional organizations (COMESA, SADC, Tripartite) of continental institutions (African Union) and / or multilateral (UN, WTO, etc.). While ensuring the principles of coordination, complementarity and subsidiarity, IOC assumes a supporting role in areas where its members require specific heightened support. Its aim is to increase the impact of its interventions, focusing on the implementation of initiatives that produce more tangible results and more visible benefit to the people.

At the national level within the region, there are some major differences in forms of government, etc. Highlights are described in Table 12.

Table 12: National government structure of the IOC Region (as of December 2014)

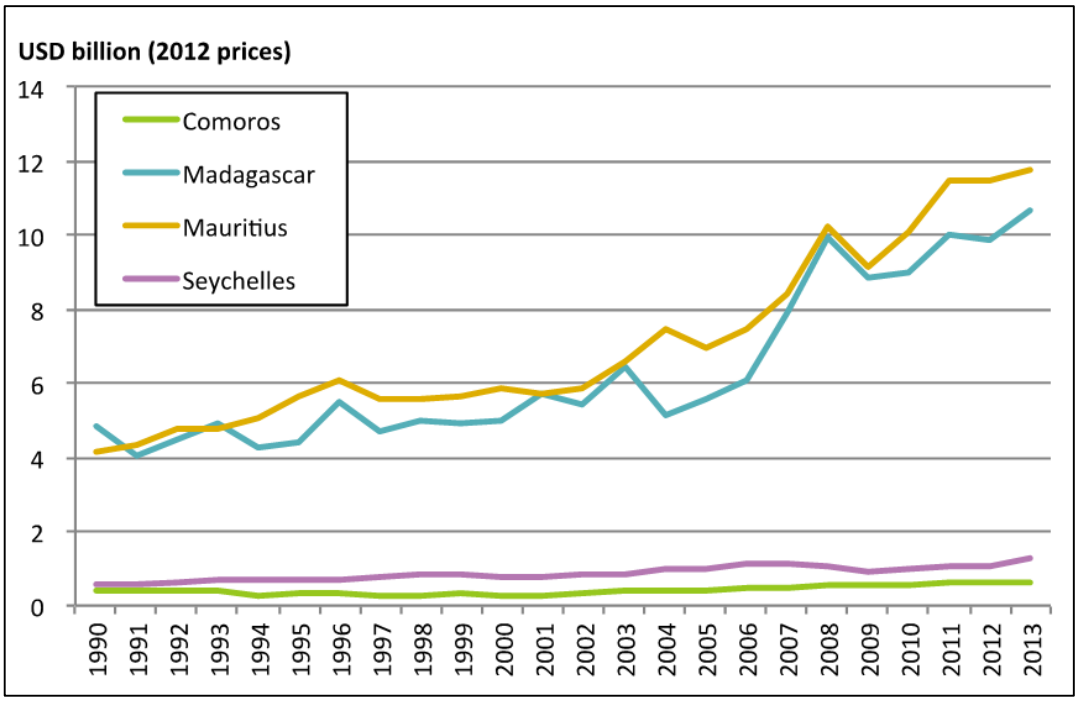
	Year of Independence	Form of Government	Legislature
Madagascar	1960	Unitary semi-presidential republic	Parliament (Senate and National Assembly)
Mauritius	1968 (Republic since 1992)	Parliamentary republic	National Assembly

Seychelles	1976	Presidential republic	National Assembly
Union des Comores	1975	Federal presidential republic	Assembly of the Union
Zanzibar	1964	Union Government, Semi-autonomous state within the United Republic of Tanzania	House of Representatives

Source: UNISDR (2015a, 2015b, 2015c, 2015e)

While economic structures[26] (i.e. as manifest in the GDP) in the region have been on the rise for Mauritius and Madagascar more or less since 2002, they have only risen since 2012 for Seychelles and have stagnated for Union des Comores (Figure 34). The trends for per capita GDP, however, demonstrate that while per capita growth is growing for Seychelles and Mauritius, the same cannot be said for Madagascar (Figure 35).

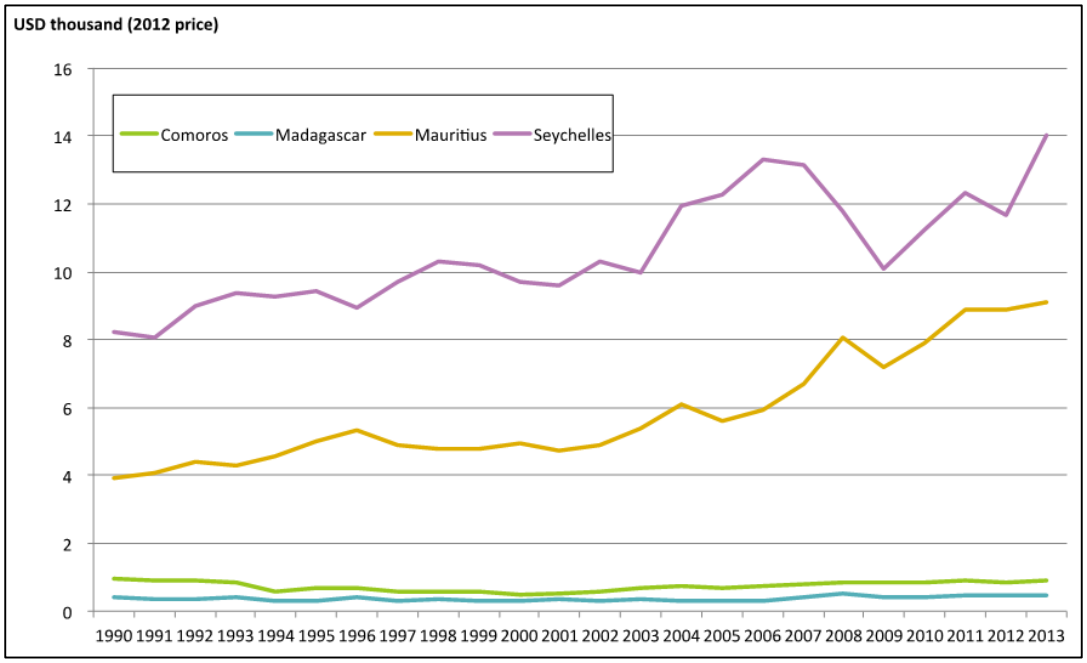
Figure 34: GDP (in USD billion at 2012 prices)



Source: World Bank Development Indicators

[26] Zanzibar was not analyzed together due to lack of comparable data

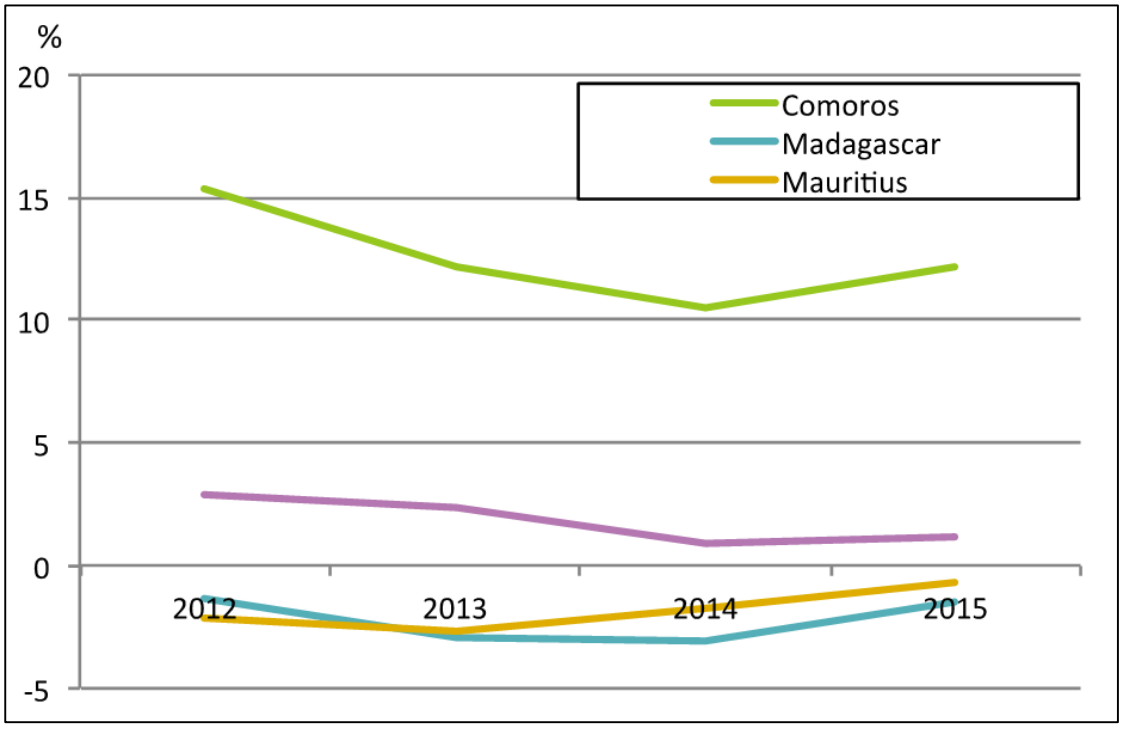
Figure 35: GDP per capita (in USD thousand at 2012 prices)



Source: World Bank Development Indicators

Public finance in the region is described by exploring trends in government balance as proportion of GDP. All four countries for which data exist show slight improvements over the past year (Figure 36).

Figure 36: Government balance, % of GDP

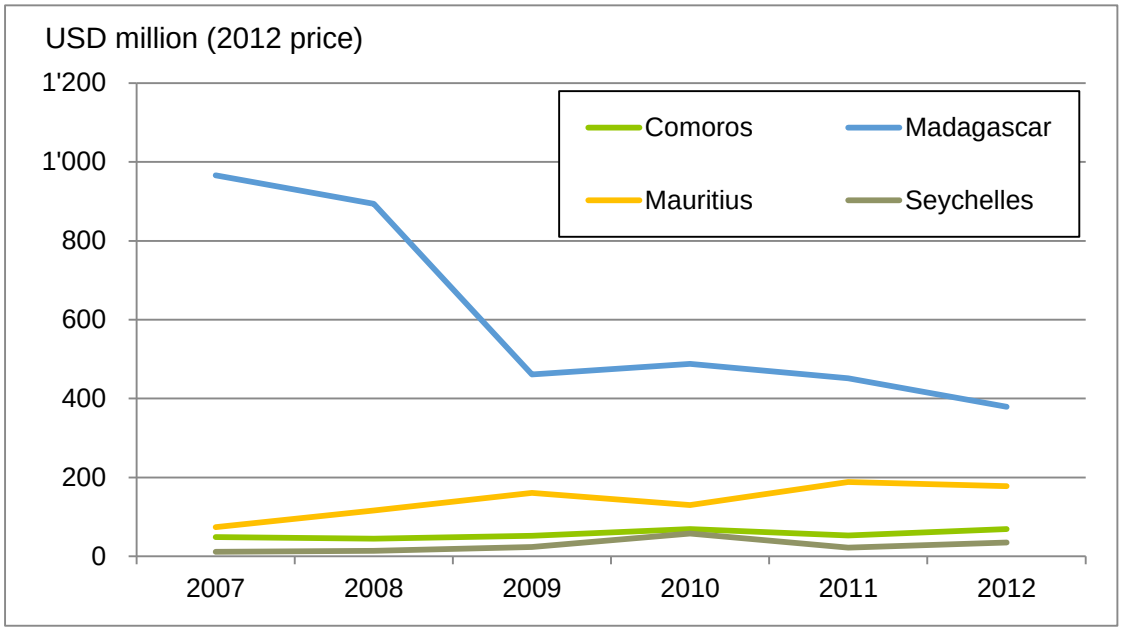


Sources: International Monetary Fund, World Economic Outlook Database, April 2014

Donor aid is an important source for DRR in this region. Except for Madagascar, whose

donor aid has fallen sharply since the civil strife, trends in donor aid has hovered under USD 200milion for the other three countries, with Seychelles and Union des Comores receiving the lowest (Figure 37). Donor fund uncertainty produces a gap between budget and expenditure (see Box in Zanzibar explanation).

Figure 37: Trends of donor aid (in USD 2012 prices)



Source: African Development Bank, Organisation for Economic Co-operation and Development, United Nations Development Programme (2014)

Box 11: Donor fund uncertainty produces a gap between budget and expenditure: Case of Zanzibar

There are reported significant differences between the budget that results from the budget preparation process and the actual expenses during the financial year. This is partly caused by the fact that during the planning process, not all details may be known and imperfect estimates are provided. During implementation, changes between the budget lines are made after gaining approval from the Principal Secretary of the concerned Ministry.

The more serious problem is external financing from various development partners, which provides 37% of the total national budget of 2014/15 and is mostly directed towards the capital expenditure as indicated in the table below. The high dependency of the government budget and in particular the capital budget on funding from external sources, makes implementation of the programs and projects risky. Anticipated external funding may be delayed or even withdrawn depending on conditions that are often beyond the control of the Government of Zanzibar. Another aspect is that by far the largest part of external funding is through loans from international development banks (World Bank, AfDB, Korean EXIM Bank, BADEA and OPEC fund) that will result in increased pressure on the Zanzibar budgets when repayments are due. Most of these larger loans are for infrastructure projects such as the new airport facilities and road construction. These are not directly related to increased preparedness for natural hazards although they might have some additional provisions to withstand extreme natural events for instance large drainage systems to accommodate the expected higher rainfall intensities.

The Bank of Tanzania in its annual reports mentions that the Government total expenditures were well below the proposed annual budgets of the past five years. While the recurrent budget is usually only a few percentage points different, the capital expenditures are 40 – 60% below the planned figures. The reason given is unavailabbility of donor funding which impacts in particular on the development expenditures.

Table 13: Zanzibar budget 2014-15 and share of external

Description	Tsh billion	%
Recurrent budget	376	53%
Capital budget (internal)	66	9%
Capital budget (external, grants and loans)	265	37%
Total Government budget	708	100%

Source: Zanzibar budget 2014/15

6.1. Disaster loss

Disaster Incidence

Table 14 portrays the compilation of data 1980 to 2014 on hazard events for the five entities in the Indian Ocean studied in this project. While 3,235 data cards were registered for GAR Universe (standardized data excluding man-made disasters and epidemics), the vast majority of registered hazards were categorized as "extensive" for all countries; overall this represents 97% of registered events in the region.

Table 14: Hazard events in the IOC (1980-2011)

	Data Cards Total Number	Extensive Events Number (%)	Intensive Events Number
Madagascar	1,378	1,298 (94%)	80
Mauritius	1,105	1,104 (99%)	1
Seychelles	636	636 (100%)	0
Union des	105	104 (99%)	1
Zanzibar	10	10 (100%)	o
REGION	**3,235**	**3,152 (97%)**	**82**

Source: National Disaster Loss Database.

Disaster Loss

Loss of lives due to the 3,235 registered events totals 1,635 (see Table 15). Over 85% of these deaths occurred in Madagascar (N=1,399). About half of the lives lost due to natural hazards were lost during intensive events.

Table 15: Mortality due to disasters in the IOC

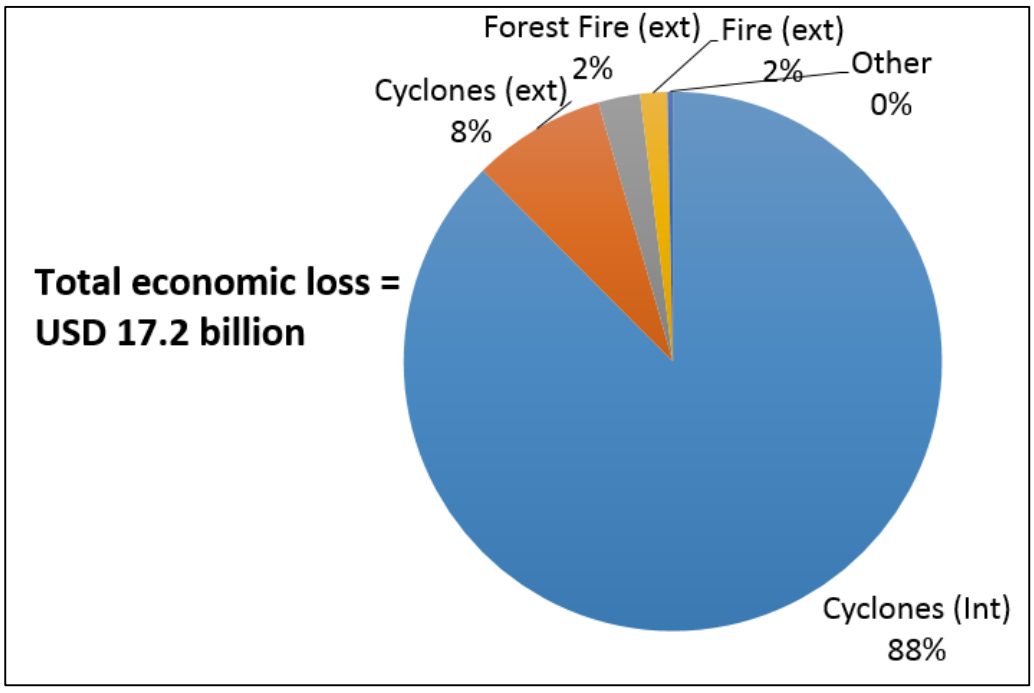
	Deaths Incurred (% in IO region)	Deaths due to Intensive Events (% of total events)
Madagascar	1,399 (89%)	785 (56%)
Mauritius	127 (8%)	1 (1%)
Seychelles	7 (0.4%)	No intensive events

	Deaths Incurred (% in IO region)	Deaths due to Intensive Events (% of total events)
Union des	34 (2%)	No data
Zanzibar	1 (0.06%)	0
TOTAL 5 Islands	**1,635**	786

Source: National Disaster Loss Database.

In terms of physical loss, the full set of events registered in the Indian Ocean totaled USD 17.2 billion at 2013 prices (see Figure 38). The most costly events in the region are intensive cyclones (contributing 88% of the loss) and extensive cyclones (an additional 8%). Fires (forest and others) are the second most costly types of hazards in the region.

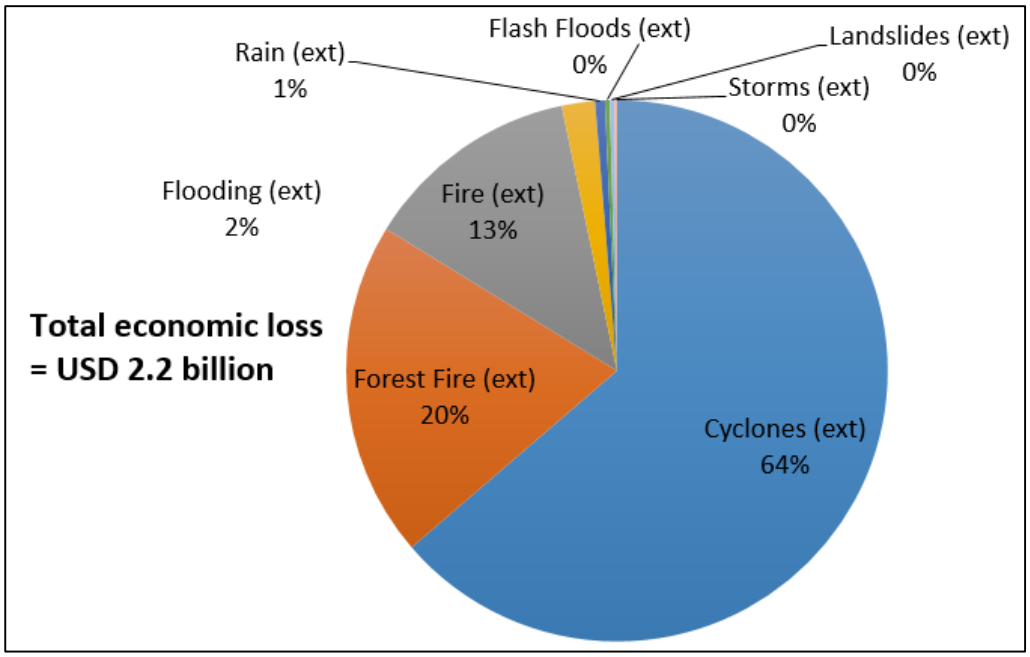
Figure 38: Total Economic Loss (infrastructure and agriculture)



Source: National Disaster Loss Database.

A closer look at extensive events alone (Figure 39), further emphasizes the destructive role that fires play in the region as well as heavy rains, despite the much lower overall loss (USD 2.2 billion).

Figure 39: Economic Loss due to extensive events (infrastructure and agriculture)



Source: National Disaster Loss Database.

Economic loss by country is as follows (Table 16). Madagascar DRR policy should mainly focus on cyclones because 93% of economic loss is due to cyclones. The target of Mauritius DRR policy should be also cyclones, which contribute to 82% of total economic loss. In Seychelles, floods and landslides are considered major natural hazards. Flooding, especially in the coastal zones where 80% of settlement and business infrastructures are accumulated, would have significant direct and indirect loss. Union des Comores has been suffered mainly from cyclones and floods. In Zanzibar, though past loss dais not still sufficiently recorded, the UNISDR/IOC (2015e) reports the disaster events are mainly related to rainfall causing droughts and floods.

Table 16: Economic losses by country (IOC)

	TOTAL	Intensive(cyclone)	Extensive (cyclone)	Flood	Fire	Others
Madagascar	8,838,785,661	85%	8%	-	5%	2%
Mauritius	59,062,996	37%	45%	5%	3%	10%
Seychelles	15,593,630	-	-	50%	-	50%
Union des Comores	9,800,000	58%		35%		7%

	TOTAL	Intensive(cyclone)	Extensive (cyclone)	Flood	Fire	Others
Zanzibar	1,286,745	-	-	88%	-	12%

Note: Others in Seychelles include tsunami, landslide, rain and storm (15%, 13%, 10%, 10% each). Union des Comoros is an approximate figure.
Source: National Disaster Loss Database.

6.2. Probabilistic Risk Assessment

In the IOC region, UNISDR supported building of probabilistic risk assessment for tropical cyclonic wind (Madagascar, Mauritius, Seychelles and Union des Comores) and earthquake (Madagascar, Seychelles, Union des Comoroes and Zanzibar). Tropical cyclone was selected because it was clear from the disaster loss data that the region (especially Madagascar and Mauritius) has been hit by cyclone very often causing much loss. Earthquake was selected due to data availability given the short time frame of the initiative, even though it is not a major hazard for the region.

Table 17 presents the regional summary of results: the AAL in absolute terms and relative to other values for both hazards in the five islands. Total Absolute AAL for both hazards in the studied islands sums to USD 161.43 million and constitutes an average of 3.65‰ of Exposed Assets, 3.7% GFCF and 0.9% of GDP. Tropical cyclone in Madagascar and Mauritius contributes to 99.6% of total AAL. AAL in Seychelles is estimated to be zero for both hazards due to the location.

Table 17: Absolute and Relative AAL in the IOC

TROPICAL CYCLONIC WIND	Absolute AAL Wind (USD million)	Relative AAL Wind (‰ for Exposed Assets and % for GDCF and GDP)		
Madagascar	USD 73.39	2.90‰	4.26%	1.21%
Mauritius	USD 86.91	8.27‰	4.40%	1.00%
Seychelles	USD 0.00	0.00‰	0.00%	0.00%
Union des Comores	USD 0.16	0.20‰	1.90‰	0.40‰
EARTHQUAKE	Absolute AAL Earthquake (USD million)	Relative AAL Earthquake (‰ for Exposed Assets and % for GDCF and GDP)		
Madagascar	USD 0.56	0.02‰	0.33‰	0.09‰
Seychelles	USD 0.00	0.00‰	0.00%	0.00%
Union des Comores	USD 0.21	0.03‰	2.44‰	0.47‰
Zanzibar	USD 0.20	0.15‰	1.39‰	0.22‰

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

Table 18 and Table 19 portray the results of the PML for cyclonic winds and earthquakes, respectively. Regional PML is estimated at USD 1465 million for wind and USD 2.29 million for earthquake in a 50-year return period, increasing with longer return periods. Earthquake PML is relatively much smaller than the tropical cyclonic wind PML. PML in Mauritius and Madagascar for tropical cyclonic winds are very high.

Table 18: PML for tropical cyclonic winds

CYCLONE PML	Madagascar	Mauritius	Union des Comores
RETURN PERIOD 50 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 367.10 (1.4%) (21.4%) (6.0%)	USD 1,094.00 (10.4%) (55.6%) (12.6%)	USD 2.61 (0.3%) (3.0%) (0.6%)
RETURN PERIOD 100 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 438.38 (1.7%) (25.5%) (7.2%)	USD 1,726.00 (16.4%) (87.7%) (19.9%)	USD 3.13 (0.4%) (3.6%) (0.7%)
RETURN PERIOD 250 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 545.03 (2.1%) (31.7%) (9.0%)	USD 2,288.00 (21.8%) (116.3%) (26.4%)	USD 3.87 (0.5%) (4.5%) (0.9%)
RETURN PERIOD 500 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 583.36 (2.3%) (33.9%) (9.6%)	USD 2,773.00 (26.4%) (141.0%) (32.0%)	USD 4.52 (0.6%) (5.3%) (1.0%)
RETURN PERIOD 1000 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 650.34 (2.5%) (37.8%) (10.7%)	USD 2,929.00 (27.9%) (148.9%) (33.8%)	USD 5.05 (0.6%) (5.9%) (1.1%)

Source: UNISDR (2015a, 2015b, 2015d)

Table 19: PML for earthquake

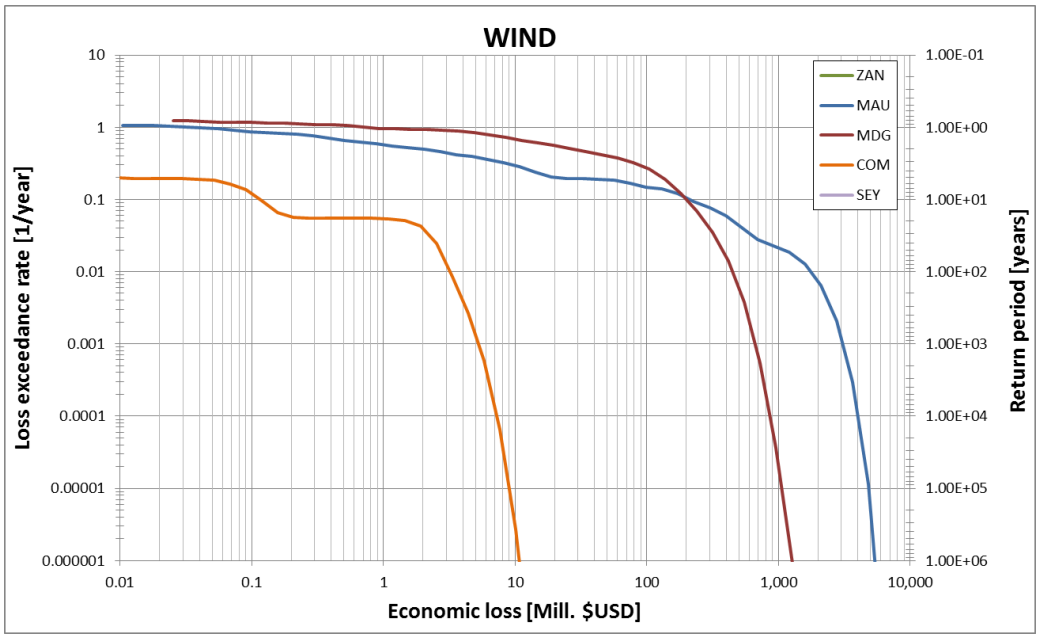
EARTHQUAKE PML	Madagascar	Union des Comores	Zanzibar
RETURN PERIOD 50 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 1.40 (0.01%) (0.08%) (0.02%)	USD 0.49 (0.06%) (0.57%) (0.11%)	USD 0.40 (0.03%) (0.28%) (0.04%)
RETURN PERIOD 100 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 3.74 (0.01%) (0.22%) (0.06%)	USD 1.25 (0.15%) (1.45%) (0.28%)	USD 1.00 (0.08%) (0.69%) (0.11%)

RETURN PERIOD 250 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 14.68 (0.06%) (0.85%) (0.24%)	USD 5.70 (0.71%) (6.63%) (1.27%)	USD 4.00 (0.30%) (2.78%) (0.45%)
RETURN PERIOD 500 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 37.20 (0.15%) (2.16%) (0.61%)	USD 17.09 (2.12%) (19.87%) (3.80%)	USD 12.50 (0.95%) (8.68%) (1.40%)
RETURN PERIOD 1000 (USD million) **(% of Exposed Assets)** **(% of Gross Fixed Capital Formation)** **(% of GDP)**	USD 83.06 (0.33%) (4.83%) (1.37%)	USD 42.07 (5.21%) (48.92%) (9.35%)	USD 34.00 (2.58%) (23.61%) (3.81%)

Source: UNISDR (2015a, 2015d, 2015e)

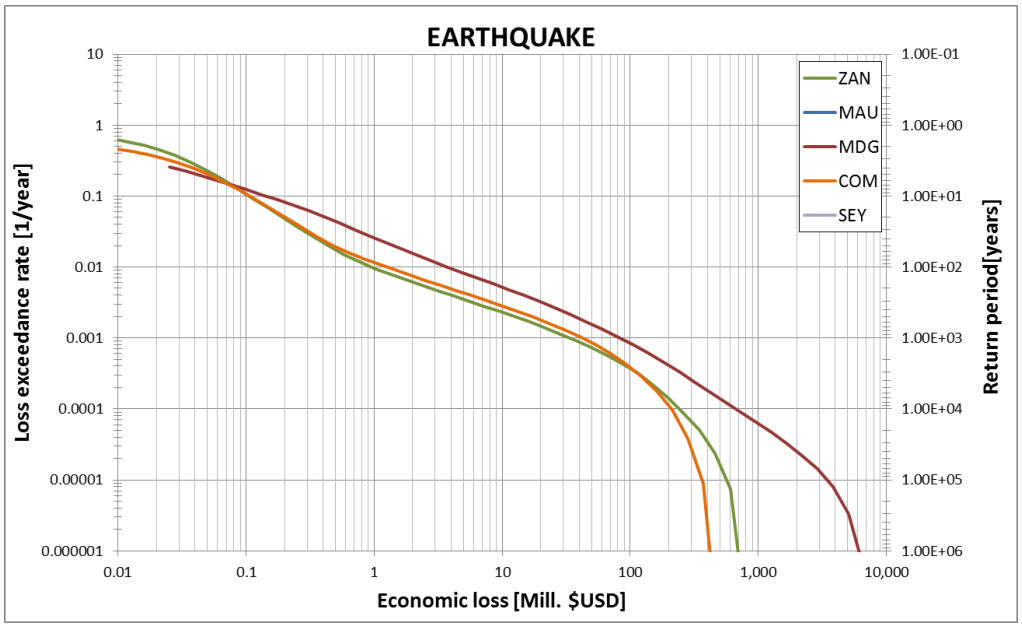
When we see the curve (Figure 40), different characteristics across countries surfaces: Regarding tropical cyclonic wind risk, higher risk in Madagascar regarding law and mid risk layers while in intensive risk layer, Mauritius risk is higher. Union des Comores needs to prepare for intensive risk for earthquake but have more needs to invest in DRR to reduce extensive tropical cyclonic wind risk instead of earthquake. Careful look at loss exceedance curve informs policy makers of the priority out of several hazards that the country faces.

Figure 40: Loss exceedance curve of SWIO region for tropical cyclonic winds



Note: Risk of Seychelles is estimated to zero. Assessment of Zanzibar was not implemented due to low risk.
Source: UNISDR

Figure 41: Loss exceedance curve of SWIO region for earthquake



Note: Risk of Seychelles is estimated to zero. Assessment of Mauritius was not implemented due to low risk.
Source: UNISDR

6.3. Current DRR Policies in South West Indian Ocean Region

In the IOC Region, there is no regional entity, or department/unit to date that is officially mandated to focus on disaster risk reduction or disaster management. Examples of such a regional entity elsewhere include the Caribbean Disaster Emergency Management Agency (CDEMA), headquartered in Barbados, or the Disaster Risk Reduction Unit inside SADC. Such an entity has been proposed for the IOC region, with many different options to consider (See URG, 2014[27]). It merits being reconsidered with a greater focus on DRR than on response.

At the national level, all studied countries have created an entity mandated to manage risk with very different names (see Table 20). While some of the countries (Madagascar and Mauritius) still have two entities, one with a primary focus on DRR, before the event, and another filling above all the role of emergency management after an event, Seychelles and Zanzibar have only one entity. All of the entities are now anchored at the highest levels of government, such as Prime Minister's Office or the Vice Presidency. This is a good sign that they can provide compelling arguments in favour of risk reduction for key decision makers.

[27] François Grünewald F. and Sallustro, J-L., 2014. Élaboration de procedures exceptionnelles en cas de crise dans les pays membres de la COI. URG; Référence projet: COI AO-PGRNC-2012-02.

Table 20: Disaster risk Management agencies

Source: UNISDR/IOC (2015a, 2015b, 2015c, 2015d, 2015e)

	Name of National Disaster Authority	Anchorage and Date of creation	Mandate (DM, DRR or both)	Number of full-time personnel
REGIONAL	None			
Madagascar	National Council of DRM (CNGRC); National Office of DRM (BNGRC); Emergency Prevention and Management Agency (CPGU)	Min. Dom. Affairs; 2006 PM 2006	Mainly DM Both	55 24
Mauritius	National DRR and Management Centre (NDRRMC) National Emergency Operations Command (NEOC) within NDRRMC	PM, 2013 PM, 2013	Both DM	1-8
Seychelles	Division for Risk and Disaster Management (DRDM)	Vice Pres., 1999	Both	6
Union des Comores	Directorate General of Civil Protection (DGSC)	2012 (COSEP since 2007)	DM	
Zanzibar	Disaster Management Department (DMD)	2nd V.P., 2006	Both	22

There are numerous continental and regional entities in Africa that provide a wider perspective of strategic thought and protection for DRM/DRR/CCA. The Africa Union established the "Disaster Risk Reduction for Sustainable Development in Africa" as a regional strategy for Sub Saharan Africa. It aims to increase political commitment to DRR; improve identification and assessment of disaster risks; enhance knowledge management for DRR; increase public awareness of disaster risk reduction; improve governance of DRR institutions; and integrate DRR in emergency response management. This strategy has also informed the sub-regional efforts made by African RECs to strengthen their capacities in the area of DRR. One REC, the Southern Africa Development Commission Secretariat (SADC, to which some IOC islands also belong) elaborated, in 2011, their "Disaster Risk Reduction Strategy and Plan of Action, 2010 – 2015". This strategy is a tool for the implementation of the SADC DRR Policy framework among the 15 member states.

The Mauritius Strategy (MS) for the 'Further Implementation of the Barbados Programme of Action (BPoA) for the Sustainable Development of Small Island Developing States (SIDS)' was adopted by 129 countries and territories in the conference held in Mauritius, January

2005. It addresses the unique development problems of SIDS and sets out the basic principles and specific actions required to support sustainable development. In Section II of the MS, all five IOC islands agreed to "strengthen their respective national frameworks for more effective disaster management and … regional mechanisms as facilities to improve national disaster mitigation, preparedness and early-warning capacity, increase public awareness about disaster reduction, stimulate interdisciplinary and intersectoral partnerships, and the mainstreaming of risk management into the national planning process"; as well as to "augment the capacity of SIDS to predict and respond to emergency situations, including those affecting human settlements, stemming from natural and environmental disasters".

The ISLANDS programme seeks to bridge these gaps through innovative pillars in: regional cooperation and integration, SIDS-SIDS knowledge exchanges, and a methodology to deal with the large asymmetries between the developmental stages of the beneficiary countries. One of the ISLANDS flagship programs is the "Capacities for Risk Financing Mechanisms" in light of natural and climatic disasters, the effort guiding this study.

Countries that have a DRM, DRR or CCA strategy are delineated in Table 21 below. New momentum for DRR has been emerging, for example, by Disaster Risk Management Act in Seychelles and Disaster Risk Reduction Management Bill (in draft) in Mauritius.

Table 21: Instruments related to DRM/DRR or DM

	Strategies, Policies and Plans	**Legislation (Bills, Acts, etc.)**
Madagascar	National Strategy on Disaster Risk Management (2003)	The Act no 2003-010 related with National Strategy on Disaster Risk Namangement
Mauritius	Disaster Risk Reduction and Management Strategic Framework and Plan; Climate Change Adaptation Policy (20 years) Climate Change Adaptation Strategy and Action Plan (1998)	Disaster Risk Reduction and Management Bill, *in draft*; Climate Change Bill, *in draft*
Seychelles	National Risk and Disaster Management Policy (2008, updated in 2014)	Disaster Risk Management Act, 2014

	Strategies, Policies and Plans	Legislation (Bills, Acts, etc.)
	Climate Change Strategy (2009)	
Union des Comores[28]	National Strategy for the Reduction of Risk and Disasters (SNRRC, draft)	Environment Law, Decree of Health
Zanzibar	Disaster Management Policy (2011) Emergency Preparedness and Response Plan (2011) Zanzibar Climate Change Strategy (2014)	Disaster Management Act, No.2 (2003, under review)

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

Based on the HFA Monitor data, the overall status of the HFA priorities among the five islands varies from 1.86 in Union des Comores to 3.68 in Mauritius, all indicators averaged (Table 22). Priority 1, "Ensuring that DRR is a national and local priority with a strong institutional basis" demonstrates the most progress, with an average of 3.25 across the region (it is among the two highest for three countries: Madagascar, Mauritius and Seychelles). Priority 4 "Reducing the underlying factors of risk" is the area needing the most support, especially for Madagascar and Union des Comores. Risk sensitive public Investment planning is the most related with Priority Action 4 (e.g. HFA Core Indicator 4.6) and needs more efforts according to the country's self-assessment reports.

[28] A recent study guided by IOC (AFD, 2014: *Renforcement des politiques publiques et appui aux structures nationales…dans les pays membres de la COI*) states that the Law on environmental protection, 1995, could be the basis upon which to develop a legislative position on DRM in Union des Comores.

Table 22: Hyogo Framework for Action progress reported by IOC countries

(Best rating is '5')	Priority Action 1: Ensure that DRR is a national and local priority with a strong institutional basis	Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning	Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience	Priority Action 4: Reduce the underlying risk factors	Priority Action 5: Strengthen disaster preparedness for effective response at all levels	Average of all Scores
REGIONAL AVG	**3.35**	**3.30**	**2.95**	**2.90**	**3.20**	**3.12**
Madagascar	3.75	3.50	3.75	2.67	3.50	**3.36**
Mauritius	4.00	3.50	3.50	3.67	3.75	**3.68**
Seychelles	4.00	4.00	2.00	3.33	3.75	**3.41**
Union des Comores	1.75	2.50	2.25	1.50	1.50	**1.86**
Zanzibar	3.25	3.00	3.25	3.33	3.50	**3.27**

Note: The figures for Zanzibar use those for the United Republic of Tanzania, as Zanzibar does not report to the HFA Monitor independently. The Tanzanian figures may not be a true reflection of capacity in Zanzibar.
Source: HFA Monitor Progress Report of each country, most recent submission (year varies)

In fact, risk-sensitive public investment is not an integral part of fiscal policy and practice in the region. Disaster risks are not addressed explicitly in most of the Indian Ocean countries. However, there have been many efforts to recognize risk (see as good practice Box for Mauritius EIA guidelines and Seychelles and Zanzibar legal/policy progress toward strengthened risk sensitive investment). Key government stakeholders in each country that would eventually be implicated in risk-sensitive public investment are described in Table 23.

Table 23: Key government stakeholders identified in each country

	Key Government Stakeholders for DRR Investment Identified in each country
Madagascar	Prime Minister's Office (CPGU), Ministry of Agriculture, Ministry of Finance and Budget the Ministry of Domestic Affairs (BNGRC), Ministry of Public Works, Ministry of Transport, Ministry of Health, Ministry of the Interior, Ministry of Education

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

Mauritius	Prime Minister's Office, NDRRMC, Ministry of Health, Police and Coast Guard, Fire Services, Meteorological Services, Local Government, Ministry of Public Infrastructure (Roads & Drainage) and Ministry of Public Utilities (Water and Electricity)
Seychelles	Ministry of Finance, Ministry of Environment and Energy, Ministry of Health, Ministry of Land Use and Habitat (Planning), Land Transport Division, Ministry of Youth, Sports and Community Development, Chamber of Commerce and Industry, Meteorology and Climate Change Division, Division of Risk and Disaster Management, Public Utilities Corporation (PUC), Police and Fire Services
Union des Comores	Directorate General of Budget, General Planning Commission (CGP), Ministry of the Interior, Ministry of Foreign Affairs, Directorate General of Civil Protection (DGSC), Technical Directorate of Meteorology (DTM and ANACM), Volcanological Observatory of Karthala, Regional Directorates of Civil Defense (Grand Comore - Anjouan and Moheli), National Directorate of Health (DNS)
Zanzibar	Disaster Management Department, Ministry of Finance and Planning Commission, Line ministries (health, natural resources, infrastructure, etc.) Disaster response agencies: police, coast guard, fire services, local government

Box 12: Good practice toward risk sensitive investment

Mauritius: One of the priorities of Mauritius has been to mainstream climate change risk management, mitigation and adaptation in the development process through the EIA mechanism. For specified projects under the Environment Planning Act 2002, either a preliminary environment report (PER) or Environmental Impact Assessment (EIA) needs to be carried out and contain relevant details on the environmental factors of the project, and the measures to avoid or minimize adverse effects on the environment. As such, all projects which have environmental risks require an EIA licence granted by the Department of the Environment. Depending on the sector, the guidelines for EIA report drafting specify that the consultant should assess the 'vulnerability of the site to natural hazard or climate change impacts like storm surges, inundation or flooding'. As such few environmental sectoral guidelines prepared by this Ministry in December 2013 on the content for EIA report have included climate change issues; such as a vulnerability assessment with respect to climate change issues, storm surges (as applicable, flooding, inundation, landslides and other climatic conditions**)**, should be provided along with the proposed adaptation and mitigation measures.

Seychelles: The Disaster and Risk Management Act, 2014 (just put to the National Assembly) addresses core DRM issues, inclusive of DRR investments, budgeting and financing. The Act has provisions for national Risk Disaster Management Fund though the levels of funding and investments are not clearly articulated. It is to note that the composite of the funds include amounts appropriated by the National Assembly and those transferred from other divisions to the Fund, as/when required and agreed upon. There is great opportunity to mainstream risk sensitive public investment in the government budget and public investments with the introduction of programme-based budgeting, which is being piloted in Seychelles.

Zanzibar: The Disaster Management Policy (2011) and the draft Disaster Management Act of 2012 propose the establishment of a Zanzibar Disaster Management Fund (ZDMF) to ensure the accessibility of enough resources for disaster preparedness, mitigation, response and recovery. The sources of the ZDMF shall consist of:

- any monies voted to it by the House of Representatives for that purpose
- any monies made by way of donations or grants made within and outside Zanzibar
- subscriptions by the public
- any monies as a result of fines imposed as penalties under this Act

It is not yet clear if the ZDMF will actually be approved by the Zanzibar House of Representatives and if so, when it will be put in place.

Source: UNISDR (2015a, 2015c, 2015e)

Beyond the legal and explicit liability, also lies the implicit liability where governments are expected to intervene promptly after a disaster event to provide relief and recovery to those affected (damaged and destroyed housing, loss of property). There are various financial mechanisms that support natural hazard management. The use of these mechanisms to address recovery and reconstruction costs in the region is summarized in

Table 24: Financial mechanisms to address recovery and reconstruction costs in the region

	Madagascar	Mauritius	Seychelles	Union des Comores	Zanzibar
Ex-ANTE (4)					
Contingency budget line	-	YES	No	YES	YES
Contingency funds	YES	NO	SOME	SOME	YES
Insurance	SOME	SOME	SOME	NO	SOME
Others	-	Corporate and population contributions	CSR Tax, Disaster relief fund from private sector	NO	-
EX-POST (7)					
Diverting funds from other budget items	YES	POSSIBLE	POSSIBLE	NO	YES
Imposing or raising taxes	NOT YET USED	NO	NO	NO	POSSIBLE
Taking a credit from the Central Bank (either prints money or depletes foreign currency reserves)	POSSIBLE	NO	NO	POSSIBLE	YES
Borrowing by issuing domestic bonds	POSSIBLE	POSSIBLE	POSSIBLE	NO	YES
Accessing international assistance	YES	NO NEED	IF NEEDED	NO	YES
Borrowing from multilateral institutions	NOT YET USED	POSSIBLE	POSSIBLE	NO	POSSIBLE
Issuing bonds on the international market	NOT YET USED	POSSIBLE	NO	NO	NO

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

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Out of the four ex-ante mechanisms, there are live examples in the region for each one. Contingency Funds are established in four islands. However reality check clarifies the limitation. For example, the contingency funds in Madagascar is deplete and needs additional funding to support the scheme. All islands have some experience with insurance, though the use level differs different across countries (see Box 13, explaining Mauritius insurance as good practice).

Five of the seven ex-post mechanisms are currently employed in the region. While Madagascar and Zanzibar commonly accept international assistance, they also cast 'diverting funds from another budget' as a mechanism employed, even if Mauritius and Seychelles deems this possible. A credit from the Central Bank and borrowing by issuing domestic bonds is used in Zanzibar, and is deemed possible by the other islands. Madagascar can also borrow from multi-lateral institutions, which is possible in the other islands. The report of each country highlights that countries are struggling with accessing sufficient money to finance disaster management and combining several tools with diversion from other budget items as main financing sources.

Table 24: Financial mechanisms to address recovery and reconstruction costs in the region

	Madagascar	Mauritius	Seychelles	Union des Comores	Zanzibar
Ex-ANTE (4)					
Contingency budget line	-	YES	No	YES	YES
Contingency funds	YES	NO	SOME	SOME	YES
Insurance	SOME	SOME	SOME	NO	SOME
Others	-	Corporate and population contributions	CSR Tax, Disaster relief fund from private sector	NO	-
EX-POST (7)					
Diverting funds from other budget items	YES	POSSIBLE	POSSIBLE	NO	YES
Imposing or raising taxes	NOT YET USED	NO	NO	NO	POSSIBLE
Taking a credit from the Central Bank (either prints money or depletes foreign currency reserves)	POSSIBLE	NO	NO	POSSIBLE	YES
Borrowing by issuing domestic bonds	POSSIBLE	POSSIBLE	POSSIBLE	NO	YES
Accessing international assistance	YES	NO NEED	IF NEEDED	NO	YES
Borrowing from multilateral institutions	NOT YET USED	POSSIBLE	POSSIBLE	NO	POSSIBLE
Issuing bonds on the international market	NOT YET USED	POSSIBLE	NO	NO	NO

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

Box 13: Insurance in Mauritius

State Owned Enterprise: Though Central Government does not insure its assets, state owned enterprises insure their assets (e.g. Central Electricity Board (CEB) for electricity infrastructure, Central Water Authority, Mauritius Wastewater Authority, Mauritius Port Authority, the Airport of Mauritius Co.Ltd).

Insurance-related Funds: In certain economic sectors, insurance funds or special grants and loans have been set up to cater specifically for damage caused by natural hazards. Under the Small Farmers Welfare Fund, an insurance scheme (Agricultural Calamity Solidarity Scheme) for registered small planters and breeders is made available, which provides financial support to those who experience difficulties in the aftermath of calamities such as cyclones, excessive rainfall, drought and flood.

The Sugar Insurance Fund Board (SIFB): Sugar industry has a long established insurance system for sugar cane planters. SIFB is a form of 'contingency finance mechanism' as it provides covers to all insured planters (compulsory for planters and millers) for losses in sugar production arising from weather-related hazards such as cyclones, drought and excessive rainfall. The Fund was set up by Government in consultation with the sugar producers and operates under the aegis of the Ministry of Finance and Economic Development. However it is funded entirely by the sugar industry. Compensation is only paid to insured planters in an event year, defined as 'crop loss beyond 20% due to unfavourable climatic conditions'. The Fund also operates a fire insurance. For instance, compensation amounting to Rs 7.6 million (USD 0.25 million) for Crop Year 2012 and Rs 6.01 million (USD 0.19 million) for Crop Year 2013 was paid to insured planters for loss consequent upon destruction of cane plantations by inter-crop fire. Moreover, Rs 0.3 million (USD 10,622) in Crop Year 2012 and Rs 1.4 million (USD 45,710) in 2013 was paid to eligible insured planters as transport allowance for the milling of burnt canes (during the harvest season) outside their respective factory areas. The SIFB however remains a fund and as such does not provide for re-insurance, which can pose a limit to the compensation to be paid in an exceptionally catastrophic year.

Source: UNISDR (2015a)

6.4. The risk sensitive budget review

Although the country analyses each employed the OECD-WB-UNISDR proposed DRM Marker method, readers are cautioned to be prudent when comparing results across countries. This is because they were obliged to use different years and numbers of years, different types of budgets (some included capital others only recurrent budget for consumption; some drew on expenditure reports while others stuck to actual budgets), levels (some were able to pull in devolved budgets and even donor funding) and sectors/ministries (while small countries may have included every budget, larger countries chose seven to 13 different budgets as their focus for the exercise) and hazards. Table 25 demonstrates the variety of different scopes that were selected for a national budget review from the five IOC countries included in the present effort.

Table 25: Different scopes in budget review

	Years (Number: Span)	Capital / Current (Budgets/ Expenditures)	Coverage (Number of sectors, ministries, etc.)	Hazard Focus
Madagascar	5 years: 2010-2014	Current (Budgets)	9	Cyclone, floods, epidemics and locust
Mauritius	2 years: 2013, 2014	Both (Both)	9	Cyclone, heavy rains, flood, landslide, drought, fire, epidemics
Seychelles	3 years: 2012-2014	Both (Both)	17	Geological (e.g. earthquake, tsunami), meteorological (e.g. Cyclone), hydrological (e.g. flood, landslide), epidemics and others

Union des Comores	4 years: 2011 to 2014	Both (Budgets)	7	uncertain
Zanzibar	1 year: 2014/15	Both (Budgets)	11	Fires, drought, epidemics (human and animal), climate change

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

The five IOC islands implemented their first ever risk-sensitive budget review in 2014, under the supervision of this project. The results, although preliminary, are an exciting first glance at possible levels of investment (and gaps) in risk reduction over the recent years. Across the region, DRM-marked investments ranged from 2 to 16% of the studied national budgets (Table 26). According to this analysis, the greatest proportion of investment in DRR to date occurs in Mauritius.

While two countries marked a greater proportion as "Significant", the others marked more as "Principle". Significant markings are considered potential signs of mainstreaming, as those investments are not pinned to specific DRR projects (or designed as such). In this respect, mainstreaming of DRR concepts would appear to be more thoroughly underway in Mauritius and Seychelles.

Table 26: DRM marked investments

Proportion of studied budgets "marked" for DRM	Principal ("2") (USD million)	Significant ("1") (USD million)	Total "Marked" (USD million)	Total "Marked" / total budget (%) (% of total studied)
Madagascar (2010-2014)	120.7	10.4	131	1.87% (of USD 7.03 billion)
Mauritius (2013-2014)	333	256	588	7% (of USD 8.4 billion)
Seychelles (average of 2012 to 2014)	3.3	13.2	16.5	3.75% (of USD 440 m)
Union des Comores	3.81	0.39	4.2	7% (of USD 52 m)

Zanzibar	2.56	10.60	13.2	3% (of USD 440 m)

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

In terms of tagging components of Risk Management (See Table 27), the overall trend points to a greater investment in preventive / mitigation action for Mauritius, Seychelles and Zanzibar. In Madagascar and Union des Comores, the greatest current investment is in response. A closer look at how this has evolved in the IOC region through the years would shed more light on whether or not it is a real trend, driven by rising awareness levels.

Table 27: Tagging by component of risk management (% of total DRM investment)

	Prevention/ Mitigation	Preparedness	Response	Recovery/ Reconstruction
Madagascar	13.7%	34.9%	47.7%	3.7%
Mauritius	74.3%	22.4%	0.1%	3.2%
Seychelles	62.6%	27.4%	9.4%	0.6%
Union des Comores	37.0%	2.0%	65.0%	0.0%
Zanzibar	80.0%	5.0%	15.0%	0.0%

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

As promising additional analysis, Zanzibar divided marked budget between DRM and CCA objectives. The analysis shows that 43% of the identified budgets are DRM related and these are in particular for activities implemented through the Ministry of Health. The balance of 57% has been classified as CCA-related, mainly in the agricultural and environment sectors such as for agricultural research and irrigation development.

The gap analysis (**Error! Reference source not found.**) was conducted in this effort more to demonstrate utility and to become familiar with the process than to produce concrete results. To be credible, a gap analysis needs to compare both observed historic loss and estimated Average Annual Loss (AAL) to estimated current investment in DRR focused on the same set of hazards. It is not useful, for example, to compare the AAL for earthquakes to a budget review focused only on flooding and storms. Nonetheless, the regional results of the gap analysis described below--to be explored with caution, can inform a healthy debate. Table 28 uncovers a gap in DRR investment for example, in Madagascar. The results

should not be interpreted, however, to signify that "enough is already being done" in the other islands.

Table 28: Gap Analysis

	A. Annual Loss (Multi-hazard, total: 1980-2013) (USD Million)	B. AAL (Quake and/or Wind) (USD Million)	C. Current Annual Investment in DRR/DRM (USD Million)	Gap (If C<A or C<B→ gap)
Madagascar	260 (8,839)	75 (both)	**26.2** (2010-2014 average)	Both
Mauritius	4.5 (59)	87 (wind only)	**294** (2013/2014 average)	Neither
Seychelles	1.2 (15.6)	0 (both)	**16.5** (2012-14 average)	Neither
Union des Comores	0.29 (9.8)	0.37 (both)	**4.2** (2011-14 average)	Neither
Zanzibar	0.04 (1.3)	0.2 (quake only)	**13.2** (2014/15)	Neither

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

The Ministries of Finance involved in the above analyses are convinced that the exercise can serve as a useful tool to both become more effective in spending (in the face of evolving risk profiles) and to demonstrate accountability to their respective publics and/or donors. Furthermore, it was proposed that such an exercise, not requiring a huge investment in time/effort and could be readily contracted to an agent each year, under the careful supervision of the NDMA and Min. Finance. Another solution would be to develop a roving team at the regional level that could lend capacity each year at a given time to the national stakeholders for a renewed analysis.

6.5. CATSIM analysis

Building on the results for loss and risk, the main findings specific to CATSIM analysis are as follows:

Fiscal resources available for reconstruction and recovery (excluding international aid) under an optimistic assumption are portrayed in Table 21. In each country, fiscal resources available for reconstruction and recovery include, for example, those drawn from budget diversion, domestic credit, IMF and international borrowing. Uncertainty regarding fiscal resources availability is high and these numbers should be interpreted with caution as locally specific economic and policy considerations could significantly limit the use of these resources. Same assumptions were applied for all islands.

Fiscal resources gap years were estimated – the return period at which each government will face difficulty in raising sufficient funds for reconstructio3n. The gaps for the IOC islands were between 24 and 329 years (see Table 29). Zanzibar was identified as having no fiscal resource gap for earthquake risk.

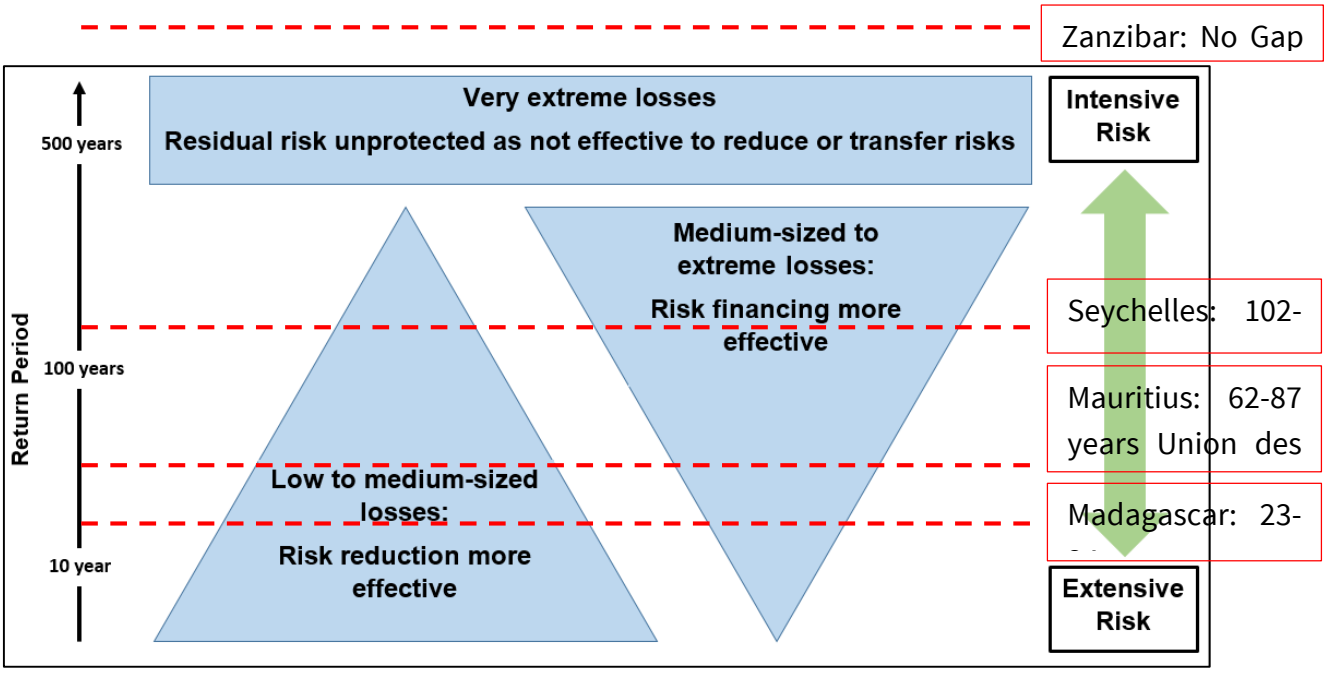
Table 29: CATSIM Analysis

	AAL (own estimate)	Financial resources available (USD Million)	Fiscal Resources Gap Year
Madagascar	58	158	24
Mauritius	58	278	62 to 87
Seychelles	0.59	34	102 to 329
Union des Comores	1.07	11	56 to 77
Zanzibar	0.18	85	None identified

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

Based on these findings, the IOC and the governments of the Indian Ocean are encouraged to take a 'layered risk management' approach, in which resources are allocated based on the varying levels of risk facing each country, with a priority given to reducing existing risk and preventing the creation of new risks in the extensive risk layer (Figure 42) Drawing from the current CATSIM analysis, because of their high volume of extensive risk and their low fiscal gap years, it would be more beneficial and effective for Madagascar and Union des Comores to focus on risk reduction efforts. Due to different exposure profiles and resources, Mauritius and Seychelles should also start to explore risk-financing mechanisms.

Figure 42: Fiscal gap and risk management strategies based on 'risk layering approach'



Source: Author based on UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

The present study identified data gaps and sources of uncertainty regarding fiscal risk assessment (see Box 14 for the data challenges in Seychelles). The present studies did not fully account for indirect effects of disaster damage, and further studies are needed to quantify and evaluate the indirect risks caused by disaster damage.

Box 14: Insufficient risk information limits credibility of fiscal risk assessment': Case of Seychelles

This study evaluated fiscal resources gap using both the current CAPRA estimates and statistical estimates available from Hochrainer-Stigler et al. (2014) (**Error! Reference ource not found.**). In general, the estimates based on CAPRA GIS shows lower loss estimates than those from Hochrainer-Stigler et al. (2014). In particular, the aggregate risk of Seychelles appears small relative to the previous estimate, and also to the empirical observations: in 2013 there was a storm event that results in estimated USD 9.3 million in damage; in 2004 there was an earthquake that resulted in USD 30 million in damage; and in 1997 there was a flood event that resulted in USD 1.7 million in damage (EM-DAT 2014). Based on the current CAPRA estimate, this 2013 storm would have a return period of approximately 200 years, while the 2004 earthquake would have a return period of 300 years and 1997 flood 140 years. The probability that such rare events happen three times in the past 17 years is very small, suggesting that the CAPRA estimates may be significantly underestimating the existing risk of Seychelles. A large discrepancy in risk information highlights further validation is advisable.

experience in CATSIM 2012 and 2014). Contingency financing mechanism for disaster management should be checked regularly. Defining government liability more concretely is also recommended.

Box 15: Madagascar CATSIM simulation in 2012 and 2014

Based on the current study, the fiscal resources gap is estimated at 24 years while 2012 study shows 23 years. The relatively close figures estimated for fiscal gaps in 2012 and this study is explained partly by the fact that assets and disaster related information collected in 2012 was used as inputs for risk analysis in Component 2. However, the breakdown of funding sources is markedly different, especially with regards to the access to domestic credit and international lending. This difference is due to the fact that the current estimate of fiscal parameters is made based on standard assumptions applied in the global assessment (Hochrainer-Stigler et al. 2014). Therefore, further validation of fiscal parameters through national workshops and interviews with national stakeholders will be necessary.

The fiscal parameters must have been changed because of political change and especially a reserve fund has been discontinued and deplete in recent years, where the government faces a practical issue regarding how the account created in the name of a former administration can be transferred to the current one.

Also, it is important to point out that the use of economic risk assessment has not been sustained in Madagascar. Economic risk assessments are hence conducted on ad-hoc bases, *i.e.* only when donor-supported project funding becomes available for this type of effort. There is therefore a need to create a more sustainable system of iterative fiscal and economic risk assessment embedded in the existing domestic institutional framework. A further assessment of capacity and institutional needs as well as development of appropriate risk assessment tools and training materials that cater to the operational needs of government decision-making should be conducted.

Source: UNISDR (2015b)

6.6. Cost-benefit analysis

In this initiative, probabilistic CBA was applied to account for the benefits of risk reduction (Box 16 for probabilistic CBA workshop in Madagascar). Forward-looking CBA was applied for Madagascar and Mauritius based on the risk data developed in Component 1 and backward-looking CBA based on past loss data was applied for Seychelles, Union des Comores and Zanzibar. The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment, thereby determining if the result is cost efficient or inefficient.

Box 16: Probabilistic CBA workshop in Madagascar

In 29 January 2015, in response to request from Government of Madagascar, UNISDR/IIASA implemented capacity building workshop for probabilistic cost benefit analysis. Participants were more than 30 government officials from Ministry of Finance and Budget, Emergency Prevention and Management Agency (CPGU), Ministry of Public Works, Ministry of Agriculture and many other critical ministries/agencies. Methodology for backward-looking CBA was first presented and participants implemented simulation. The main objective was that participants understand the basic method to calculate AAL by using statistical rule called Simpson rule, and understand that difference of AAL before and after DRR investment can be the benefit of CBA. The analysis is possible by using EXCEL spreadsheet. And then, forward-looking CBA was presented and participants were asked to implement simulation using CAPRA model. The main objective is that they understand that DRR policy can change the vulnerability curve and therefore AAL. UNISDR/IIASA saw the potential that future capacity building workshop for probabilistic risk assessment can integrate a component of probabilistic CBA because it clearly shows the participants how probabilistic risk assessment can be utilized to support public finance planners and DRR practitioners.

Results from the exercise in the IOC (Table 30) determined that, in the case of Madagascar, Mauritius and Seychelles, the scenarios were judged to be cost-efficient while the cases of Union Des Comores and Zanzibar was cost-inefficient. The lack of documentation regarding past disaster damage and losses seems to lead to underestimation of probabilistic benefit in the latter cases (see Box 17 for Zanzibar case).

Table 30: Cost Benefit Analysis

	Scenario / Project evaluated	Type of Analysis	Benefit-Cost Ratio at 5% discount rate	Result
Madagascar	Retrofitting wooden housing for tropical cyclonic wind	Probabilistic (forward-looking)	1.01	Cost efficient
Mauritius	Retrofitting iron housing for tropical cyclonic wind	Probabilistic (forward-looking)	2.80	Cost efficient
Seychelles	Flood alleviation (Point La Rue)	Probabilistic (backward-looking)	1.21	Cost efficient
Union des Comores	Retrofitting housing for tropical cyclonic wind and flood	Probabilistic (backward-looking)	0.32	Cost inefficient
Zanzibar	Urban surface water drainage	Probabilistic (backward-looking)	0.14	Cost inefficient

Source: UNISDR (2015a, 2015b, 2015c, 2015d, 2015e)

Box 17: Insufficient loss data limits accuracy and credibility of CBA: Zanzibar CBA case

Based on limited data, the surface drainage project seems inefficient use of funds, given the negative NPV and B/C ratios less than one, regardless of the discount rate or increase in exposed assets.

For estimating the AAL for Zanzibar, data only offered was one previous event, a 2005 flood. Given this event and probability of first loss, a probable maximum loss curve was created.

Information revealed inconsistencies in the damages caused by the 2005 flood. In the data received and analysed in this report, there were only 64 houses destroyed (IFRC 2005). Yet another source claim that "20,000 people" were affected in the 2005 flood event and still other source claims that 3,645 housings are affected annually by flooding (questions for expert opinions, 2011). However, with no concrete data other than the 64 housings destroyed and the water sanitation recovery costs, it is difficult to obtain a rather accurate amount of economic losses caused by the 2005 flooding in the region where the drainage system will be implemented.

Lack of any further detailed information on the economic losses as a result of the flood limits the robustness of any attempt at accurately estimating the probabilistic losses caused by flooding or any other event. Without a robust assessment of the losses caused by past hazardous events, estimations of the benefits of disaster risk reduction investment will also be inaccurate.

In addition, the present assessment did not take into account many of the indirect and intangible losses that may result due to natural disasters, such as business losses due to floods, additional medical cost associated with morbidity and any reduction in land values that may result due to frequent inundation. These are clear limitations of this current analysis and further studies are certainly needed to improve the accuracy and comprehensiveness of our analysis.

Source: UNISDR (2015e)

Based on these findings, the IOC and the governments of the Indian Ocean are encouraged to compile more complete sets of damage and cost data that will refine future cost benefit analyses. They are also encouraged to explore how to systematize the use of CBA in the hopes of making risk reduction a predominate characteristic of public investment.

6.7. Policy Recommendations

Comparison of empirical observations of economic loss (1980-2013) related to registered disaster events and projected risk estimates (AAL and PML) demonstrate considerable uncertainty. The main findings of the regional loss and risk assessment are synthesized below:

- The Indian Ocean Region has lost at least **USD 17.2 billion** in infrastructure and agricultural investments since 1980 (at 2013 prices). It loses an average of **USD 430 million each year** to the registered natural hazards, the greatest volume lost in Madagascar.

- The projected combined Average Annual Loss (AAL) associated with two hazards (tropical cyclonic wind and earthquake), however, is estimated in **USD 161 million,** or nearly 1% of the combined GDP for the region (relative loss ranges from 0.02% of Zanzibar GDP to 1.2% Malagasy GDP each year). Beyond the sheer number of hazards included in the risk estimates, other differences between registered losses and AAL may be attributable to a combination of incomplete registered exposed assets and the uncertain future impacts of climate change, etc.

- Probable maximum losses for the 50-year return period (combining wind and earthquake) sum to **USD 1.5 billion** in the region, the greatest losses to be incurred in Mauritius (USD 1,094 million) followed by Madagascar (USD 368 million).

Regardless of the level of loss, investing in DRM is already underway in the five IOC islands. Across the region, DRM-marked investments found in national budgets over the past years ranged from 2 to 16% of total annual budgets amounts. This amounts to a combined **USD 457 million** each year in the region, ranging from USD 288 million each year in Mauritius to USD 4.2 million in Union des Comores.

The overall trend points to a greater investment in preventive / mitigation action only for Mauritius, Seychelles and Zanzibar. In Madagascar and Union des Comores, the greatest current investment is still in emergency response. Clearly, DRR, the prevention and reduction of risk, merits greater investment now.

While at face value, comparing these figures to registered loss and AAL points to a gap (or need for greater investment) only in Madagascar, the results should not be interpreted to signify that “enough is already being done” in the other islands. In fact, there are strong indications that the real value of losses and risks is not currently sufficiently captured and that the budget analysis may overcompensate for some efforts.

Through the present study, the IOC islands are now exposed to a suite of tools and a list of risk management options to prepare them for an uncertain future. With more improved data, and enhanced in-house capacity, the respective governments should be posed to

choose which of those tools and options are best suited for their risk profile (hazard events, exposure and loss, etc.). A risk-layered approach suggested by CATSIM analysis and cost benefit analysis highlights how to choose more appropriate policies in DRR/DRM.

Further challenges: Data gaps, capacity training and awareness raising toward risk layered approach

During several meetings with the Ministries of Finance in the IOC region, it was established that a scattered approach to DRM is inefficient and there is need for stronger collaboration between the DRM agency, Ministry of Finance and other key sectoral ministries. Continuous capacity building on risk terminology and concepts, loss and risk information management and economic analysis was recommended by Ministries of Finance in the region. Institutional support for iterative management should be embedded in the existing DRR/CCA policy framework of respective countries. This can begin only alongside a regularly refreshed regional awareness-raising endeavor, highlighting risk-sensitive pubic investment.

The present study identified data gaps and sources of uncertainty regarding fiscal risk assessment. While the CATSIM portion of the study assessed cyclone wind and earthquake risks only (except for Zanzibar where only earthquake risk was evaluated), further analyses are certainly needed to include risks from additional hazards. Also, a large discrepancy in risk data was identified for Seychelles, which requires further validation. Given the relatively short period of data availability for these countries, high uncertainty can be expected of catastrophic risks with return periods of above 500. It is advisable, therefore, to promote further data collection, registry and tracking, validation and analyses performed in an iterative fashion to reduce this range of uncertainty. The present studies also did not fully account for indirect effects of disaster damage; further studies are needed to quantify and evaluate them.

The loss and risk information should be examined from the perspective of both DRM policy maker and financial planners. Given the importance of public investment in DRR, continuous refinement of loss and risk information should be promoted through regular dialogue with data users. In the process of economic analysis, Ministries of Finance understood and appreciated the importance of loss and risk information. On some cases, they identified several mistakes and inconsistencies in the records in disaster loss databases and the data were corrected. Such exchanges of information will improve overall quality of knowledge management to support DRM decision making.

Technical and institutional support is necessary to establish iterative risk management system in the IOC countries. In terms of technical needs, knowledge regarding probabilistic risk assessment (CAPRA) and economic assessment tools (CATSIM) would be required along with general awareness of risk related concepts and statistics. Given the limited availability

of risk experts in each country, a regional approach may be appropriate. A pool of trained resource persons at regional level whose main focus is not only to regularly update the event registry, risk analyses, RSBR, CATSIM and CBA, but are skilled as trainers to promote national-level capacity building may be an effective way to leverage local capacity and resources.

Government needs to develop investment and financing strategies to address both extensive (small scale but high frequency) and intensive (low frequency but high impact). Climate change will increase risks in terms of frequency, geography and intensity. Understanding risk structures and the expected economic impact in the country is the critical first step to determine the optimum policy mix for each risk layer. In developing investment and financing strategies to address disaster risk, DRR investment and risk financing should not be considered separately. Depending on risk layers, the most appropriate policy mix changes and DRR investment and risk financing are not mutually exclusive. For example, DRR investment often decreases insurance premiums.

This packaged approach with a focus on financial planners in government will be standardized and replicated in Asia, Africa, Latin America and other regions in the coming years and the knowledge is planned to be archived and presented globally in a working paper series of UNISDR on “Public Investment and Financing Strategy for DRR”. The report summarizing activities in IOC region will thereby contribute to increasing the global knowledge base.

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