Review of Mauritius

UNISDR Working Papers on Public Investment Planning and Financing Strategy for Disaster Risk Reduction

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Public Investment Planning and Financing Strategy for Disaster Risk Reduction

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Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on disaster risk reduction.

Contents

List of Tables

List of Figures

List of Acronyms

AAL	Annual Average Loss
AFD	Agence Française de Développement
CAPRA	Comprehensive Approach for Probabilistic Risk Assessment
CATSIM	CATastrophe SIMulation
CBA	Cost Benefit Analysis
CCA	Climate Change Adaptation
CCIC	Climate Change Information Centre
CDCU	Communicable Disease Control Unit
DBM	Development Bank of Mauritius
DRM	Disaster Risk Management
DRR	Disaster risk Reduction
EHRSP	Education and Human Resources Strategy Plan
EIA	Environmental Impact Assessment
EU	European Union
GAR	Global Assessment Report on Disaster Risk Reduction
GDP	Gross Domestic Product
GEF	Global Environment Fund
GFCF	Gross Fixed Capital Formation
HFA	Hyogo Framework for Action
ICT	Information and Communication Technologies
ICZM	Integrated Coastal Zone Management
ICAO	International Civil Aviation Organisation
IIASA	International Institute for Applied System Analysis
IMO	International Meteorological Organisation
IMF	International Monetary Fund
IOC	Indian Ocean Commission
MID	Maurice Ile Durable
MFRS	Mauritius Fire and Rescue Service
MoESD	Ministry of Environment and Sustainable Development
NCC	National Climate Committee

NDRRMC	National Disaster Risk Reduction and Management Centre
NEOC	National Emergency Operations Command
NOSCP	National Oil Spill Contingency Plan
POPs	Persistent Organic Pollutants
PML	Probable Maximum Loss
RSBR	Risk Sensitive Budget Review
SIDS	Small Island Developing States
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
WB	World Bank
WCDRR	World Conference on Disaster Risk Reduction

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Executive Summary

In 2013, following a grant agreement signed between UNISDR and the Indian Ocean Commission, a joint UNISDR/ISLANDS project was started entitled "Strengthening Capacities for Unified Climate Change Adaptation and Disaster Risk Reduction Through the Facilitation of Risk Transfer and Financing Mechanisms". It was implemented within the "ISLANDS Programme for Financial Protection against Climatic and Natural Disasters". It also forms a part of UNISDR's global project for around 30 countries: "Building Capacities for Increased Public Investment in Integrated Climate Change Adaptation and Disaster Risk Reduction: 2012-2015" financed by the European Union.

Four island countries in the Indian Ocean as well as the Government of Zanzibar participated in the ISLANDS programme composed of three components: the establishment of reliable disaster loss database (Component 1), risk evaluation and probabilistic risk assessment profiles (Component 2) and incorporation of risk management into public investment planning (Component 3). Economic analysis and policy reviews were developed as a package. This report aims to summarize all activities implemented in the project with a focus on public investment planning (Component 3) while a technical report on Components 1 and 2 is also available[1].

As a first step (Component1), a total of 1,105 data cards on disaster events and losses between 1980 and 2013 were registered in the national disaster loss database. Economic loss totalled USD 59 million (2012 constant price), out of which, 82% was due to intensive and extensive cyclones. In the subsequent probabilistic risk analysis (Component2), Average Annual Loss (AAL) for tropical cyclonic wind was estimated at USD 86.91 million, with a Probable Maximum Loss (PML) of USD 1,726 million for a 100-year return period.

This loss and risk information pointed to the need to reduce tropical cyclone risk. However, in itself it did not suggest policy guidance. Grounded in the loss and risk analysis, a thorough policy review and economic analysis were implemented (Component 3).

CATSIM analysis developed by IIASA identified that the fiscal resource gap year (*i.e.* the return period at which the government will face difficulty in raising sufficient funds for reconstruction) for tropical cyclone and earthquake hazards was 62 to 87 years. This corresponds to the middle risk layers (*i.e.* between intensive and extensive risk) and means that Mauritius must target risk reduction investment and development of risk financing mechanisms simultaneously.

The following probabilistic cost benefit analysis (CBA) presents how CBA can support concrete and specific evidence-based decision making. As an example, the CBA of house retrofitting to withstand tropical cyclonic wind found that the retrofitting of iron and wood housings is the most cost-efficient option, resulting in benefit to cost ratios of 2.80 and 1.92 respectively. However, retrofitting all housings would only be cost efficient if retrofitting costs are below 5% of housing value, in spite of substantial annual benefit of approximately USD 40 million.

Based on these findings, current Disaster Risk Management (DRM) policy in Mauritius and especially public finance (including DRR investment and risk financing mechanisms) were examined. In spite of much progress in HFA implementation and an excellent disaster management system, no definite and systematic DRR investment policy exists in Mauritius. Risk sensitive investment is made implicitly by several sectorial ministries. Cost benefit analysis, although required for large scale projects, does not take disaster risk into consideration. Critical infrastructure is not sufficiently protected against disaster risk. Contingency financing mechanisms are also under-developed.

To explore the financial aspects of DRM policy, Mauritius also estimated the current investment in disaster risk management by applying a DRM Marker method in an examination of national budgets, proposed for the OECD by the World Bank in partnership with UNISDR.

About 10% of the current budget (2013, actual) and 2014 (planned) and about 15% of the capital budget (in 2013-2014) was estimated to be invested in DRM. This corresponds to approximately USD 550 million and USD 130 million, respectively. On average in 2013 and 2014, 22% and 70% of current and capital DRM budgets are marked "significant", which demonstrates that they are embedded in development projects mainly dedicated to prevention/mitigation. This indicates the level of mainstreaming of DRR investment in Mauritius. On the other

[1] For component 1 and 2, please see UNISDR /IOC (2014). Component 1 and 2: Comoros, Madagascar, Mauritius, Seychelles and Zanzíbar. Building capacities for increased public investment in integrated climate change adaptation and disaster risk reduction: 2012-2015. European Commission - Directorate General for Development and Cooperation. Geneva, Switzerland.

hand, a more detailed budget examination with a focus on specific agencies and programmes, highlights that the "primary" category (stand-alone projects for DRM) is more dominant. The focus of such projects is also prevention/mitigation. Compared to AAL, this was a positive balance, but Mauritius identified that budgets need to be linked to specific hazards (in this case tropical cyclones) to be more meaningful.

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.

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.

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.

Introduction: Conceptual Framework [2]

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.

In the Indian Ocean Commission (IOC) region, this initiative has been separately planned and implemented in 2013-2015 in the cooperation with ISLANDS, in accordance with the project design developed by UNISDR and implemented through the "ISLANDS Financial Protection Programme against Climatic and Natural Disaster Risks".

The initiative has three components:

- Component 1: disaster loss
- Component 2: probabilistic disaster risk assessment
- Component 3: 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".

UNISDR has been in charge of designing methodologies for Component 3 and in the process, considered how natural science can be linked to social science to contribute to better decision making in public investment planning. In the Indian Ocean Commission (IOC) region, this project has been planned and implemented from 2013 to 2015 in cooperation with ISLANDS, in accordance with the project design developed by UNISDR.

This report summarizes all activities implemented for Mauritius[3]. Chapter 1 introduces basic country structure as background. Chapters 2 and 3 outline loss and risk as the starting point of analysis. Chapter 4 briefly explains the DRR policies of the country. Chapter 5 outlines the current state of risk-sensitive public investment planning and risk financing policy as well as brief summary of three types of economic analysis implemented in the country.

In Component 3, 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).

In Chapter 6, recommendations for policy makers are presented drawing from the analyses implemented. Annexes A, B and C provide theoretical and technical background and detailed case studies on each tool.

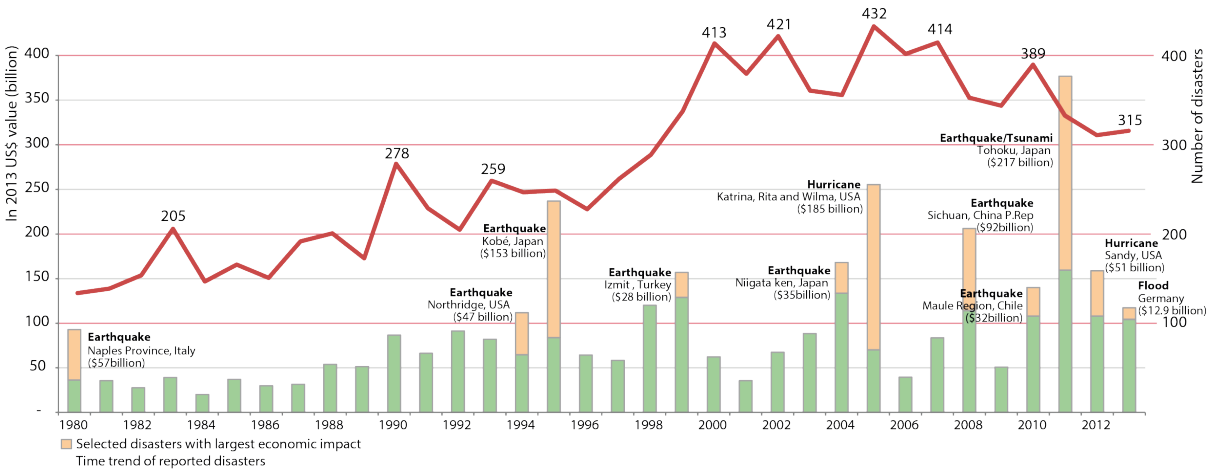
In this introductory chapter, the background, especially why we need risk-sensitive public investment, is explained. Then, the overall streamlined process from loss data analysis through probabilistic risk assessment into economic analysis is explained. Lastly basic concepts of economic loss are defined to provide a common understanding of key terminology.

[2] This chapter was drafted by Kazuko Ishigaki (UNISDR)
[3] A series of workshop/meeting implemented in IOC region are listed in Annex D.

A. Background: what are challenges?

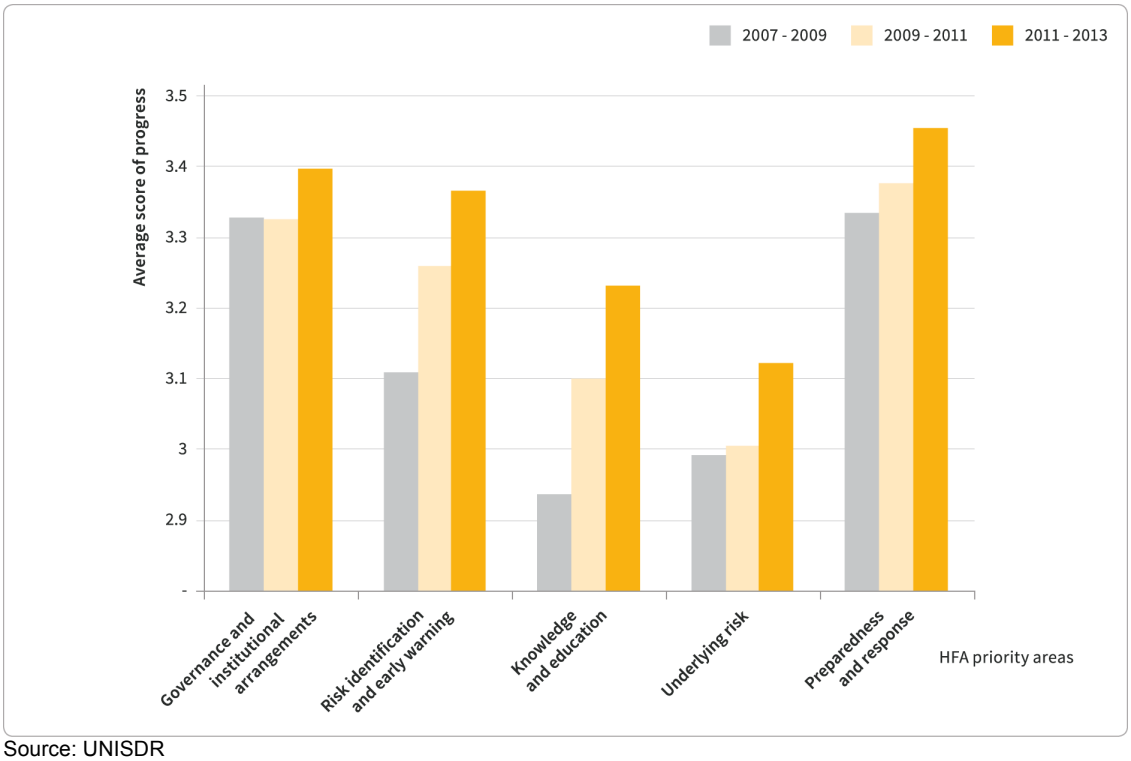
Why do we need to promote risk-sensitive public investment? First of all, economic loss due to disasters has been increasing in spite of substantial progress in DRR policies promoted by Hyogo Framework of Action (HFA) (Figure 1 and Figure 2). HFA priorities have been progressing in all areas mainly due to the effort of DRM agencies. 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

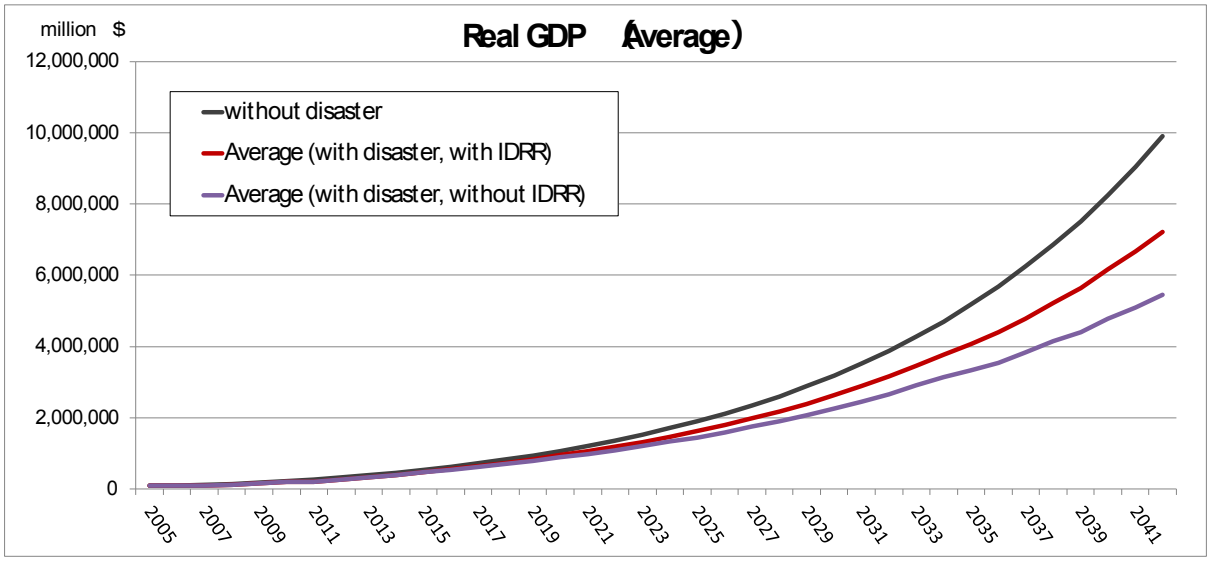
Figure 2: HFA Progress



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

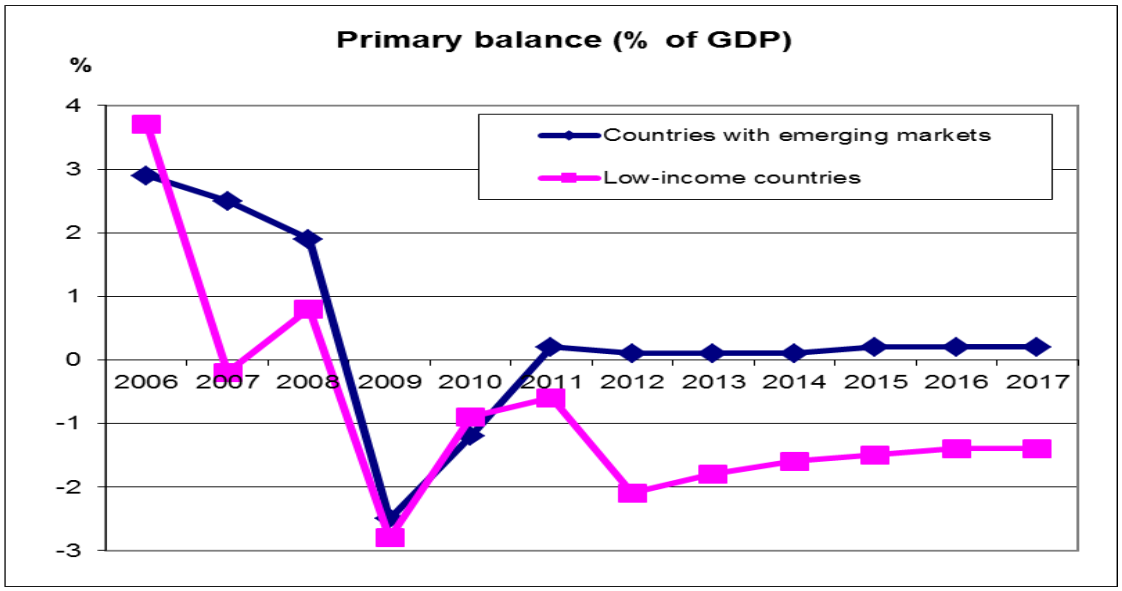


Note: IDRR means DRR investment.
Source: Author based on the figure provided by JICA

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 the 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[4]

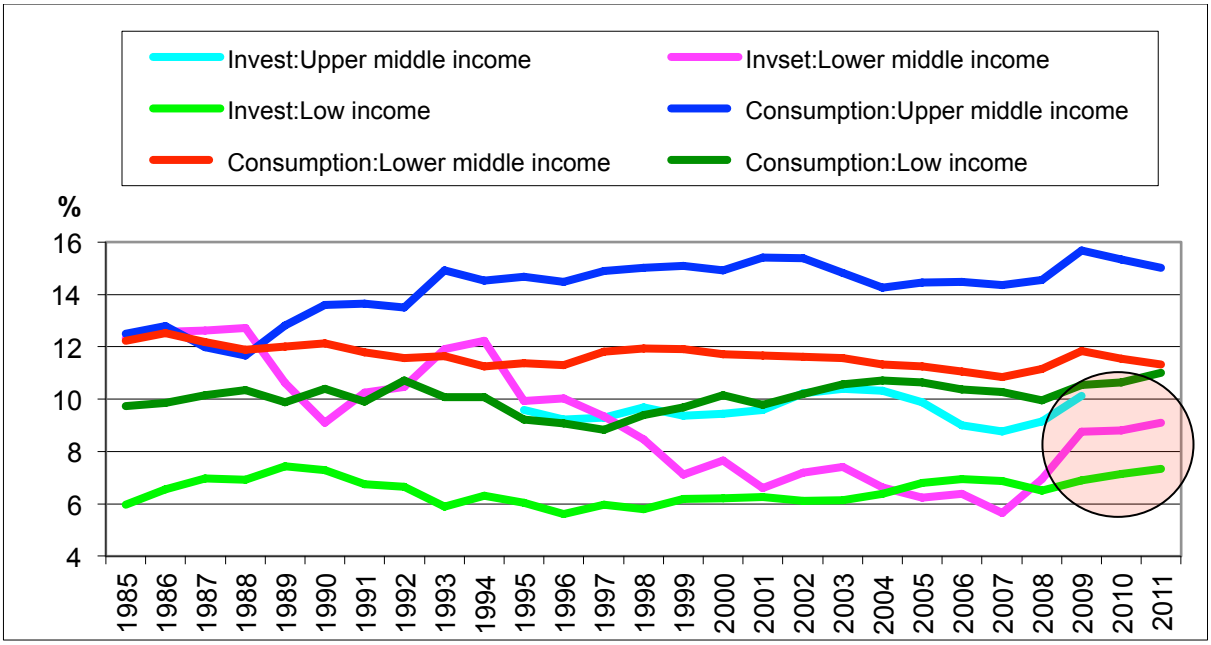


[4] The primary balance is the difference between a government's revenues and its non-interest expenditures; it is the most accurate reflection of government fiscal policy decisions. A country with a primary deficit, for example, spends more on roads, schools, defense, than it takes in from taxes and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

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.

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. 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 *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 the service and the goods are likely to be under-produced (*i.e.* free-rider problem[5]).

[5] Typical examples of free rider problem include congestion in public roads and pollution of air and water.

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[6]. 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 reduces 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 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 support from national governments.

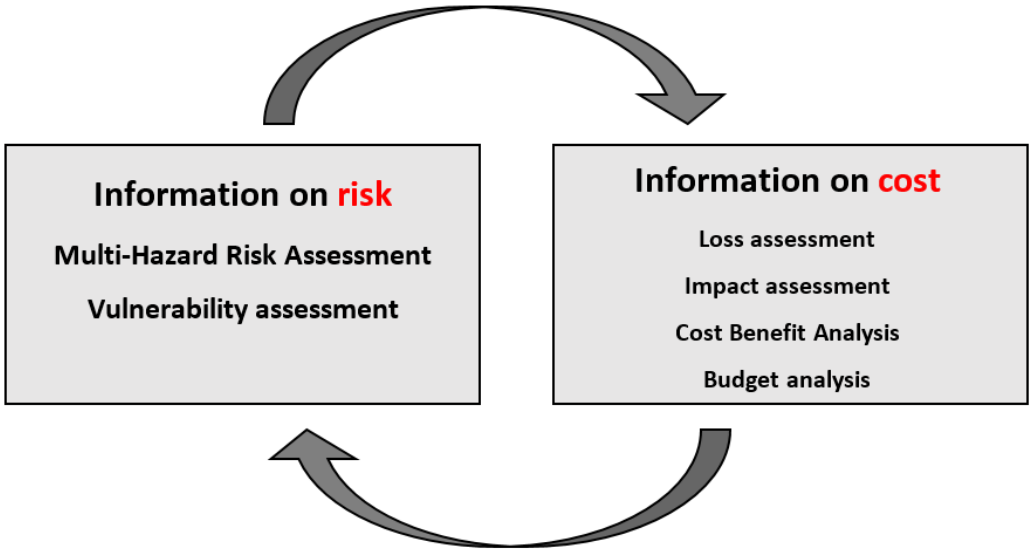
In case of catastrophe, horizontal risk transfer mechanisms such as insurance may often not be sufficient. DRR investment is, unlike risk transfer mechanism, considered inter-generational risk sharing. Following the definition of sustainable development by the Bruntland Committee, only development that 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 "*[7].

[6] A socially desirable state is called Paleto Optimum in economic terms.
[7] HFA Report of Solomon Islands, 2009-2011 Reporting cycle

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 growth and 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 that 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"*[8].

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 (*i.e.* appropriate combination of contingency funds, insurance and other tools).

[8] HFA Report of Nepal, 20xx

Table 1: DRM structure

Risk reduction			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**

B. Streamlined process for evidence based decision making

Given challenges identified in Section B, **how to combine risk and cost information?** The initiative introduced a five-step process (Figure 7). The first step was to identify loss trends and produce risk profile (mainly activity of Components 1 and 2). Subsequently, the current state of DRR policy, public investment policy and budget was 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 was conducted. It is of note that there should be a cost benefit analysis for all kinds of DRR policies and this initiative presented a methodology using only one example. These analyses, combined, are expected to provide insights on and facilitate evidence-based decision making for risk-sensitive public investment planning.

Figure 7: Overall design to support evidence based decision making

STEP 1: Identify loss trend and produce risk profile

(Loss analysis, risk assessment)

STEP 2: Check the gap between the risk and current levels of DRR policy

(Policy review, budget review)

STEP 3: Measure the impact of disaster on economy and public finance

(Macro-economic analysis)

STEP 4: Measure the impact of investment on DRR

(Probabilistic Cost Benefit Analysis)

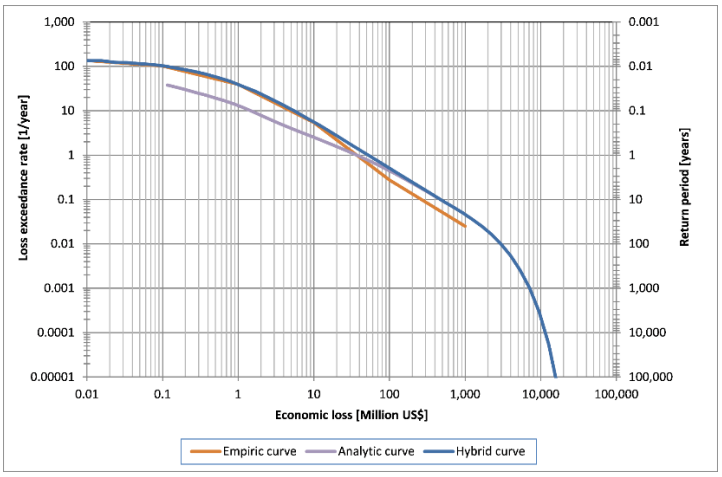
STEP 5: Political discussion based on evidence

(What to do with the gap between risk and current DRR?)

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 8) in all risk layers including intensive (low frequency and high loss) and extensive (high frequency and small loss) (See Chapters 2 and 3). However, as outlined above, this information alone cannot determine how much should be invested in DRR.

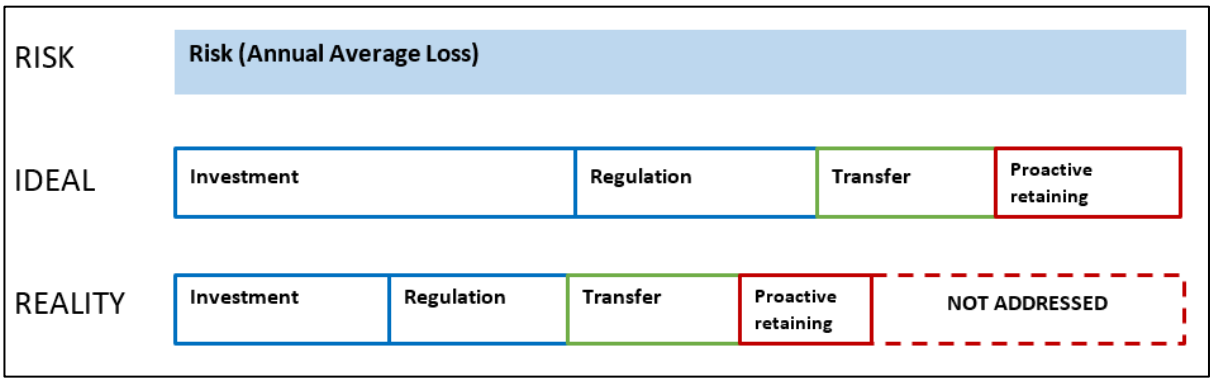
Figure 8: Hybrid loss exceedance curve



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 9). (See Chapters 4, 5 and Annex A).

Figure 9: Gap identification, drawn from budget and policy analysis



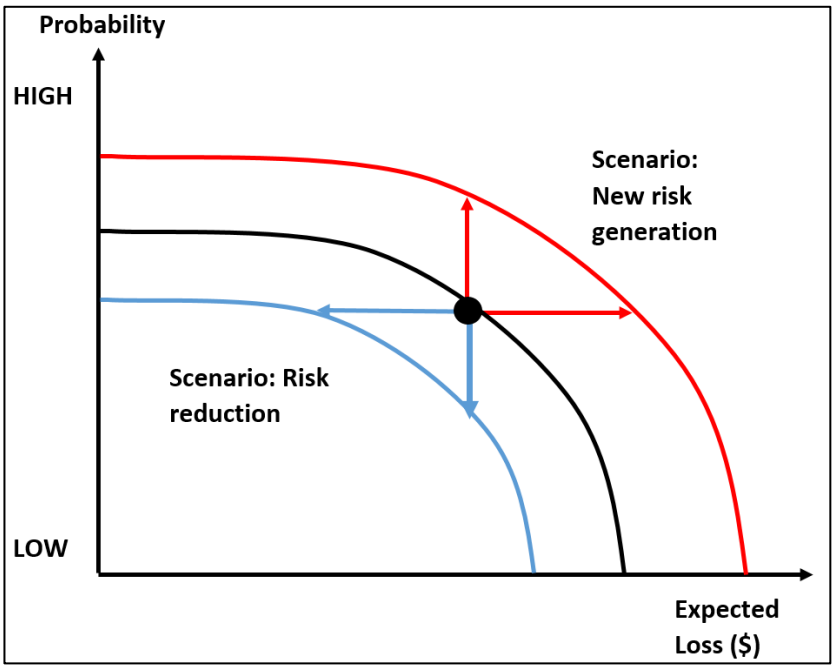
Note: Impact of investment usually lasts for certain project periods and therefore reduces AAL the following year.

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 (See Chapters 5 and Annex B).

Step 4 aims to measure the impact of policy on DRR. 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. (See Chapter 5 and Annex C). DRR policy can shift the risk curve inward (i.e. lower frequency of event happening and/or decrease of expected loss) (Figure 10).

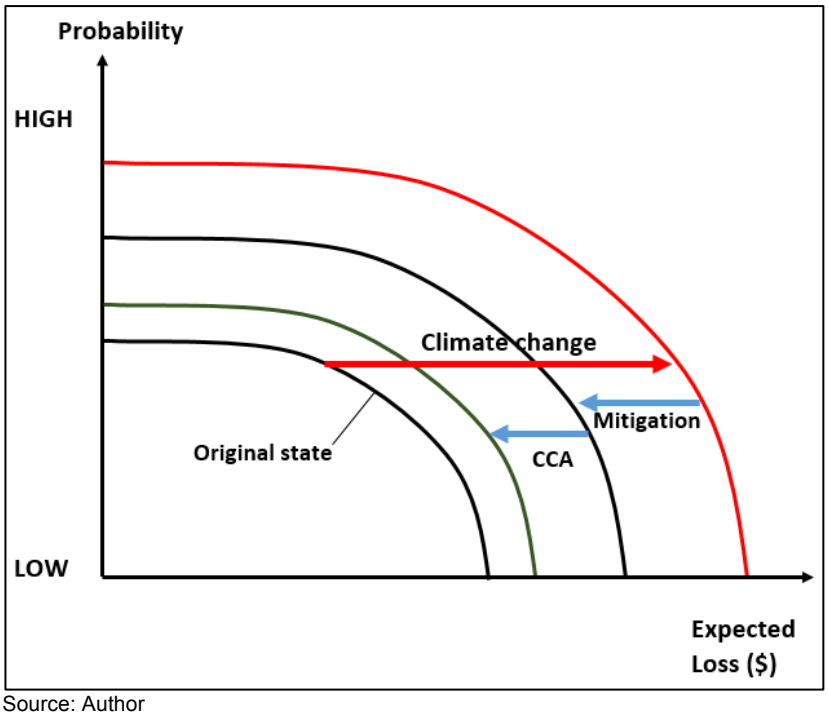
Figure 10: Shift of loss exceedance curve by DRR investment (blue) and new risk generation (red)



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 11: Climate change impact

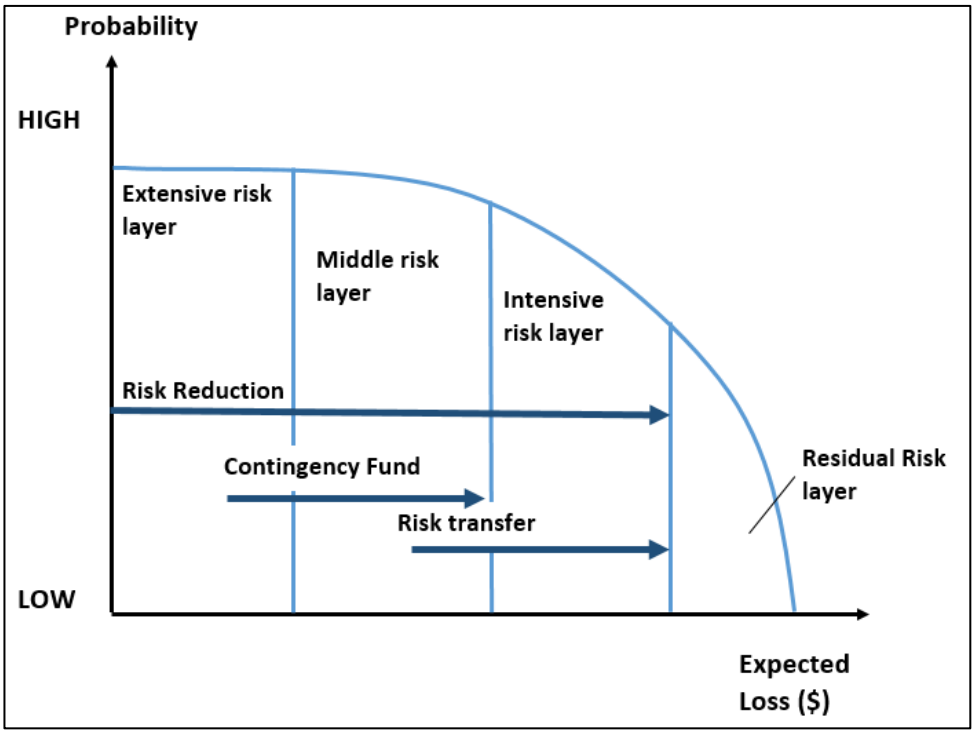


Source: Author

These analyses, in combination, suggest that a risk-layered approach is crucial to manage disaster risk (Figure 12). In the extensive risk layer (high probability and low expected loss), investment for risk reduction is basically

the most cost-efficient. However, some measures for risk reduction (*e.g.* emergency drills as preparedness) can be cost-efficient (and efforts should be devoted to) at all risk layers. 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 decrease the scope for risk financing mechanisms, bringing risk premiums down and making 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 12: Risk layered approach

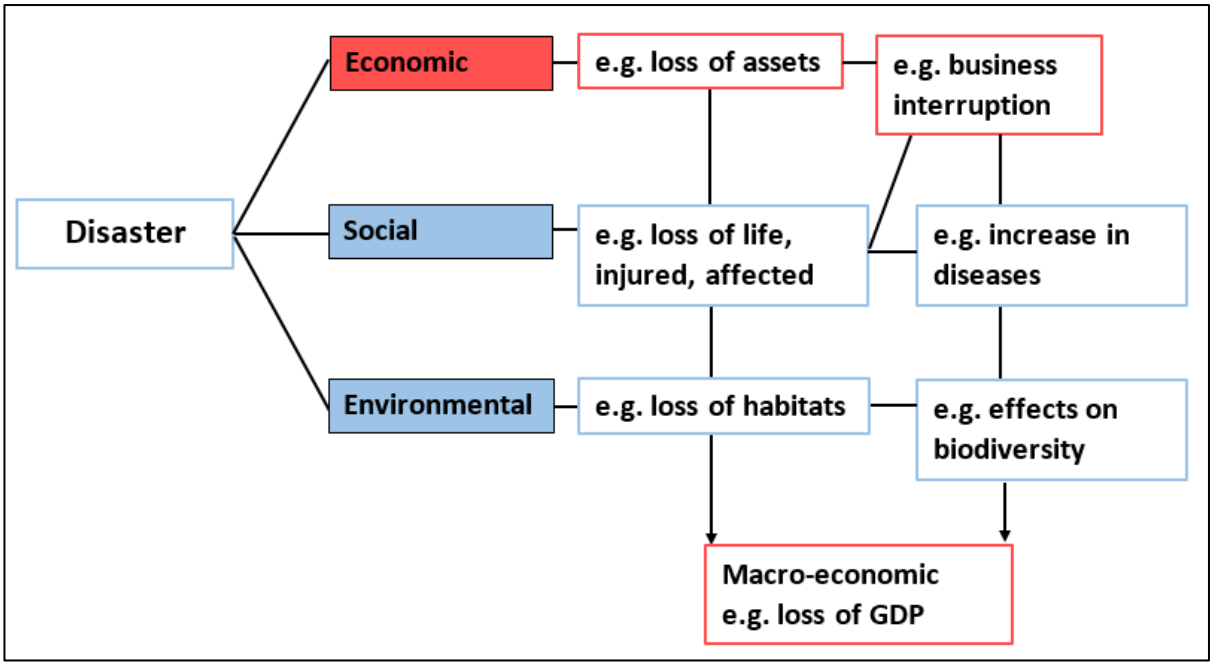


Source: Author

C. 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 13). 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 13: Impact of Disaster

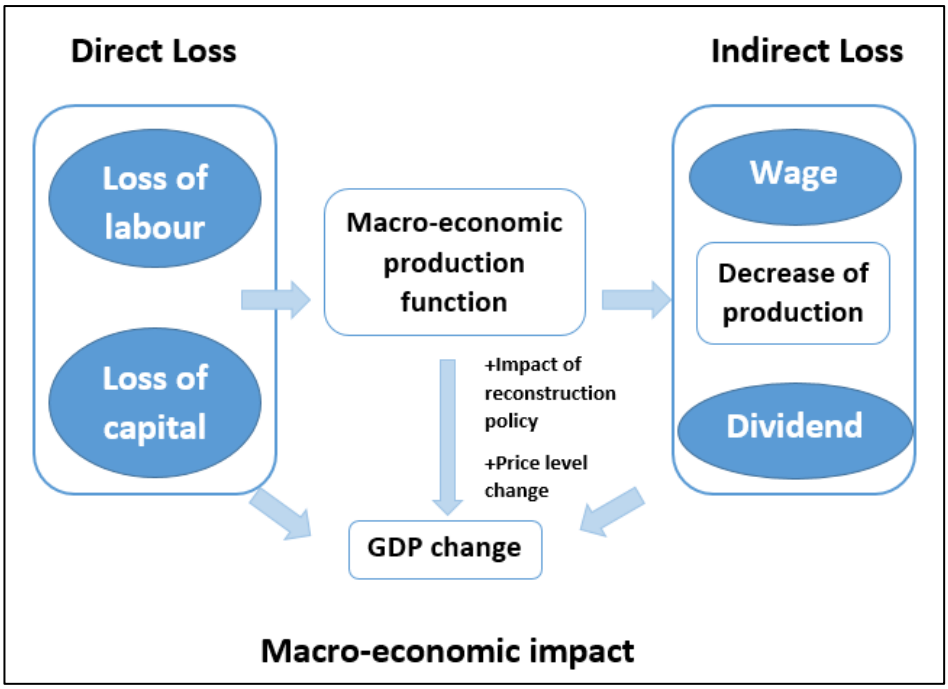


Source: Author

It is important to clarify the difference between direct loss (physical loss centred), indirect loss and macro-economic impact at the start of analysis (Figure 14, 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. The initiative underway in this project is not an exception. Our focus in the cost benefit and CATSIM analyses is on direct physical loss and does not include indirect loss and macro-economic impact[9].

[9] CATSIM analysis includes indirect loss to certain extent because it considers "implicit liability" of government, which means compensation to the affected. For Madagascar, the impact of public finance on macro-economy was also estimated.

Figure 14: 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

Source: Author

C.1. Direct loss

Direct loss is nearly equivalent to physical damage. 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[10] or replacement cost[11]?

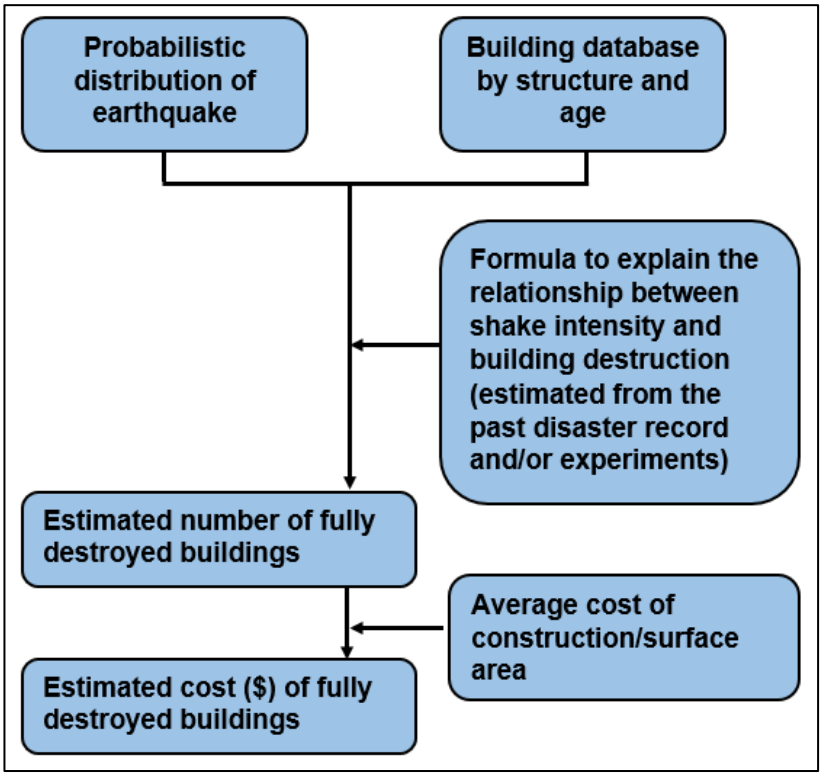
[10]

[11] 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 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.

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. But sometimes, monetary value is assigned to human loss. For example, after 911, NY City estimated the monetary value of human loss in the World Trade Center, Many were high income, young to middle-aged people who pay high taxes and consume and invest heavily in the NY economy. The economic planner of city government practically would have needed the economic and financial impact of loss of such people, but this is a very rare case. It is not common to monetize human loss[12].

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 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 15[13]).

Figure 15: Impact of earthquake on building



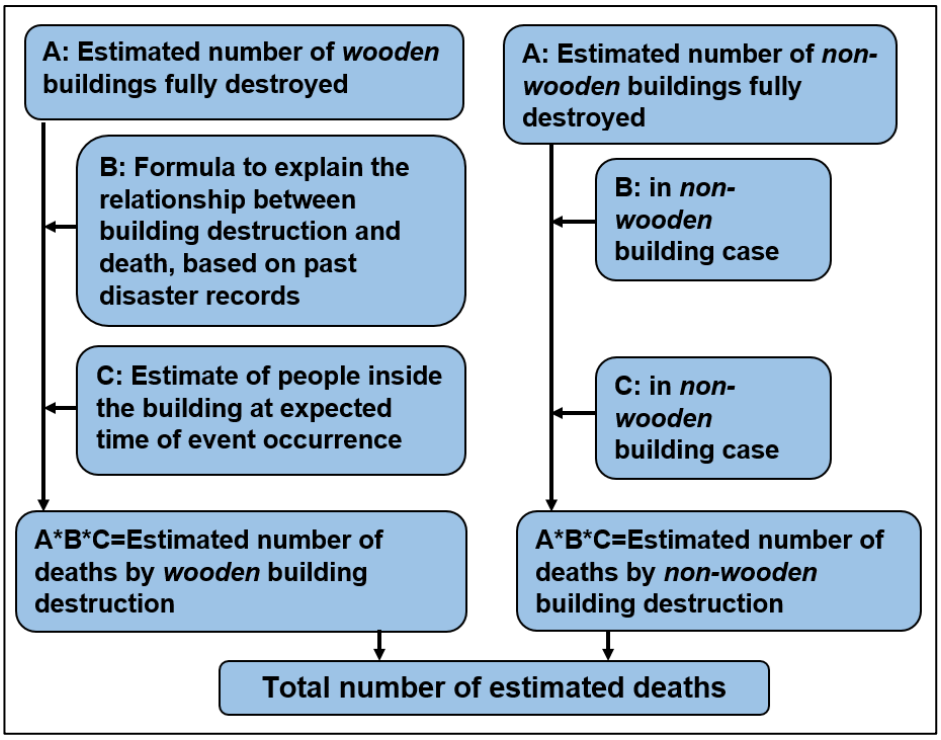
Source: Author

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 (Figure 16).

[12] This does not necessarily mean policy makers should not evaluate human loss at all. 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 explained in Annex C, this approach compares several options and evaluates cost-efficiency given certain objective such as x % reduction of mortality.

[13] The formula in the figure is often called "vulnerability function" in probabilistic risk assessment.

Figure 16: 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.

C.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. 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[14]. Though these indirect losses might be seemingly measurable, it is difficult to isolate the impact of disaster from others, for example, global financial crisis[15]. Technically speaking, to estimate indirect loss, it is necessary to have a "production function" linking labour and capital with production.

There are immeasurable indirect losses, for example, human suffering. Though they are not easily measurable, it is important to recognize such issues.

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[16]. 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.

[14] Decrease of production will impact the wage level and dividend level.
[15] 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.
[16] 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.

Indirect loss and macro-economic impacts are highly analytical and the results change depending on many factors. First, the result depends on geographic scale, for example, 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.

C.3. Macro-economic impact

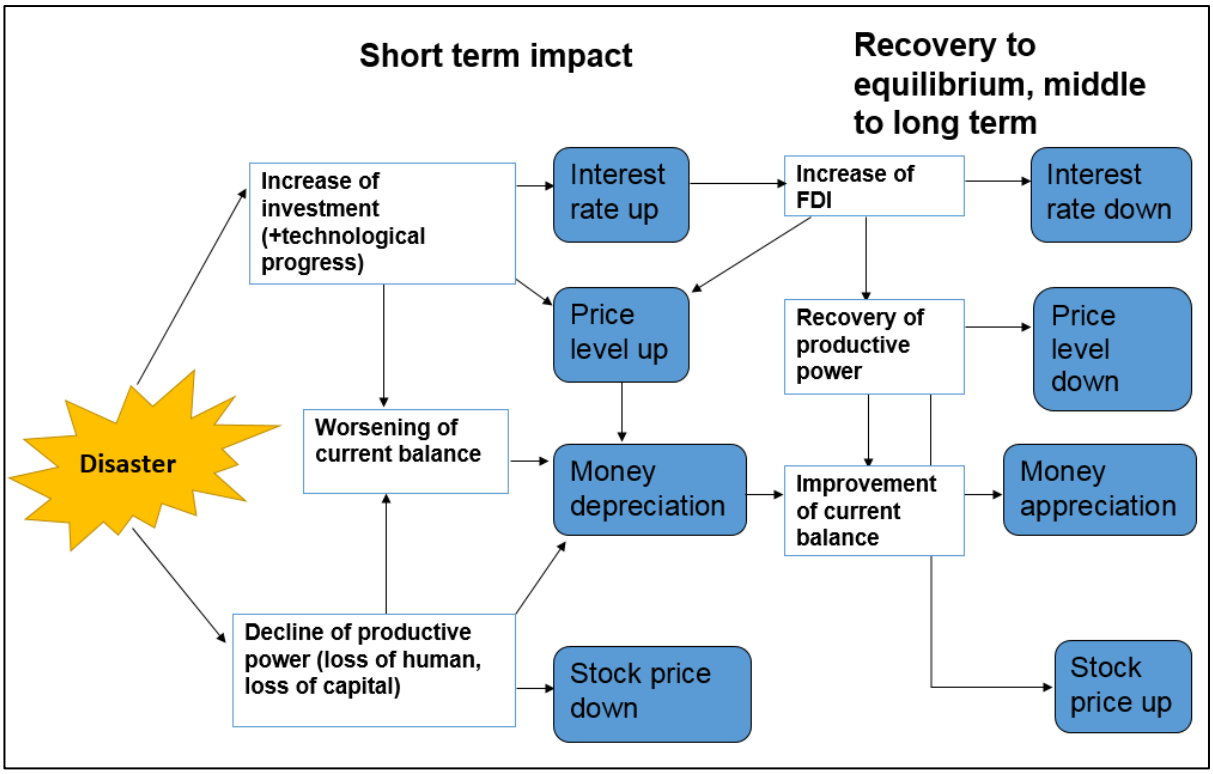
In analysing macro-economic impact, it is very important to analyse the impact from supply and demand sides and short and long-term perspective (Table 3). From supply side, decrease of production due to capital loss can be observed as a negative impact in the short term. However, in the long term, replaced 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 (Figure 17 and Figure 18).

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	Positive

Source: Author

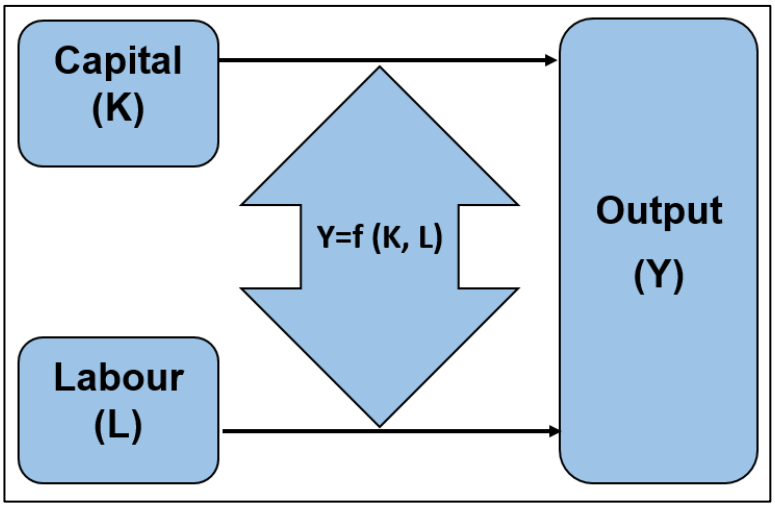
Figure 17: Example of economic modelling



Source: Author

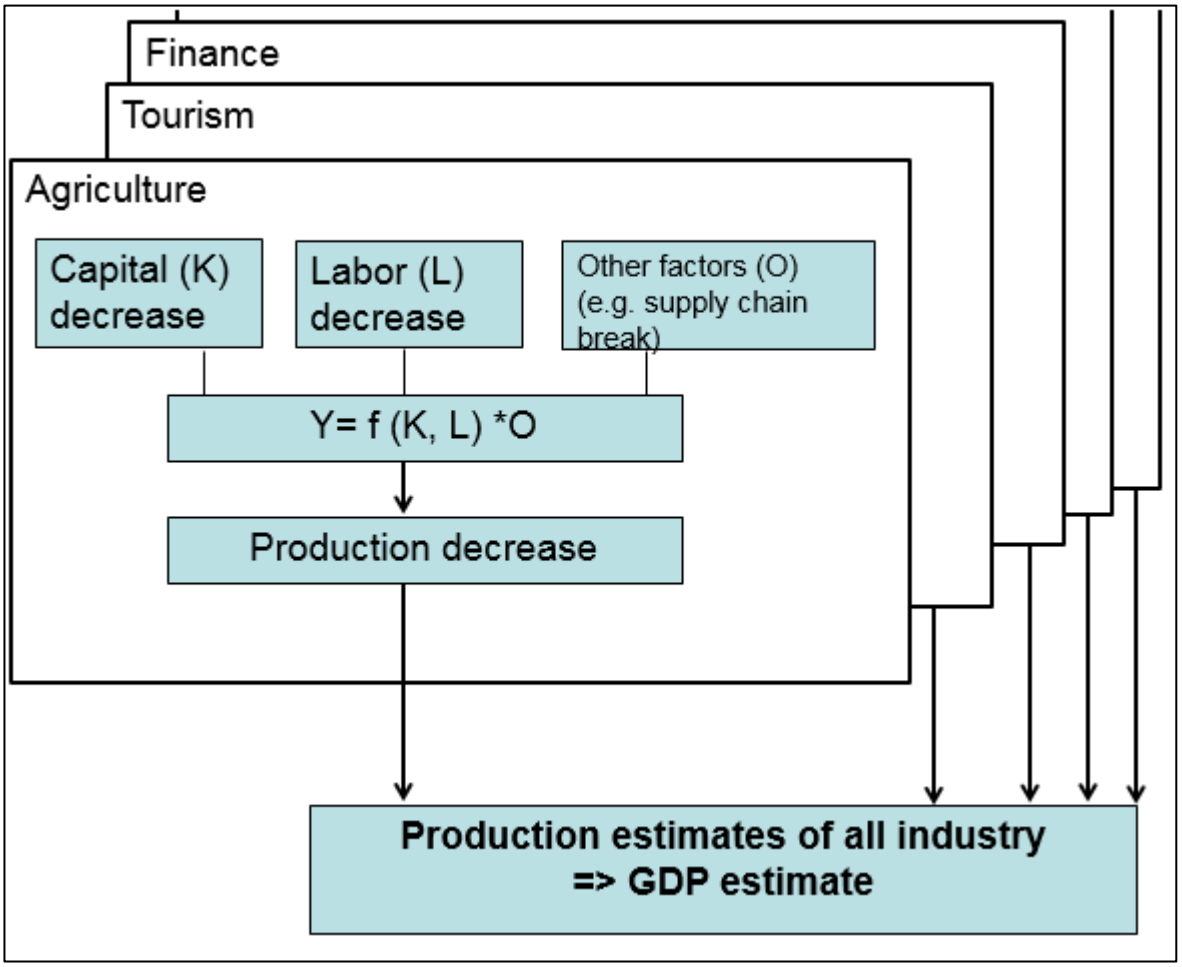
When macro-economic modelling is not available or a more micro-level approach is more practical, a sectoral-based approach might be preferable. The essence of estimating economic impact is in how disasters impact labour and capital --the two most important factors for economic growth (Figure 18). If capital and/or labour decrease, 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 19). 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 also should be checked using an input-output table, if possible.

Figure 18: Production function



Source: Author

Figure 19: Production function by sector

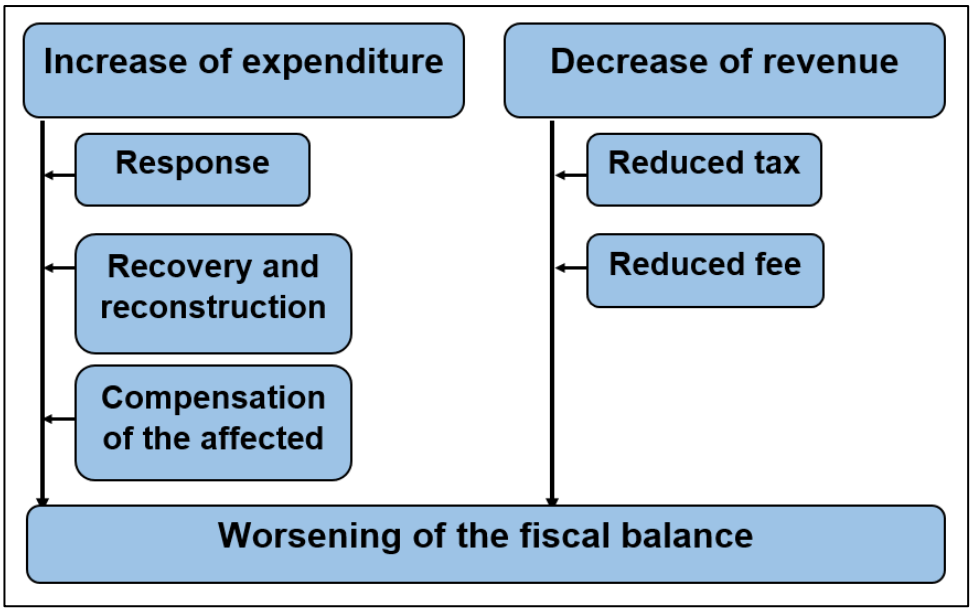


Source: Author

C.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 20).

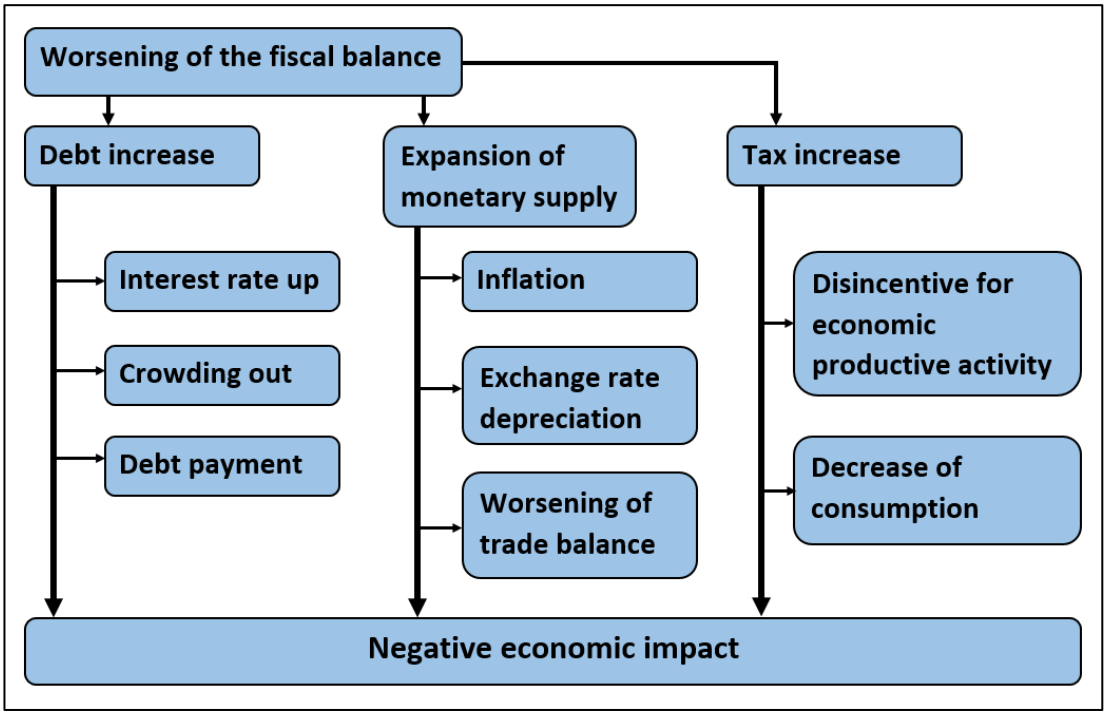
Figure 20: Fiscal impact of disasters



Source: Author

A worsened fiscal balance often has a negative impact on the macro economy. Figure 21 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 21: Relationship between fiscal impact and economic impact



Source: Author

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IMF

World Bank Development Indicators

1. Country Structure[17]

Mauritius is located in the Indian Ocean, about 800 km east of Madagascar, and occupies a total area of 2,040 square kilometres, including its outer islands namely Rodrigues, the Cargados Carajos (St Brandon), Agalega, Tromelin and the Chagos Archipelago. Mauritius has an Exclusive Economic Zone (EEZ) of over 2.3 million km^2. Independent since 1968, the country rests on sugar, tourism, textiles and apparel, and financial services, and is expanding into fish processing, information and communications technology, and hospitality and property development.

Source: US Central Intelligence Agency

A. Population

Mauritius population is estimated at 1.26 million (as of 1 July 2014) of which 41.5% live in urban areas. The population density is 618 people per square kilometre (Mauritius: 654 and Rodrigues: 401).

The annual population average growth rate for the last five years has been 0.4%. The age dependency ratio is close to 40, which means that there are 40 dependents (aged under 15 years or over 64 years) for each 100 people of working-age (15-64 years) (Table 4).

Table 4: Key demographic data

Demographic element	Data	Source
Population	1,261,208 (1 July 2014)	Statistics Mauritius
Growth rate (annual average of the past 5 years)	0.4% (2010-2015)	Human Development Report 2014
Urban population (% of total population)	41.5%	Statistics Mauritius
Urban growth	0.6% (2011)	World Bank Development Indicators
Age dependency ratio	26.4 per 100 (15-64 years) for 0-14 years 13.3 per 100 for 64+ years	Human Development Report 2014
Spatial distribution	Port Louis (capital) : 118,431 Beau Bassin Rose Hill : 103,098 Quatre Bornes : 71,633	2011 Housing and Population Census,

[17] This chapter was drafted by Pamela Leste De Perindorge.

	Vacoas Phoenix: 104,271 Curepipe : 77,466 Pamplemousses District : 136,268 Riviere du Rempart District : 105,774 Flacq District : 135,406 Grand Port District : 110,907 Savanne District : 67,906 Plaines Wilhems District: 362,292 Moka District: 82,302	Statistics Mauritius

The geographical distribution of the population and land use is illustrated in Figures 22 and 23. In addition to the conurbation comprising the City of Port Louis and the towns of Beau Bassin Rose Hill, Quatre Bornes, Vacoas-Phoenix and Curepipe, the main settled areas include the villages of Triolet, Riviere du Rempart, Centre de Flacq, Mahebourg, Rose Belle, Bel Air, St Pierre, Bambous, Baie du Tombeau each with over 15,000 people.

Figure 23: Land use

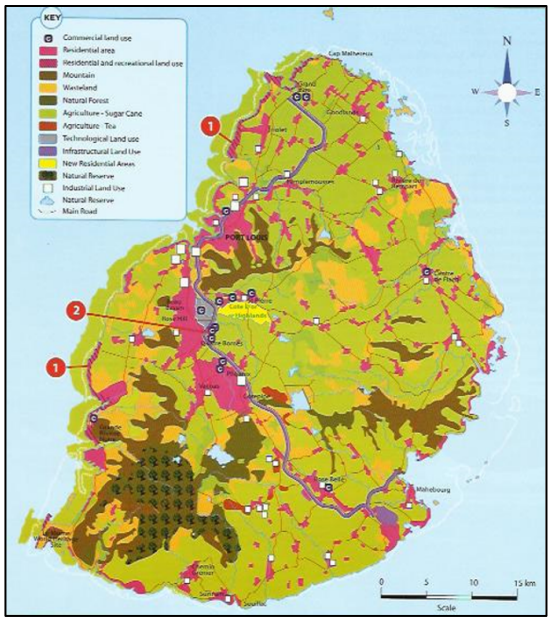
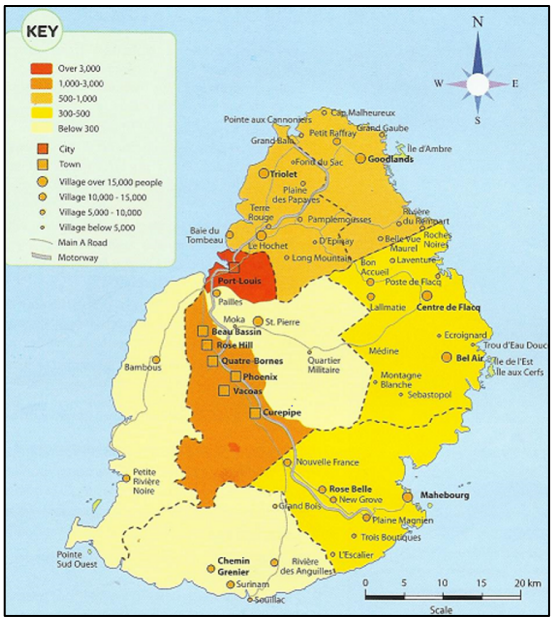


Figure 22: Population density



Source: Atlas of Mauritius

B. Political Structures

Mauritius obtained its independence from England in 1968 after having been successively under French administration and British rule. It became a Republic in 1992. The Head of Government is the Prime Minister while the Head of State is the President. The current Prime Minister is Honorable Sir Aneerood Jugnauth and the Head of State/President His Excellency Rajkeswur Purryag (Table 5). There is a proposal for a Second Republic, where the President will be elected.

Table 5: Mauritian Government

Year of Independence	Independence from Great Britain in1968; Republic since 1992
Form of Government	Parliamentary Republic [The President of the Republic is the Head of State; the Prime Minister is the Head of the Government]
Legislature	National Assembly

Names of President and Prime Minister	- President/Head of State: His Excellency Mr. Rajkeswur Purryag, GCSK[18], GOSK - Prime Minister: The Right Hon Sir Anerood JUGNAUTH, GCSK, KCMG, QC (Labour Party)

The main parties are the Mouvement Socialiste Mauricien (led by Aneerood Jugnauth), the Labour Party (led by Navinchandra Ramgoolam), the Mouvement Militant Mauricien (led by Paul Bérenger), the Parti Mauricien Social Démocrate (led by Xavier Duval) and have formed changing coalitions since independence. A number of new parties have equally been formed in recent few years to challenge the old ones. The last general elections were held in December 2014 and saw the victory of the Alliance MSM/PMSD/Muvman Liberateur. At each general election, a total number of 60 candidates are elected, in addition to two seats for Rodrigues and eight seats allocated to best losers. Parliament, also known as the National Assembly hence consists of 70 members.

In addition to the Prime Minister's Office, there are 23 different ministries[19] (Table 5).

Table 6: List of Ministries

Prime Minister's Office
Deputy Prime Minister's Office, Ministry of Energy and Public Utilities
Vice-Prime Minister's Office, Ministry of Finance and Economic Development
Vice-Prime Minister's Office, Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping
Ministry of Foreign Affairs, Regional Integration and International Trade
Ministry of Housing and Lands
Ministry of Social Security, National Solidarity and Reform Institutions
Ministry of Education and Human Resources
Ministry of Agro-Industry and Food Security
Ministry of Environment and Sustainable Development
Ministry of Tertiary Education, Science, Research and Technology
Ministry of Information and Communication Technology
Ministry of Fisheries
Ministry of Youth and Sports
Ministry of Local Government and Outer Islands
Ministry of Arts and Culture
Ministry of Labour, Industrial Relations and Employment
Ministry of Tourism and Leisure
Ministry of Health and Quality of Life
Ministry of Industry, Commerce and Consumer Protection
Ministry of Social Integration and Economic Empowerment
Ministry of Business, Enterprise and Cooperatives
Ministry of Gender Equality, Child Development and Family Welfare
Ministry of Civil Service and Administrative Reforms

Source: http://www.gov.mu/ (accessed as of 8 September, 2014)

While the constitution of Mauritius does not specify the form of local government, Port Louis has a city council, whereas the four townships each have a municipal council (Beau Bassin-Rose Hill, Curepipe, Quatre Bornes, and Vacoas-Phoenix). Local Government consists of five Municipalities, seven District Councils (Figure 24) [20]

[18]

GCSK: Grand Commander of the Order of the Star and Key of the Indian Ocean
GOSK: Grand Officer of the Order of the Star and Key of the Indian Ocean
KCMG: Knight Commander (of the Order) of St Michael and St George
QC: Queen Counsel
MP: Member of Parliament

[19] As at end November 2014, prior to the formation of the New Government which now consists of 25 Ministries (including the Prime Minister's Office).

[20] Seven District Councils are Pamplemousses, Rivière du Rempart, Moka, Flacq, Black River, Grand Port and Savanne.

and 124 Village Councils, which are all elected bodies. They are responsible for providing a wide range of services such as street-lighting, waste collection, construction and maintenance of roads, drains and public spaces, provision and maintenance of bus shelters and traffic centres, organisation of sports and cultural activities, etc.

The Ministry of Local Government and Outer Islands ensures local government administration coordination in general and also allocates grants on a yearly basis for the functioning of the local authorities. In Rodrigues, there is since 2001, a Regional Assembly constituted of 18 members and an executive council headed by a Chief Commissioner (currently Serge Clair, leader of the *Organisation du Peuple de Rodrigues* –OPR).

Figure 24: Map of districts

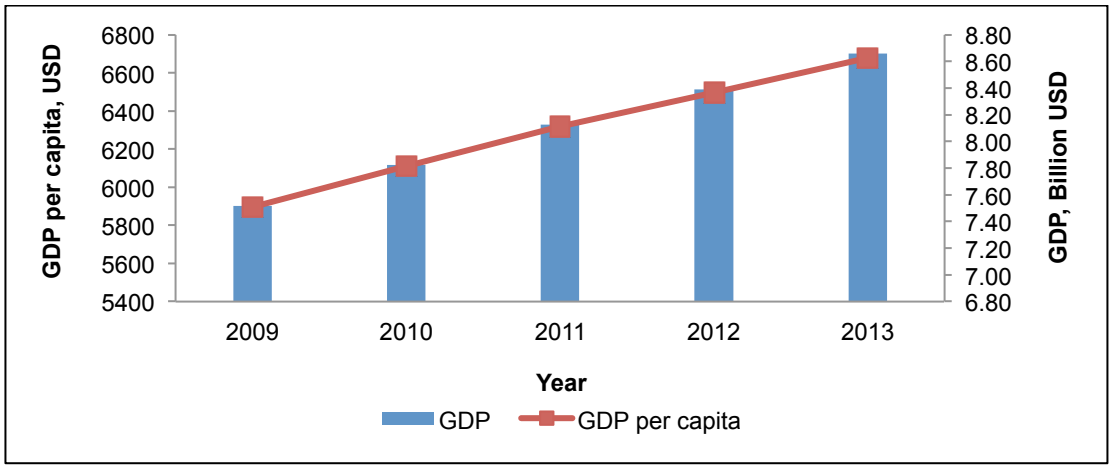
Source: Atlas of Mauritius, 2012

C. Economic Structures

Gross Domestic Product

Mauritius is among the largest economies in the Indian Ocean, with a total GDP amounting to USD 8.66 billion in 2013 and USD 8.39 billion in 2012 (constant 2005 USD). Figure 25 shows GDP and GDP per capita for the years 2009 to 2013. Annual growth for the period 2012-2016 is estimated at 4.1% for GDP and 3.9% for GDP per capita. Mauritius is an upper middle-income country with a GDP per capita of USD 8,570 (2013). While sugar and textile exports have contracted, the financial services and ICT sector are experiencing continued growth.

Figure 25: GDP and GDP per capita (2009-2013) in constant 2005 USD



Source: World Bank Development Indicators

Mauritius used to be a mono-crop country highly dependent on sugar cane cultivation and agriculture in general until the 1970s, when the economy started to diversify into tourism, manufacturing and more recently into the service sector including financial services and ICT. In 2012, services accounted for 71.9% of total GDP (Table 7). A diversification of the economy has thereafter been initiated namely with manufacturing and textile, based on foreign investment and the Export Processing Zone (EPZ) model. In parallel, tourism was given an unprecedented boost, specialising in the 'haut de gamme' sector. The services sector has focused on the development of offshore and outsourcing services. Economic activities are largely private led, where large conglomerates initially involved in the sugar industry have prospered thanks to the guaranteed market for sugar in the European Union under the Lomé Convention then ACP-EU or Cotonou Agreement. Despite external shocks and the recent global financial crisis, Mauritius has remained resilient and continues its efforts in remaining competitive regionally and globally by tapping new markets.

Table 7: Structure of the Economy

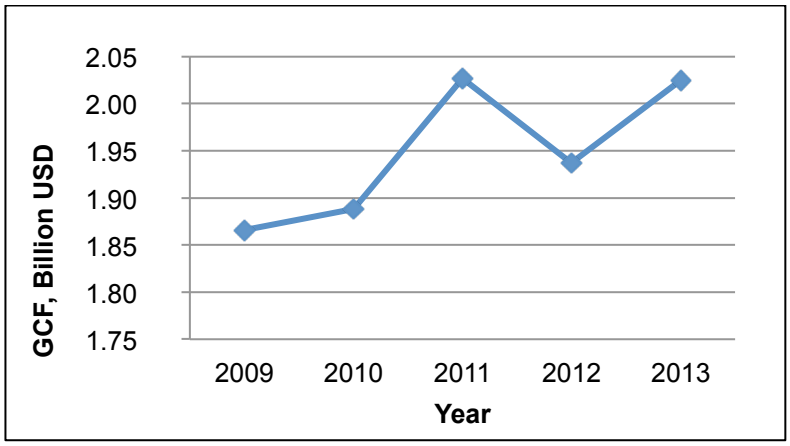
	% of GDP, 2012	Average Annual Growth
Agriculture	3.5	-0.2
Industry	24.7	0.9
Of which: Manufacturing	16.7	2.2
Services	71.9	4.4

Source: World Bank Development Indicators

Gross fixed capital formation

An analysis of GDP and of aggregate demand shows that domestic investment, commonly measured by Gross Fixed Capital Formation (GFCF), stood at USD 1.94 billion in 2012 and USD 2.02 billion in 2013 in constant 2005 USD (Figure 26).

Figure 26: Gross Capital Formation, 2009-2013, in constant 2005 USD

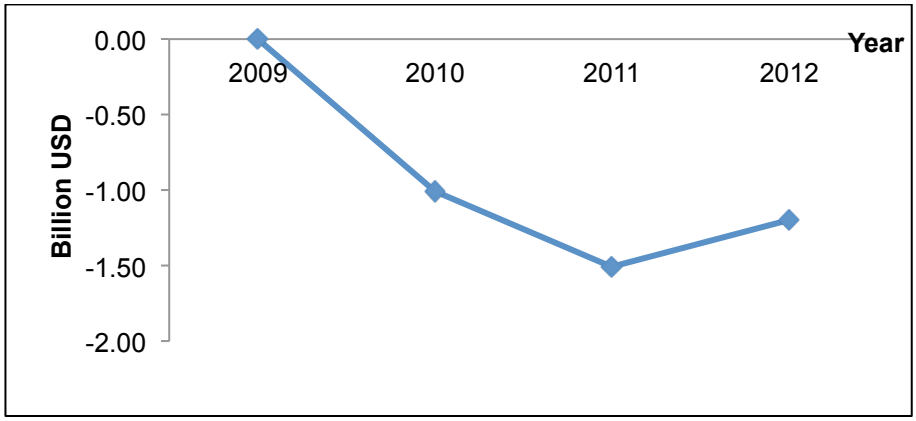


Source: World Bank Development Indicators

While GFC declined in 2012, it has experienced a slight rise in 2013. While private investment as a % of GDP suffered a setback, this has been offset by a rise in public investment as a % of GDP. The investment rate has declined from 24% of GDP in 2011 to 22% in 2013 due to bottlenecks in the public sector that have affected the take-off of projects as well as a reduction in business confidence. The gross domestic savings rate has also declined during the period from 13% of GDP to 11.8%.

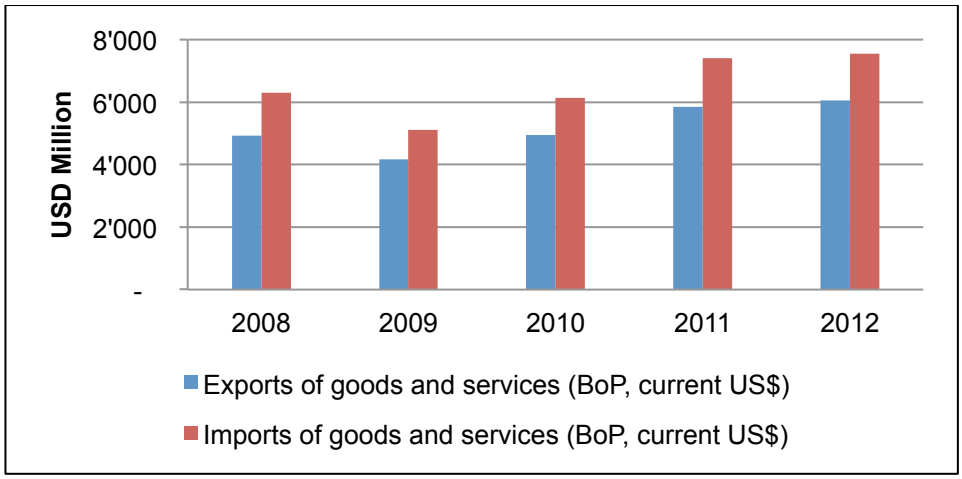
Figure 27 shows the current account balance over 2009-2012. The current account deficit stood at USD 1.19 billion in 2012 and represented 10.8% of GDP. The persisting trade deficit over 2008-2012 is portrayed in Figure 28, with the growth of imports further outpacing that of exports, while a slight improvement is noticed in 2012. Total exports of goods and services in 2012 reached USD 2,576 million while total imports attained USD 5,359 million (Table 8). Having no natural resources, Mauritius relies heavily on imports. Key imports comprise capital goods, fuel and food. The principal exports are manufactured goods and sugar.

Figure 27: Current Account Balance, 2009-2012, USD Billion



Source: World Bank Development Indicators

Figure 28: Exports and Imports, 2008-2012



Source: World Bank Development Indicators

Table 8: International Trade (USD million), 2012

Overall surplus/deficit	-5.1
Total exports (fob)	**2,576**
Manufactures	1,618
Sugar	247
Total imports (cif)	**5,359**
Capital goods	1,151
Fuel and energy	700
Food	816
Export price index (2000=100)	132
Import price index (2000=100)	164
Terms of trade (2000=100)	80
Current account balance/GDP	-10.8%

Source: World Bank Development Indicators

Destination of exports: Mauritian exports to Europe accounted for 58.9% in 2012, declining from 61.3% in 2011. Exports to Africa and especially South Africa have experienced significant growth. Trade accounts for 120.5% of GDP, and the national policy is to position the country in the African region as a regional hub for manufacturing, financial services, trade and knowledge. This "Africa Strategy", outlined in the 2014 national budget, is expected to give a new impetus to cross border exchanges and the development of value added products.

Origin of imports: India and China are the main import source markets (respectively 39% and 15% of total imports in 2013). The key imported products (value-wise) from India include gas oils, fuel oils, jet fuel, petrol/gasoline, plain cotton weave, medication and basmati rice. Main imports from China comprise plain cotton, portable digital computers, cellular and other phones, bars/rods of aluminium alloys.

Moreover, total debt as a percentage of GDP reached 42.5% in 2012. The present value of the debt represented 32.3% of total exports while the total debt service accounted for 1.5% of total exports (see Table 9).

Table 9: Debt related indicators, 2012

Interest payments/GDP	0.6
Total debt/GDP	42.5%
Total debt service/exports	1.5%
Present value of debt/exports	32.3%

Source: World Bank Development Indicators

D. Public Finance

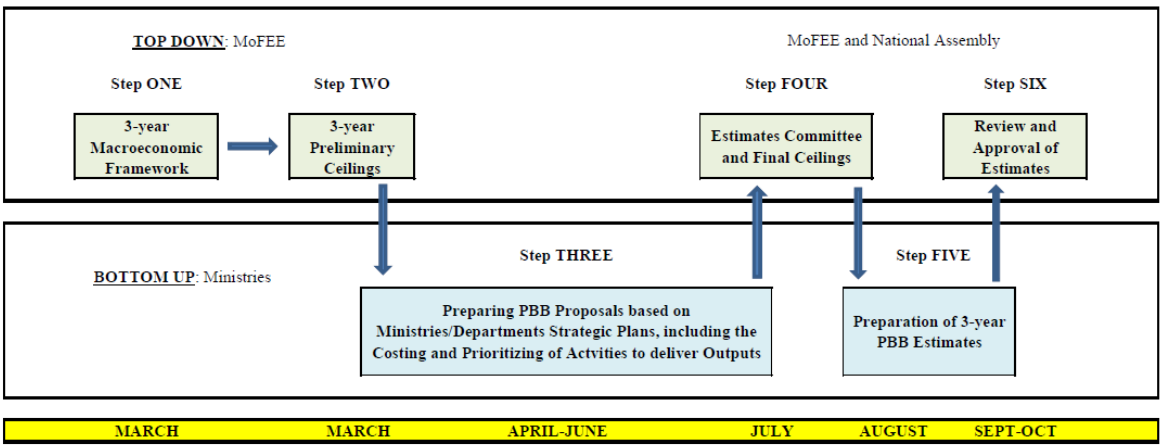
Government expenditure and investment in Mauritius rests on two pillars, namely Programme-Based Budget (PBB) and Public Investment Sector Programme (PISP). The PBB caters for the annual expenditure by Government and is a most vital tool for the planning function of Ministries/Departments. The PBB covers three calendar years and is reviewed annually. For instance, the 2014 PBB figures include estimates for 2014 and planned figures for 2015 and 2016. The 2014 PBB also includes expenditure figures for 2013 for comparison (estimates).

The Public Investment Sector Programme (PISP) on the other hand outlines the way Public Sector infrastructure investment decisions and policies are planned, financed and implemented. It comprises a 5-Year pipeline of Public Sector investment projects for funding through Government budgetary resources, state-owned institutions and loans and grants from development partners. The PISP also includes the actual expenditure for the last three years. For example, 2014 PSIP includes planned investment for 2014-18 and the actual expenditure for 2011-13.

The Budgeting Process is anchored on a top-down medium term resource envelope at the same time requiring bottom-up cost estimates (Figure 29). There is much emphasis on policy commitment and it is also recognised that spending policies need to be consistent with strategic priorities.

The fiscal year is from January to December. Whenever necessary, there can be adjustments to the budget, that is, through a 'supplementary budget', in particular for PBB. The Public Investment Process, also known as the Budgeting Process starts around March each year with discussions lasting through October, while the budget is itself presented in early November. Approval takes place either in late November or early December of each year.

Figure 29: Public Investment Processes in Mauritius



Source: 2010 Manual for Programme Based Budgeting

All Local Authorities (Municipal City Council, Municipal Town Councils and District Councils) receive an annual grant from Central Government Consolidated Fund under PBB. The amount allocated takes into account the financial and development needs of the particular Local Authority, including the human resource needs, any special needs, the possibility for local authorities to raise their own revenue, as well as the state of public finance and of the economy of Mauritius in general (Local Government Act 2011).

The 2013 budget totalled MUR 113.7 Billion (USD 3,656 Million[21]) 8.6% up from MUR 104.7 Billion (USD 3,412 Million) in 2012. For the current budget, the main items of expenditure are 'compensation to employees', 'use of goods and services', 'interest expense', 'subsidies', 'grants' and 'social benefits'. On the revenue side, total revenues reached MUR 78.2 Billion (USD 2,642 Million) in 2013 The principal sources of revenue are 'taxes', 'social contributions', and 'grants'. Taxes accounted for 86.9% of total Central Government revenue in 2013 and the main source of revenue was by far 'Taxes on goods and services', followed by 'Taxes on income, profits, and capital gains'.

An important source of revenue for public finance is taxation (Table 10). Revenue accounted for up to 23% of total GDP in 2012 and has been more or less constant over the last few years.

Table 10: Public finances (percentage of GDP)

	2009	2010	2011	2012
Revenue, excluding grants (% of GDP)	23.5	22.8	22.4	23.0
Tax revenue (% of GDP)	18.7	18.5	18.4	19.0

Source: World Bank Development Indicators

The budget deficit reached 2.7% of GDP in 2013 and had widened compared to 2.1% of GDP in 2012. The deficit is financed from domestic debt and concessional foreign borrowing. The debt to GDP ratio is a cause for concern as it is close to the legal limit of 60%.

Table 11 provides a breakdown of external debt as well as the flow of international funds in and out of the country. Government's main creditors include multilateral financial institutions like the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Monetary Fund (IMF), bilateral credits (countries like China, India and Japan), private credit as well as a number of short term loans.

The country is also a recipient of several grants. It also attracted, Foreign Direct Investment amounting to USD 361 million (net inflows) in 2012.

Table 11: External Debt and Resource Flows (USD million), 2012

Total debt outstanding and disbursed	**4,459**
IBRD	274
IDA	6
Total debt service	**185**
IBRD	10
IDA	1
Composition of net resource flows	
Official grants	83

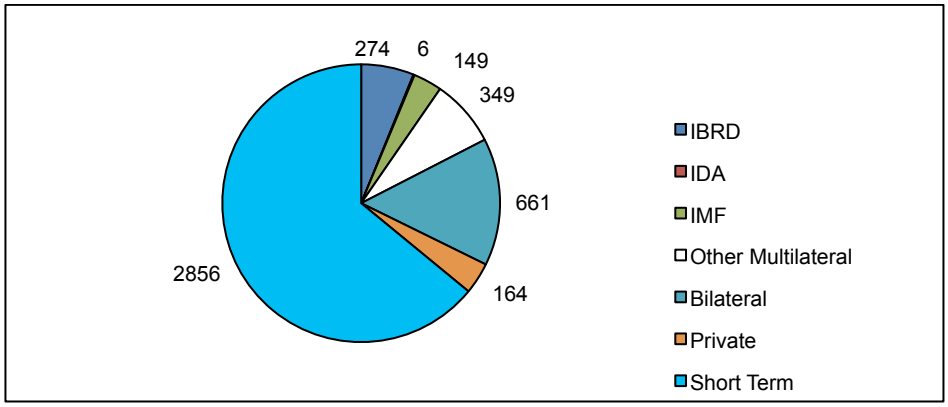
[21] Conversions in USD using for 2014 MUR 30.9, for 2013 MUR 31.1 and for 2012 MUR Rs 30.7 are applied in this report.

Official creditors	92
Private creditors	-24
Foreign direct investment (net inflows)	361
Portfolio equity (net inflows)	0
World Bank Program	
Commitments	35
Disbursements	36
Principal repayments	8
Net flows	28
Interest payments	3
Net transfers	25

Source: World Bank Development Indicators

The different providers of credit to Government are shown in Figure 30 below. The bulk of Government debt in 2012 was attributed to short-term loans (64%).

Figure 30: Composition of 2012 Debt (USD Million, current)



Source: World Bank Development Indicators

E. Other socio-economic elements

The country ranked 63rd in the 2013 UN Human Development Index, and was classified in the High Human Development band. Life expectancy at birth is 70.15 years for men and 77.13 years for women while the infant mortality is 13.7 per 1,000 live births (Table 12). The official language is English but Creole and French are widely used as well as a few Asian languages.

Table 12: Socio-economic indicators

Religions (in order of prominence)	Hinduism, Christian, Islam, Buddhist
Life expectancy at birth (years)	70.15 years of men and 77.13 years for women
Infant mortality (per 1,000 live births)	13.7

Child malnutrition (% of children < 5)	…
Access to improved water (% of pop)	100
Literacy (% of population age 15+)	88.8
Gross primary enrolment (% of school-age pop)	108 (109 for men, 107 for women)
Human Development Index	0.771 (Rank 63rd)

Source: Human Development Report, Statistics Mauritius

Table 13 provides an overview of national income distribution. According to Statistics Mauritius, in 2012 there were 9.6% households who lived in relative poverty, which is equivalent to 122,700 individuals.

Table 13: Indicators on poverty

Gini (2012)	0.413
Poverty (% of households in relative poverty in 2012)	9.6
Poverty headcount : number of individuals in relative poverty in 2012	122,700

Source: World Bank, Statistics Mauritius

Reference

2010 Manual for Programme Based Budgeting

A.Cader Kalla (2012). Atlas of Mauritius. Osman Publishing

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2. Disaster Loss[22]

A. Overview

Component 1 of this initiative was to build a disaster loss database that registers not only large-scale but also small-to-medium scale disasters. 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 introduced in the loss data analysis 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[23].

During the project, data on extensive and intensive disasters that occurred from 1980 to 2014 were collected. The data were registered by district, 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. The disaster data not directly associated with natural hazards (*e.g.* traffic accident, marine accident, epidemic, shark attack) were registered in the database but excluded for analysis in this report[24].

The disaster loss database takes into account the different disaster types and registers a series of indicators to classify impact 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[25].

The National Disaster Risk Reduction and Management Centre (NDRRMC) hosted Component 1 with cooperation from the Mauritius Meteorological Services.

The data are open to the public in the following site:

http://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=mus

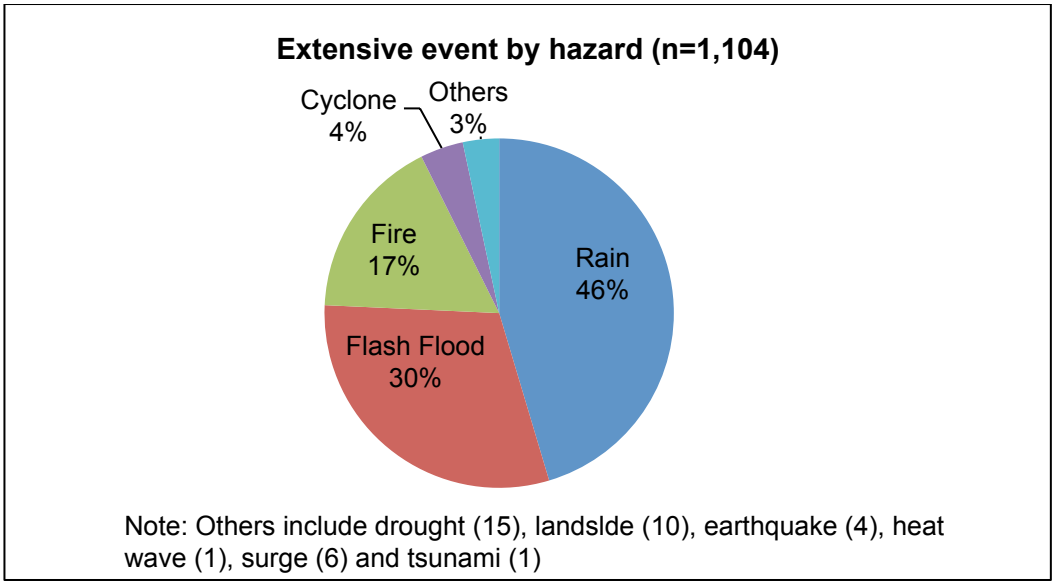
[22] This chapter was drafted by Kazuko Ishigaki (UNISDR) with the support of Pamela Leste De Perindorge.
[23] The most well-known international disaster loss database called EM-DAT registers disasters for a minimum of 10 deaths (see http://www.emdat.be/criteria-and-definition).
[24] Fire is included in the analysis, though.
[25] For methodology of assigning monetary value to loss, see http://www.preventionweb.net/english/hyogo/gar/2013/en/gar-pdf/Annex_2.pdf

B. Disaster loss in Mauritius[26]

The island of Mauritius and Rodrigues are generally prone to a wide range of natural hazards including cyclones, flash floods, torrential rains, landslides, drought, pest, epidemics, tsunamis and tidal waves. Light earth tremors have also been felt in Rodrigues. Coastal erosion arising from climate change can also be added to this list.

A total of 1,105 data cards were registered for natural hazards: 1,104 cards were categorized as extensive disasters while only one card was categorized as an intensive disaster. Intensive loss was due to Cyclone Firinga in 1989, which resulted in 507 injured, 844 missing and USD 21.7 million of economic loss (at 2012 price). Out of 1,104 extensive disasters, rain is the most prevalent (46%), followed by flash flood (30%), fire (17%) and cyclone (4%) (Figure 31).

Figure 31: Extensive event by hazard



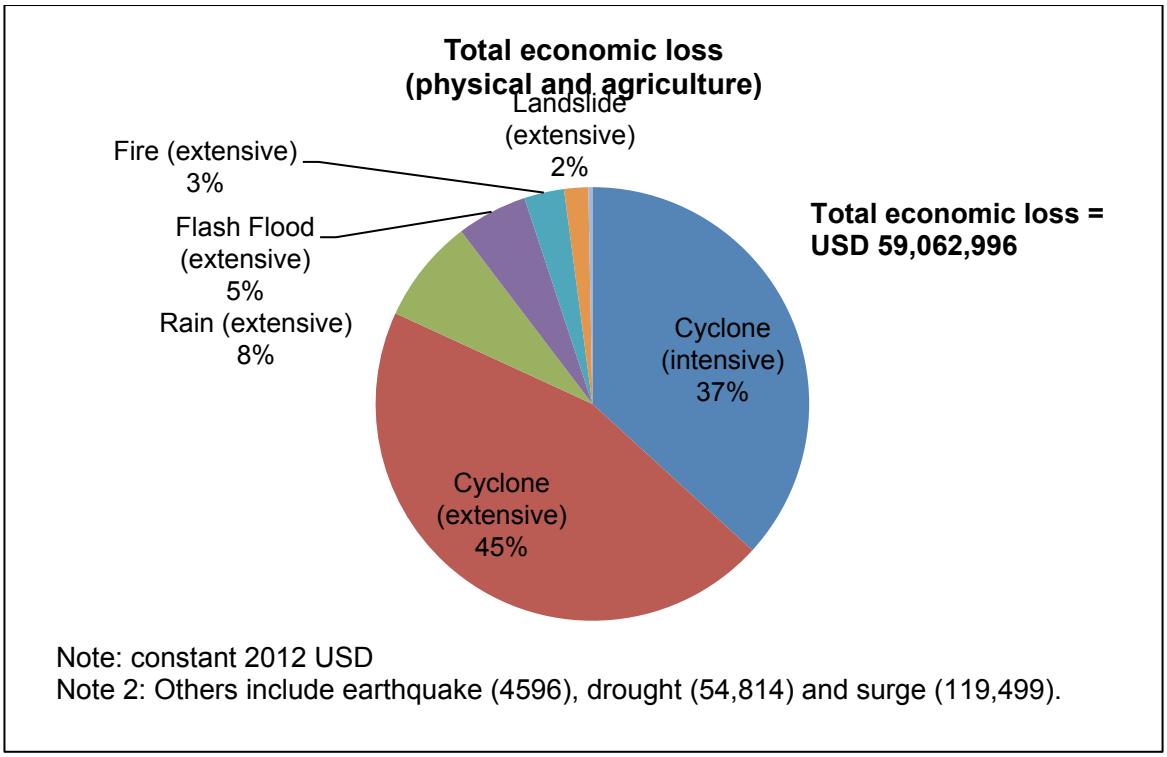
Source: Author based on Mauritius National Loss Database

Total mortality is 127 due to: intensive cyclone (1), extensive cyclone (36), extensive fire (47), extensive flash flood (28) and others (extensive rain and surge).

Economic loss (physical and agriculture) is estimated at USD 59 million at 2012 prices. The intensive cyclone (one event) contributed 37% of the total economic loss. If extensive and intensive cases are combined, 82% of economic loss was due to cyclone (Figure 32).

[26] For detailed methodology, see UNISDR/IOC (2014) and http://www.desinventar.net/methodology.html

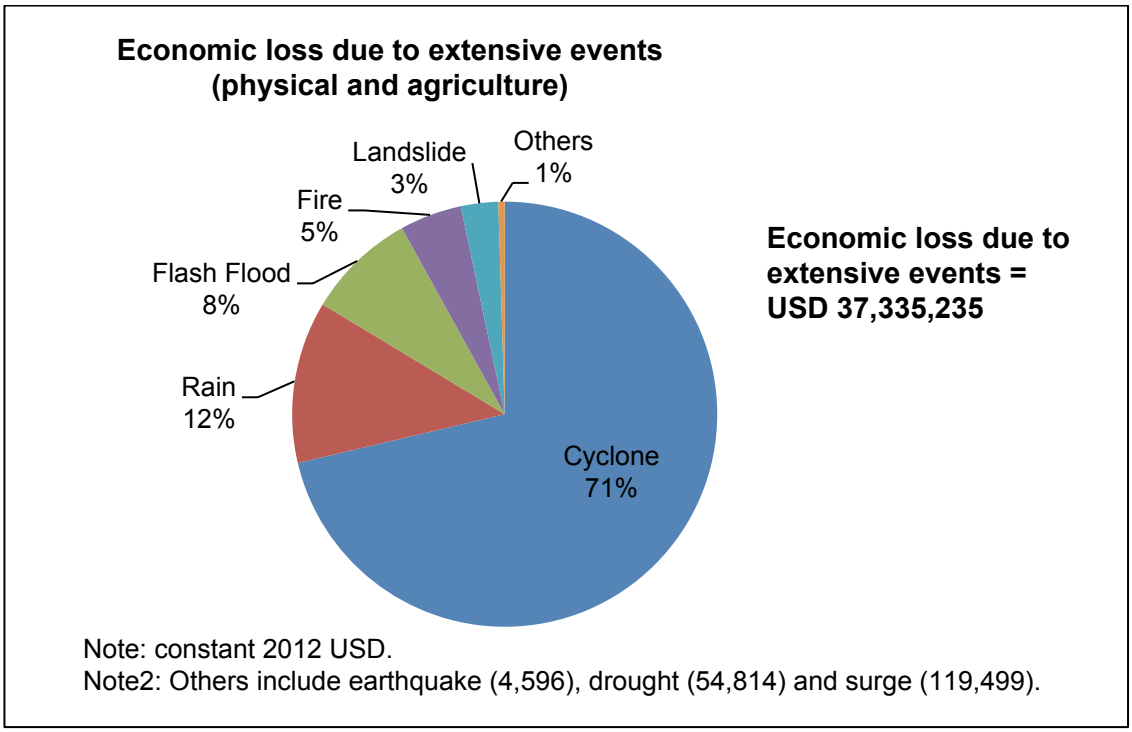
Figure 32: Total economic loss (physical and agriculture)



Source: Author based on Mauritius National Loss Database

Out of the set of extensive disasters, cyclones accounted for 71% of economic loss, followed by rain (12%), flash flood (8%), fire (5%) and landslide (3%) (Figure 33).

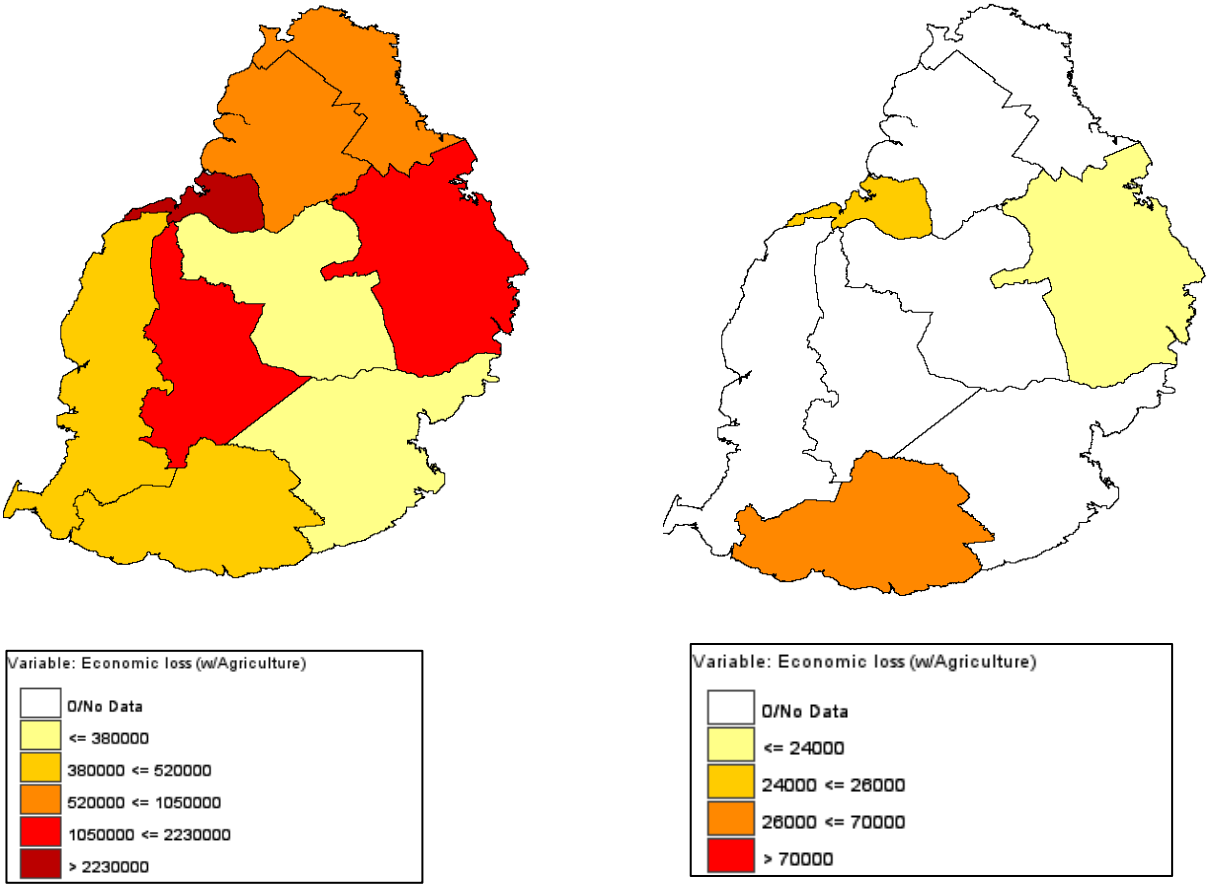
Figure 33: Economic loss due to extensive events (physical and agriculture)



Source: Author based on Mauritius National Loss Database

We conducted geographical analysis only on extensive disasters because there was only one data card on intensive loss. Geographically, cyclone loss was registered for the districts of Savanne, Port Louis, and Flacq while there were no data or disaggregated information to estimate loss for the other districts. However, if we look at all hazards, we see that all districts except for Moka and Grand Port were severely exposed to extensive loss affected by recurrent flash floods, torrential rains and landslides (Figure 34).

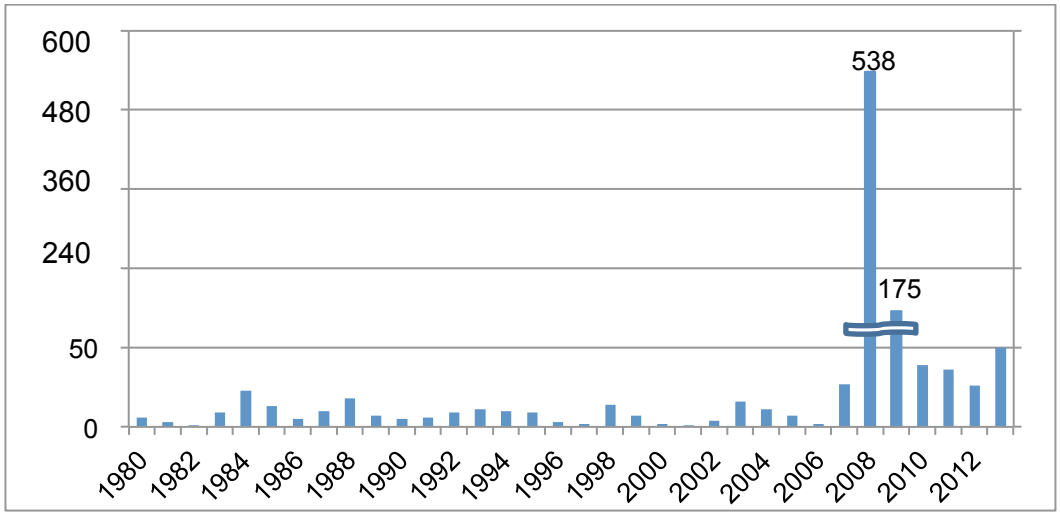
Figure 34: Geographical distribution of extensive economic loss (in million USD) due to all hazards combined and cyclone (physical and agricultural)



Source: Author based on Mauritius National Loss Database

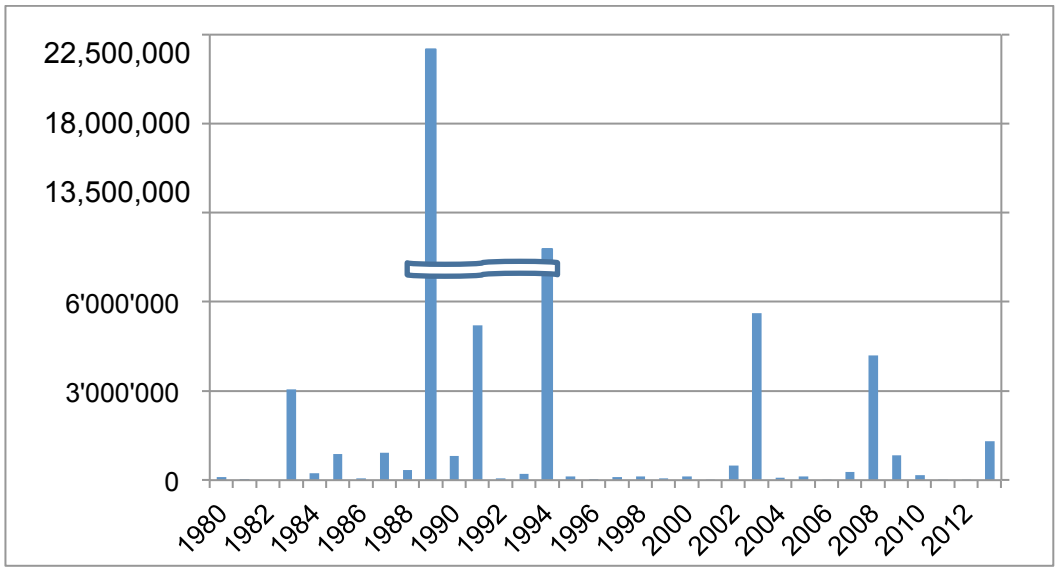
The number of data cards each year has increased since 2007. Before 2007, the number of events was always less than 50. The economic loss is significant in 1989 (USD 21.7 million - Cyclone Firinga) and 1994 (USD 11.7 million - Tropical Depression Hollanda).

Figure 35: Annual Number of data cards, 1980-2013



Source: Author based on Mauritius National Loss Database

Figure 36: Economic Loss, 1980-2013



Source: Author based on Mauritius National Loss Database

Lessons to be learned

Natural hazards that are the most appropriate targets for future policies are cyclones, which can be both extensive and intensive events. Cyclones cause not only direct loss such as damage to utilities and other infrastructures, but also indirect loss including loss of economic activities due to no water or electricity to run business. It also leads to negative macro-economic impacts such as GDP and trade balance. Flash floods and torrential rains equally need special attention as demonstrated by the significant damage caused by such events in the months of February and March of 2013.

Loss information is very valuable for different analyses including risk assessment and economic analysis and these databases can be helpful to know the trend of disasters in the country and suggest need for understanding on why they are persisting or increasing. Information of past disasters indeed gives an essential supply for finding solutions for reducing those “invisible” risks that can affect the wellbeing of the communities. Continuity on recording effects of events is important for better approximations of disaster and risk trends.

There are challenges in use of the extensive/intensive dichotomy. For instance, coastal erosion is mainly due to climate change (neither intensive nor extensive). Hence, it is difficult to classify beach erosion. The dichotomy of extensive and intensive does not take into account risks that are of high severity and high frequency.

3. Disaster Risk[27]

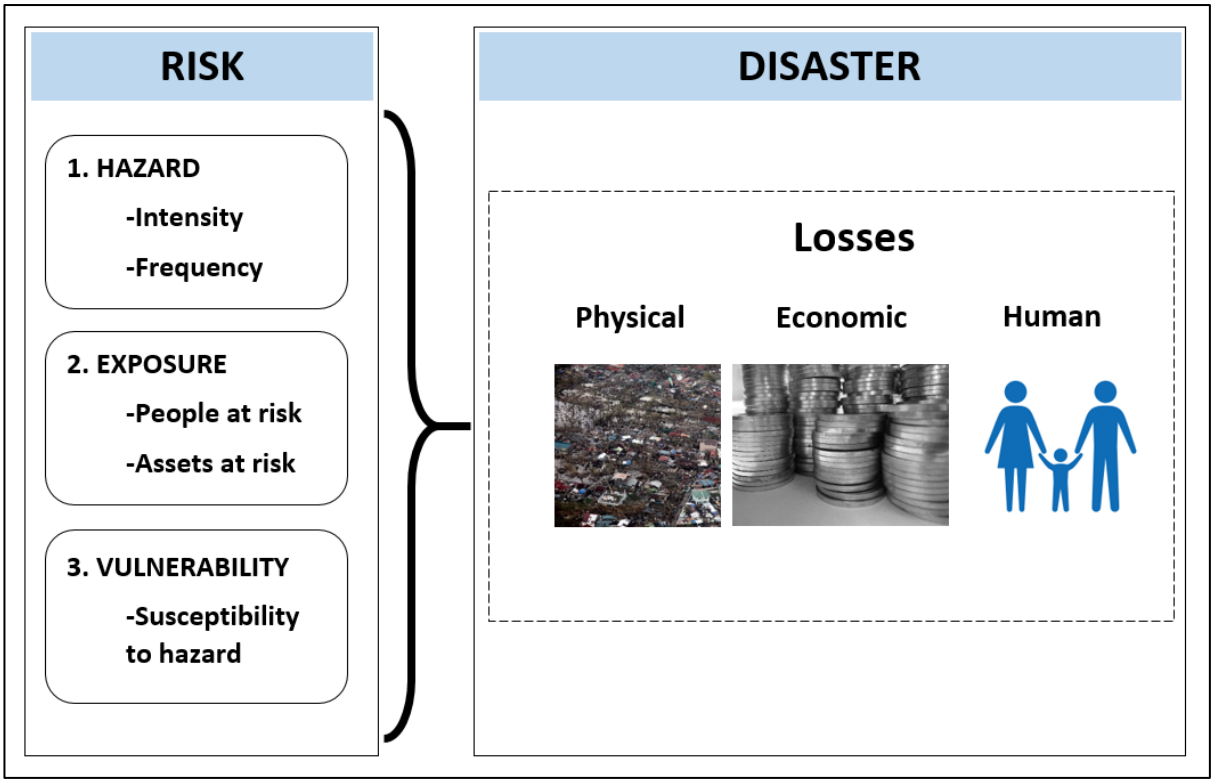
A. Overview

Component 2 of this initiative aimed to build a database for probabilistic risk assessment. UNISDR facilitated the identification and consolidation of a national focal point for disaster risk information and enhanced the understanding of risk concepts and risk assessing methodologies through capacity building workshops

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 37). Hazard data are basically calculated from a set of stochastic scenarios and in this initiative the data were extracted from global datasets[28]. **Exposure** data measures the degree at which people and assets will be at risk when a hazard hits, and often consists of inventories of buildings, population and infrastructure. In this initiative, we used a combination of global exposure databases and data compiled by national experts (processed to construct a proxy). **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 show the relationship between hazard intensity and the expected values of damage. In this initiative, vulnerability data were also taken from global data sets.

Figure 37: Key concepts of probabilistic risk assessment

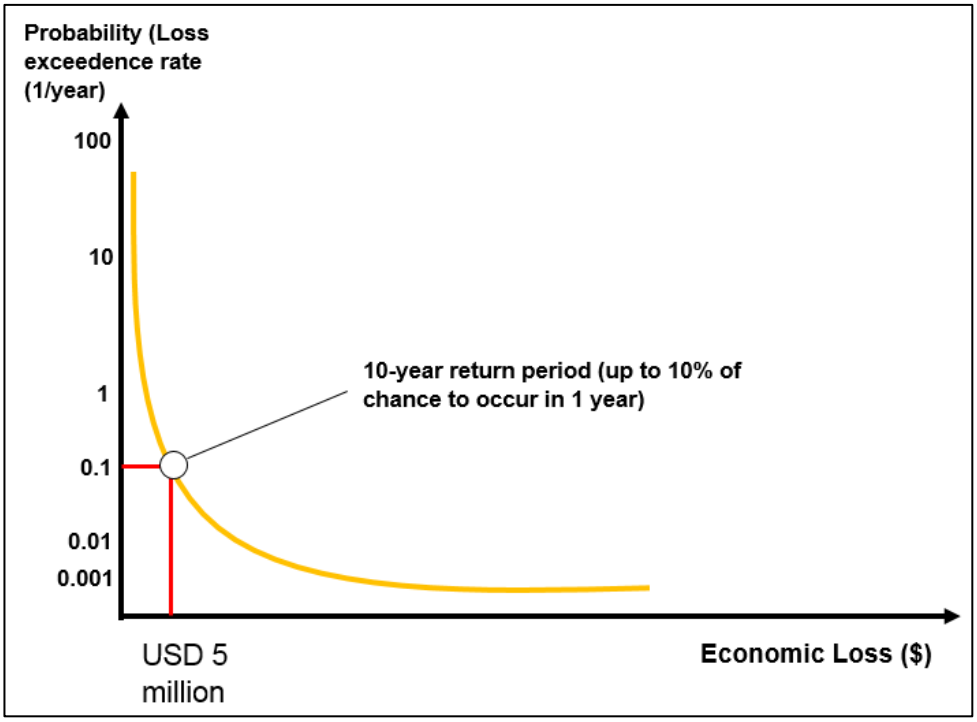


Source: Author

[27] This chapter was drafted by Kazuko Ishigaki (UNISDR).
[28] Hazard, exposure and vulnerability data used for the risk assessment in Mauritius is outlined in INGENIAR (2014) and UNISDR/IOC (2014).

Based on probabilistic risk assessment, a loss exceedance curve for each hazard is produced (Figure 38). The curve shows the relationship between each value of the losses and the likelihood (probability) of having such loss during one year.

Figure 38: Loss exceedance curve



Source: Author

This curve 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 plausible. 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.

In the IOC region, UNISDR supported probabilistic risk assessment for tropical cyclone (wind) and earthquake hazards. Tropical cyclone was selected because it was clear from the disaster loss data outlined in Chapter 2, 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.

UNISDR and the national team collaborated to produce hybrid loss exceedance curves that combine probabilistic risk curves based on data collected in Component 2 with empirical risk curves based on historic loss data registered in Component 1 (see Chapter 2). Probabilistic risk assessment tends to underestimate the extensive risk and historic loss data is used to remedy this problem.

The challenge is that the current historic loss databases have time series that are 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.

As described above, the probabilistic risk assessment implemented in this initiative is very often based on global data and 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 also 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.

In Mauritius, the National Disaster Risk Reduction and Management Centre hosted the Component 2 workshop in cooperation with Mauritius Meteorological Services.

B. Probabilistic Risk Assessment in Mauritius[29]

In Mauritius, UNISDR and the national team only conducted probabilistic risk assessments for tropical cyclone wind, because earthquake risk was determined to be minimal.

Table 14 presents the AAL and PML in absolute and relative values to exposed assets, gross fixed capital formation (GFCF) and GDP. AAL is USD 86.91 million and constitutes 0.04% of GFCF. PML is USD 1,094 million for a 50-year return period and it increases with longer return periods.

Table 14: AAL and PML for tropical cyclonic winds in Mauritius

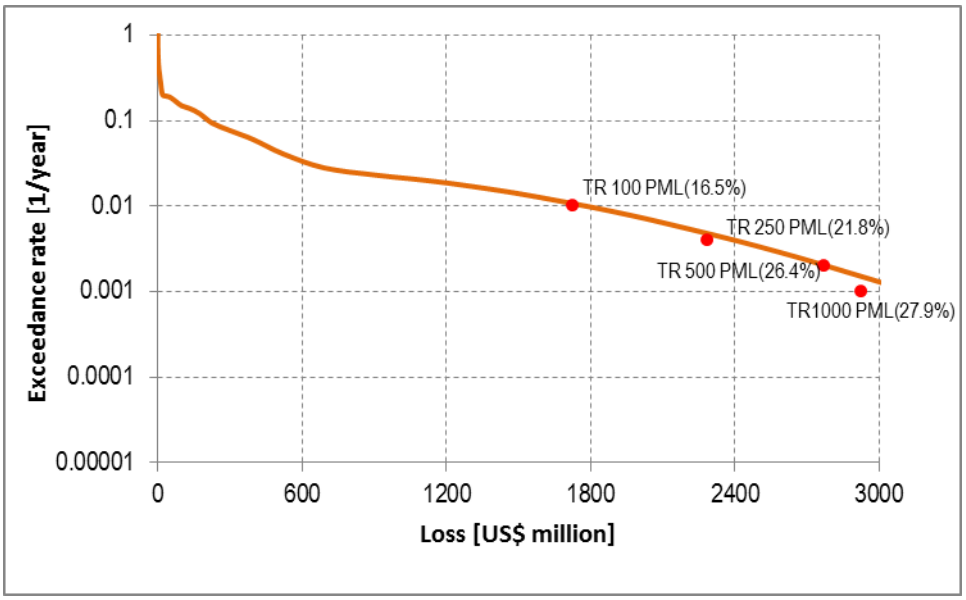
	USD million	**Exposed Assets (2014)**	**GFCF** (2013)	**GDP** (2013)
		10,516	1,967	8,658
	Absolute	Relative		
Annual Average Loss (AAL)	86.91	8.265‰[30]	4.4%	1.0%
Probable Maximum Loss (PML) in given return period (years)				
50	1,094	10.4%	55.6%	12.6%
100	1,726	16.4%	87.7%	19.9%
250	2,288	21.8%	116.3%	26.4%
500	2,773	26.4%	141.0%	32.0%
1000	2,929	27.9%	148.9%	33.8%

Sources: Exposed Assets, AAL, PML: UNISDR/IOC (2014), GFCF and GDP: World Bank Development Indicators

Figure 39 shows the loss exceedance curve while Figure 40 shows the PML curve. In addition, the exceedance curves for different PML given different periods, specifically 50, 100 and 200 years, are presented in Figure 41. These plots show the probability of exceeding a certain value of loss in a given time frame; for example, the probability of exceeding a loss of USD 2,773 Million (PML for 500 years return period) in 50 years is 10%.

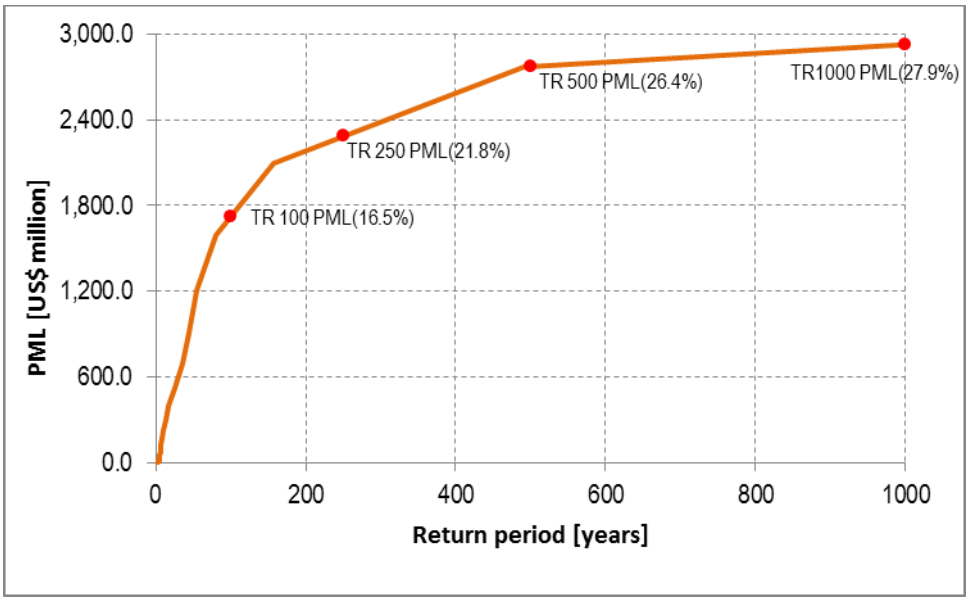
[29] For detailed data source and methodology, see UNISDR/IOC(2014), INGENIAR (2014).
[30] Mille is mathematical term that means per thousand, as its name in French suggests. It is represented by the symbol ‰.

Figure 39: Loss exceedance curve for tropical cyclonic winds



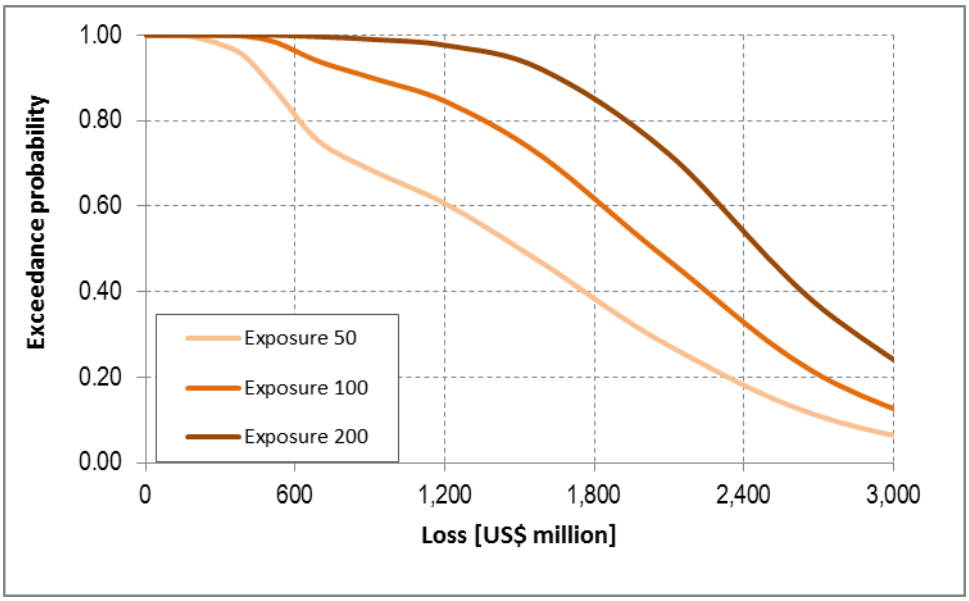
Source: UNISDR/IOC (2014)

Figure 40: PML curve for tropical cyclonic winds



Source: UNISDR/IOC (2014)

Figure 41: Exceedance probability curves given different times



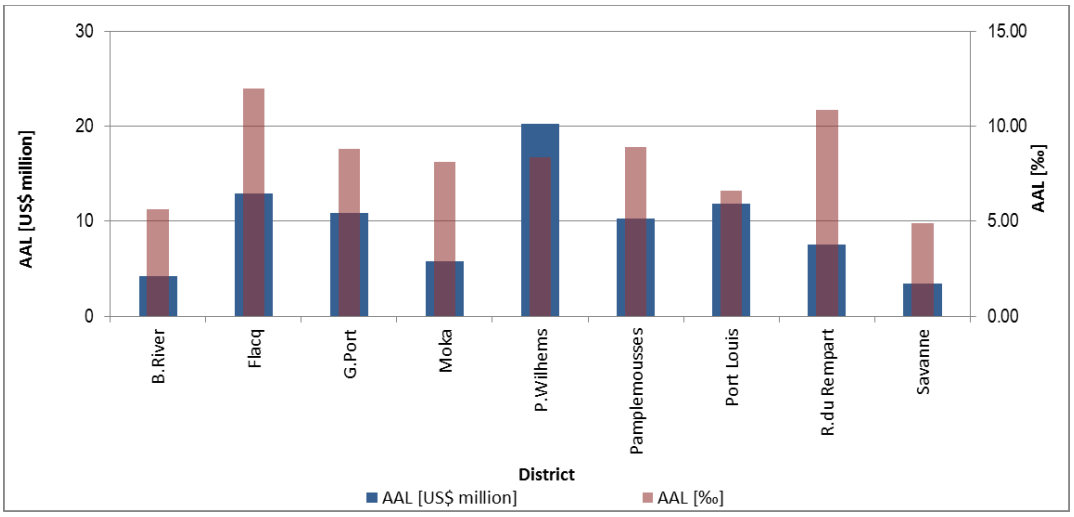
Source: UNISDR/IOC (2014)

The analysis of risk concentration is first carried out for the different districts in Mauritius, and then for the different sectors (for both the public and private sectors, and for the main components of infrastructure at national level).

Figure 42 and Figure 43 show the AAL (absolute and relative to the exposed assets) by district. Despite the fact that Flacq District is not the one that contributes the most to the AAL in absolute values (USD 13 million), AAL in relative terms is around 11.98 ‰ which is the highest of all districts and corresponds to a considerable level of risk. On the other hand, Plaines Wilhems has the largest absolute AAL (USD 20 million) but the relative loss is close to 8.38‰

The risk in both absolute and relative terms is concentrated along the eastern side of the country. This is absolutely compatible with the hazard results; in the Plaines Wilhems District, high absolute risk can be associated with the vulnerability of the assets *(i.e.* a high concentration of urban construction and urban infrastructure).

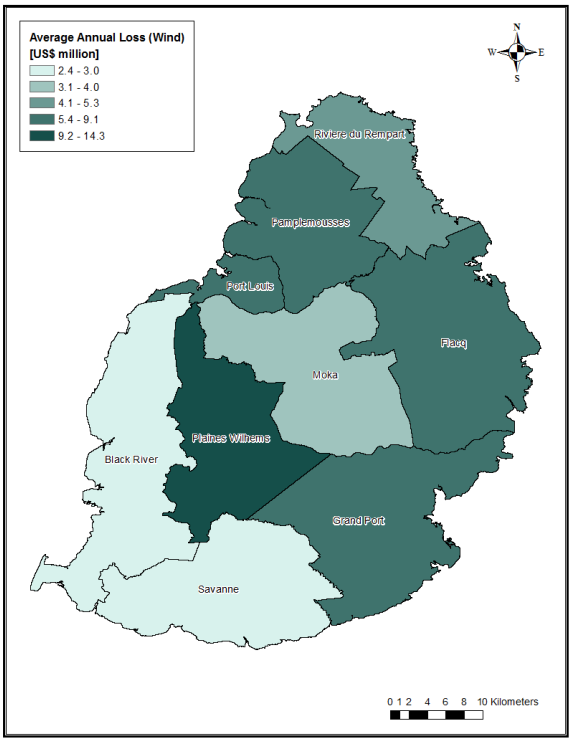
Figure 42: AAL (absolute and relative) by district for tropical cyclonic winds



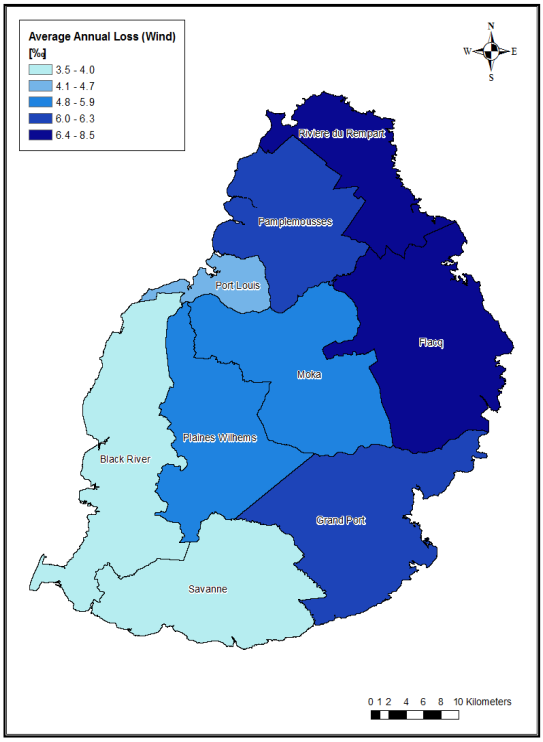
Source: UNISDR/IOC (2014)

Figure 43: AAL (absolute and relative) by district for tropical cyclonic winds

Absolute AAL



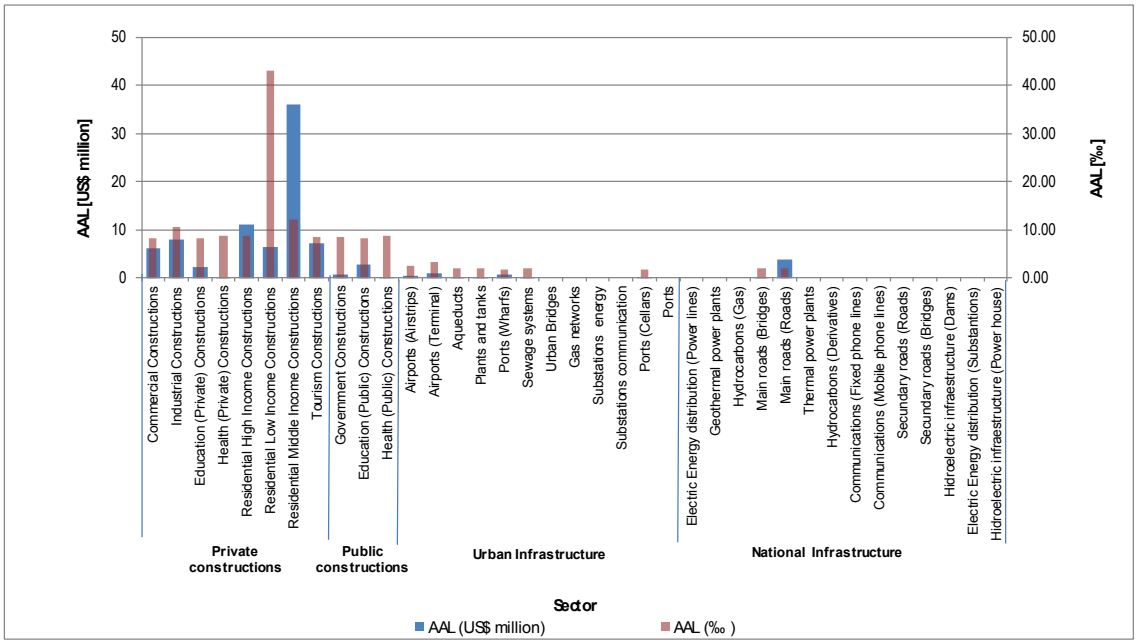
Relative AAL



Source: UNISDR/IOC (2014)

Figure 44 summarizes the AAL in absolute and relative values to the exposed assets for each sector. Clearly the highest AAL (both absolute and relative) is attributed to private construction and in particular residential units. Residential construction (private) accounted for the highest AAL, being residential low income constructions the assets that have the highest relative AAL. Other private construction include buildings for health, education, commercial and tourist purposes. The most vulnerable public construction includes public health institutions and schools.

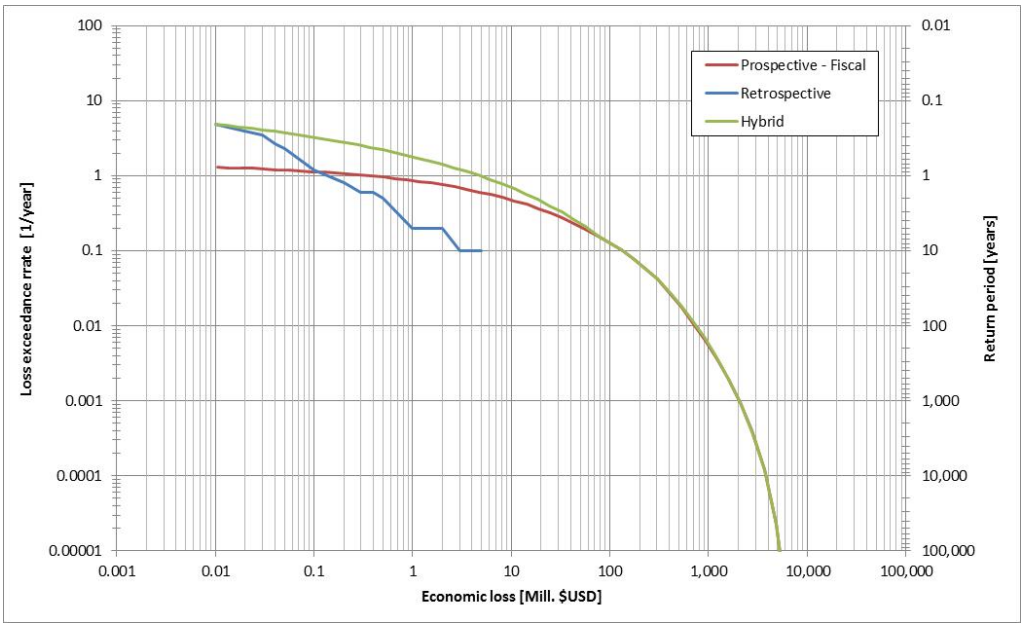
Figure 44: AAL by sectors for tropical cyclonic wind



Source: UNISDR/IOC (2014)

Figure 45 shows the hybrid loss exceedance curve for Mauritius. The time frame of historical records of disaster is too limited to assure sufficient quantity for constructing the first part of the curve (empirical loss exceedance curve)[31]. Therefore, even though a hybrid curve is obtained, insufficient quality of input data results in a curve, that is not statistically significant.

Figure 45: Hybrid loss exceedance curve



Source: UNISDR/IOC (2014)

Reference

INGENIAR (2014). Building capacity on probabilistic risk assessment. Country Risk Profile: Mauritius. In the frame of the project: Strengthening capacities for unified climate change adaptation (CCA) and disaster risk reduction (DRR). Bogota, Colombia

UNISDR /IOC (2014). Component 1 and 2: Comoros, Madagascar, Mauritius, Seychelles and Zanzíbar. Building capacities for increased public investment in integrated climate change adaptation and disaster risk reduction: 2012-2015. European Commission - Directorate General for Development and Cooperation. Geneva, Switzerland.

[31]The disaster loss database contains records since 1960, but it is only after 2003 that these records display a more uniform number of events per year and can be considered complete. Unfortunately, this period of time (2003 – 2013) is short for a significant statistical analysis. Even though a retrospective assessment was performed, given the caveats for a rigorous analysis, the hybrid curve cannot be considered of good quality.

4. National DRM/DRR/CCA Framework[32]

A. Institutional Structures

This section describes the main organizations mandated to work in DRM/DRR and in CCA, with a focus on the key institutions made up of the National Disaster Risk Reduction and Management Centre (NDRRMC), the Mauritius Fire and Rescue Service, the National Climate Committee (NCC), the Ministry of Environment and Sustainable Development and the Focal Point for the Hyogo Framework for Action. It also describes the level of institutional coordination between DRM and CCA and the status of any pertinent national platforms, as well as the commitment of sectoral agencies to DRM/DRR/CCA.

National Disaster Risk Reduction and Management Centre (NDRRMC) and the NDRRM Council:

The National Disaster Risk Reduction and Management Centre (NDRRMC) started operating in October 2013. It is the first permanent structure in Mauritius that deals with disaster risk reduction and management in a holistic manner. The NDRRMC falls under the aegis of the Prime Minister's Office. The NDRRMC is located in Port Louis, in a strategic location (Line Barracks). Its Director General is also the Commanding Officer of the Special Mobile Force. The Centre is meant to be staffed with the following human resources, although not all of the positions have been filled to date:

- Director General
- Director Preparedness (New)
- Director Recovery (New)
- Director Response (New)
- Coordinator for Community Mobilisation and Social Community Support (New)
- Education and Training Coordinator (New)
- Disaster Monitoring Officer (New)
- ICT Supervisor (New)
- Information Manager (New)
- Recovery Programme Officer - Economist (New)
- Recovery Programme Officer - Engineering (New)
- Office Management Assistant
- Confidential Secretary
- Word Processing Operator
- Office Care Attendant/Senior Office Care
- Attendant

The NDRRMC is responsible for, among other elements, the development and updating of a comprehensive and integrated disaster management information system and database, including hazard data, vulnerability information, risk assessment data and a GIS-based national risk map.

One of the priorities has been the development of an Inundation, Flooding and Landslide National Risk Profile, Maps, Strategy Framework and Action Plans for Disaster Risk Management for The Republic of Mauritius. A series of maps has been completed already but further work needs to be done to obtain maps with a higher resolution that can effectively assist in preparedness and mitigation measures at a micro scale.

Whenever a major disaster occurs, the National Emergency Operations Command (NEOC) within the NDRRMC (under the command of the Commissioner of Police), coordinates with all ministries and agencies. The NEOC deals essentially with emergency situations and is responsible for coordinating rescue, recovery, early warning, information, security, emergency shelter or food or health care and the restoration of utilities. Such response is conducted as per established contingency plans and standard operating procedures.

It is worth noting that prior to 2013, disasters were handled in an ad-hoc manner by structures that were operating only when disasters were about to strike or had already struck. Such structures include the National Disaster and Operations Coordination Centre that was set up, under the command of the Commissioner of Police, as an operational arm of the Central Cyclone and Other Natural Disasters Committee. Pending the enactment of the National Disaster Risk Reduction and Management (NDRRM) Bill, Cabinet has agreed to the setting up of a permanent NDRRM Council, which has a composition quite similar to the former Central Cyclone

[32] This chapter was drafted by Pamela Leste De Perindorge.

and Other Natural Disasters Committee. The Council focuses on preparedness and post disaster response while the concern is growingly on prevention.

The NDRRM Council comprises (Figure 46), among others, representatives of:

- Prime Minister's Office,
- Ministry of Finance and Economic Development,
- Ministry of Civil Service and Administrative Reforms
- Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping,
- Ministry of Social Security, National Solidarity and Reform Institutions,
- Ministry of Local Government and Outer Islands,
- Police Department,
- Mauritius Meteorological Services Department,
- Mauritius Fire and Rescue Service,
- Mauritius Red Cross Society.

Representatives of other Ministries/Departments/Organisations are co-opted as and when required.

Figure 46: NDRRM Council

The different provisions made for Disaster Risk Management to-date include:

- A NDRRM Council[33] (known as the Council) oversees disaster management activities in Mauritius and the outer islands;
- NDRRMC acts as the main institution for the State of Mauritius for the planning, organizing, coordinating and monitoring of disaster risk reduction and management activities at all levels;
- A Local Disaster Risk Reduction and Management Committee in the Municipal City Council, the Municipal Town Councils and the District Councils manage disaster risk reduction in the respective localities;
- A Rodrigues Disaster Risk Reduction and Management Committee assists in the preparedness, response, rehabilitation and recovery operations before, during and after the occurrence of a disaster or an emergency in Rodrigues; and
- A Rodrigues Disaster Risk Reduction and Management Centre is responsible for the planning, organizing, coordinating and monitoring of disaster risk reduction and management activities in Rodrigues.

33 The Council is not a permanent structure but it holds meeting regularly.

The Mauritius Fire and Rescue Service

The Government Fire Services, has been renamed the Mauritius Fire and Rescue Service (MFRS) since June 2013 following the enactment of the Mauritius Fire and Rescue Service Bill. The Fire Services are mandated to extinguish fires but also to respond to a wide range of emergencies such as floods, storms, explosions, landslides, terrorist acts, accidents, sea surges on land, leakages of harmful substances or oil spills. The new services encompass the participation of the MFRS in national schemes for the management, prevention, mitigation and reduction of disasters. The MFRS moreover ensures that buildings hold a valid fire certificate. The officers are regularly involved in awareness campaigns to sensitise the public in adopting fire prevention measures.

The National Climate Committee

The Mauritius Meteorological Services set up in May 1990 a multi-sectoral National Climate Committee (NCC) involving all Institutions and Organizations with an interest in climate change including relevant ministries, parastatal bodies, the private sector and non-governmental organisations (NGOs). The NCC was formally established in 1991 under the chairmanship of the Prime Minister's Office with the Director of the Meteorological Services acting as co-chairperson and has the following objectives: to monitor progress on the science of climate change and to evaluate the possible impacts of climate change on key sectors of the economy.

A Climate Change Action Plan was developed in 1998, under the aegis of the NCC. Mauritius submitted its first National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in 1999. A Climate Change Division was set up at the Ministry of Environment and Sustainable Development on 1st March 2010 following the 2010 budget recommendations. Mauritius submitted its second national communication to the UNFCCC in 2011.

The Ministry of Environment and Sustainable Development:

The responsibility for leading initiatives on Climate Change now falls under the Ministry of Environment and Sustainable Development, which hosts a Climate Change Division since March 2010. A Climate Change Information Centre (CCIC) has also been set up at the Ministry to provide up to date information on climate change for informed decision-making. The CCIC is meant to be a “Data Repository” for climate change information. It is mandated to provide digital toolkits for strengthening adaptation skills in key sectors. The Fifth International Conference on Climate ‘Impacts and Responses’ was held in Mauritius in 2013.

In 2011, the First Mauritius Environment Outlook Report in 2011 contained one chapter on climate change: trends, projections, and vulnerability assessment and adaptation measures. In 2012, National Risk Profiles were published for flooding, landslide and coastal Inundation. These include maps, a Strategy Framework and Action Plans for Disaster Risk Management for the Republic of Mauritius in 2012. Further refinement of risk profile is expected.

The Ministry of Environment and Sustainable Development implemented from 2010 to 2013, the Africa Adaptation Programme (funded by the Government of Japan), whose main objective was to integrate and mainstream CCA into the institutional framework and into core development policies, strategies and plans. The key sectors that have been taken into account are: agriculture, disaster risk reduction, education, environment, public infrastructures, health, finance, fisheries, tourism and water. The Ministry of Environment and Sustainable Development is the lead coordinating and executing agency while several other ministries were taken on board. Part of this project will address current climate change risks at three vulnerable coastal sites namely Mon Choisy, Rivière des Galets and Quatre Soeurs/Deux Frères. The strengthening of an Early Warning System for coastal communities at risk is also being envisaged.

Focal Point for Hyogo Framework for Action

The Focal Point for the Hyogo Framework for Action is the Mauritius Meteorological Services. Mauritius drafted a National Report (2004), which was submitted in preparation for the World Conference on Disaster Reduction, 2005, Kobe, Hyogo, Japan. At regular intervals, Mauritius has prepared and submitted to UNISDR its national report with respect to the Hyogo Framework for Action (HFA):

- National Report on the implementation of the HFA (2007)
- National progress report on the implementation of the HFA (2007-2009)

- National progress report on the implementation of the HFA (2009-2011) ..

B. Legal Structures

This section highlights and describes basic laws and plans related to DRM/DRR and/or CCA including other important laws/plans that may contribute to reducing risk (*e.g.* building codes, coastal management plan) and the level of visible coordination between them. It also describes the extent to which DRM/DRR and CCA have been integrated into the national development plan, poverty reduction strategy and/or sectorial plans (*e.g.* education, health).

While the NDRRMC is now giving greater importance to prevention and preparedness, the actions and initiatives need to be integrated more visibly into all sectors and ministries' budgets. Budgeting for risk reduction remains scattered and does not provide much traceability for programmes linked to risk reduction and management. Similarly in post-disaster situations, spending is scattered and not monitored for providing a consolidated view of efforts and funds injected.

There are yet no laws directly related to either disaster risk reduction or climate change adaptation although there are projects / bills to establish such legislations, hence providing a legal framework and a larger concern towards these risks. A few are described below:

The NDRRM Draft Bill

The objective of the Disaster Risk Reduction and Management Bill is to ensure that the Government is able to manage risk before, during or immediately after a disaster, through prevention and DRR; the mitigation of the adverse impacts of disasters; disaster preparedness; rapid and effective response to disasters; and management of post-disaster activities, including post-disaster recovery and rehabilitation. The Draft Bill is yet to be discussed by all parties. It establishes the institutional framework for disaster risk management including the NDRRM Council and the NDRRMC and elaborates powers and functions of the institution.

The Climate Change Draft Bill

The objective of the Climate Change Bill is to set up a legal framework and mechanism aimed at making Mauritius climate change-resilient and adopting a low-carbon economy, which is in line with government objectives of developing a green economy. The Climate Change Bill will further support and facilitate the development and implementation of policies, strategies and programmes to address CCA as well as greenhouse gas emission reduction. The Bill has been drafted with the assistance of the Africa Adaptation Programme in 2012 and is yet to be debated in Parliament. The content of the proposed Climate Change Bill has already been discussed during a national workshop. Its formulation involved consultations with public and parastatal sectors, as well as academics and NGOs.

As previously mentioned, the Ministry of Environment and Sustainable Development (MoESD) has the responsibility for leading initiatives on Climate Change. This is specifically tackled under the National Climate Change Adaptation Policy Framework developed in 2013. The Framework report comprises of a National Climate Change Adaptation Policy; a Climate Change Adaptation Strategy and Action Plan; a Climate Change Adaptation Investment Program, and Project Concept Papers.

Moreover the Mauritius Environment Outlook (2011) which sets the policy action, mentions cyclones as a challenge and devotes a whole chapter to Climate change (Chapter 9[34]). Also, the Rio+20 National Synthesis Report also refers to both natural disasters and climate change as challenges. At the same time, it is recognized that current constraints to enabling climate change adaptation and mitigation include the lack of trained personnel, technical and technological options as well as funding. The National Environment Policy 2006 lists the Strategies for Mauritius in priority thematic areas which include land-use, water resources management, marine/coastal zone management, the built environment, environment and health, natural and environmental disasters management. The strategic paper highlights the government's commitment to promote capacity

[34] http://environment.gov.mu/English/DOCUMENTS/MAURITIUS%20ENVIRONMENT%20OUTLOOK%20REPORT%20SUMMARY%20FOR%20DECISION%20MAKERS.PDF

building in the field of disaster management, to improve its early warning system and response contingency plans with respect to human induced as well as natural hazards in an effective manner.

The National Meteorological Service Act (Provisional)

The functions of the Mauritius Meteorological Service (MMS) inclde the monitoring of climate change, in addition to making, recording and archiving meteorological and other observations required for related purposes (*e.g.* investigating the state of the atmosphere and ocean, forecasting weather, publishing timely meteorological reports and bulletins). According to the Act, the MMS is called to work in close collaboration with the World Meteorological Organisation, while also considering guidelines from the International Meteorological Organisation (IMO), the International Civil Aviation Organisation (ICAO), the UN Framework Convention on Climate Change Secretariat, and the other UN Specialised Organisations.

Building codes and land management

The Building Control Act 2012 makes provision for a number of guidelines with respect to buildings and takes into account safety, society's well-being, the protection of the environment, and aesthetic value. The Act lists the requirements for structural safety (*e.g.* adequate design in terms of column, beam, wall, floor slab etc), user safety (*e.g.* protection from fire) as well as sustainability (air quality, protection from water, waste management, energy efficiency). All new constructions or expansions require a building permit from local authorities, hence being a measure for building control. There are provisions for the formulation of regulations with respect to minimum building standards, energy efficiency and sustainability. New regulations are currently in draft stage and should be finalized soon to replace the Building Regulations first introduced in 1919 and subsequently amended.

With respect to public buildings including offices, schools, hospitals, police stations, prisons, fire stations, sports complexes, community and health centres, they are subject to the Building Control Act 2012 and regulations thereon. It can be highlighted that in general, architectural design is based on British Standards while structural engineering are based on both British Standards and European Union Standards. All design also takes into particular account the need to be resilient to disasters and in particular high wind velocity during cyclones.

Other important legislations include the Town and Country Planning Act 1990 and the Planning and Development Act 2004. Wherever a building has a floor area exceeding 150 square metres, the plans and drawings for the proposed building works have to be signed by an architect. Recent concerns about sustainable buildings have focused on making them more energy efficient and green building retrofits (Policy on Sustainable Buildings, 2012).

Coastal Zone Management

With respect to coastal zones, building guidelines provide specifications with respect to the distance from the coast. The Ministry of Housing and Lands has issued specific guidelines for residential coastal development with details on setback from the low and high water mark level, development height, vegetation protection among others[35]. The Ministry of Environment and Sustainable Development also has an Integrated Coastal Zone Management (ICZM) Division since 2000 that caters to the sustainable management of the coastal zone and its resources. It focuses on the monitoring of coastal erosion, coastal protection works and development control around the coast and shoreline management. Projects implemented thus far include the protection and rehabilitation at eroded public beaches around Mauritius.

Environmental legislation

In the Environment Protection Act 2002 (amended in 2008), Part A provides for the list of undertakings requiring a Preliminary Environmental report while Part B caters for the list of undertakings requiring an Environmental Impact Assessment (Fifth Schedule of the Environment Protection Act as amended in 2008).

The Environmental Protection Act 2002 makes provision (in Part V) for Spill and Environmental Emergency, outlining measures for cleaning and restoration but also for prevention and contingency. Besides, a National Oil Spill Contingency Plan (NOSCP) includes an oil spill response strategy, an action and operations plan, as well as a Coastal Sensitivity Atlas of Mauritius for oil spill response.

[35] http://housing.gov.mu/English/Documents/coastal.pdf

The Dangerous Chemicals Control Act 2004, falls under the Ministry of Health and Quality of Life. It deals with all dangerous chemical substances and seeks to protect human health as well as the environment against the harmful effects of chemicals.

In addition, the Radiation Protection Act 2003 makes provision for the control of all items imported, handled or used which emits radiation, including radiological equipment for medical facilities or testing equipment. It is also worth mentioning that a national contingency response plan is being currently drafted to tackle hazardous materials (Hazardous Material or HazMat).

Integration of DRR/CC in National Plans

Climate change is integrated into the **Maurice Ile Durable (MID) Policy, Strategy and Action Plan**[36], which represents the implementation path for sustainable development in Mauritius. It has five pillars (energy, environment, employment, education and equity). Climate Change is specifically mentioned as an action for the 'Environment' pillar. Reference is hence made to the formulation and implementation of a Climate Change Legislation as well as Adaptation and Mitigation Frameworks. The MID Policy moreover recognizes that the country is susceptible to natural disasters such as droughts and floods, and henceforth supports the drafting of a Strategy Framework and Action Plans for Disaster Risk Management. Under Education, the MID Action Plan advocates the promotion of critical consciousness with regard to both disaster risk reduction, and climate change adaptation and mitigation.

The Energy Pillar of MID is related to energy efficiency but also the reduction of fossil fuels that are held responsible for climate change. Two main targets set are to produce 35% renewable energy by 2025 and to reduce energy consumption in non-residential and public sector buildings by 10% by 2020.

There is a permanent MID Commission, which has been set up as the driver of MID, and it operates under the aegis of the Prime Minister's Office. The MID Policy also supports the delivery of international commitments such as RIO+20 and the Programme of Action for the Sustainable Development of Small Island Developing States (SIDS).

Sectorial plans

Although there is no specific sectorial plan for Health, the Ministry of Health and Quality of Life continuously addresses the preparedness for facing risks associated with for example health epidemics or water-borne diseases (health) and awareness of measures that can allow the population to best adapt to climate change (education). The Ministry of Health and Quality of Life also addresses communicable diseases, through the Communicable Disease Control Unit (CDCU). There is for instance an 'Operational plan for the Prevention and Control of Chikungunya and Dengue[37]' that has established a comprehensive preparedness plan listing all procedures in case of outbreaks and actions required to limit the spread of such epidemics, including mosquito control and communication lines as well all stakeholders involved. In addition, the Health Information, Education and Communication Unit is responsible for the design and implementation of information, education and communication programmes of the Ministry.

With respect to education, there is a sectorial plan known as 'Education and Human Resources Strategy Plan (EHRSP) 2008-2020', which does not specifically address the curriculum. However, the National Curriculum Framework at both primary and secondary levels, integrates the issues of natural risks and hazards. Their causes, preparedness and their consequences are addressed through the subjects Geography and Social Studies. The secondary textbooks for Lower forms (Social Studies) also cover the topic of climate change and the threat that it poses for islands like Mauritius.

The agricultural sector in Mauritius comprises the sugar sector and the non-sugar sector (crops and livestock). The current policy for sugarcane is described in the 'Multi Annual Adaptation Strategy (MAAS)'. Sugarcane as a crop is quite resistant to cyclones and droughts, which explains why they have been privileged over other crops. The Strategy moreover mentions about the risk of soil erosion in both uplands and lowlands that ultimately pose risks to agricultural land, tourism and coastal fishing. The 'Blueprint for a Sustainable Diversified Agri-food Strategy for Mauritius 2008-2015[38]' seeks to enhance food supply stability and recognizes that cyclones and floods constitute a challenge for crops and in particular fresh vegetables. It highlights the likeliness of extreme

[36] http://www.gov.mu/portal/sites/mid/file/full%20report%20midpolicy.pdf. Accessed 24 October 2014.
[37] http://health.gov.mu/English/Documents/deng-act-plan.pdf
[38] http://agriculture.gov.mu/English/Documents/Report/agri%20foodstrategy%20pdf.pdf

weather conditions being made worse or more recurrent with climate change, and suggests the adoption of alternate crop species and varieties.

Multilateral Agreements

In addition to the Hyogo Framework for Action, to which Mauritius is a party, the country has signed / ratified the following conventions and protocols related to disaster risk management and climate change (Table 15).

Table 15: Multilateral agreements

Multilateral Agreements	Dates	National Focal Point
The Kyoto Protocol to the Convention on Climate Change	Ratified in 2001	MoESD
International Convention to Combat Drought and Desertification	Acceded in 1996	MoESD
United Nations Framework Convention on Climate Change	Ratified in 1992	MoESD

It can also be highlighted that Mauritius plays an active role in the global initiatives for sustainable development and is a party to around 36 environment-related conventions, protocols and other internationally binding and non-binding instruments. Mauritius is particularly active in international and regional agreements concerning climate change, protection of the ozone layer, biodiversity, sound management of hazardous and toxic wastes, including persistent organic pollutants, disaster management such as oil spill and chemical spills, protection of the marine environment, etc.

C. Status of Hyogo Framework for Action

The National Progress Report on the implementation of the Hyogo Framework for Action (2011-2013) mentions the following levels reached for the five Priority Areas. For most priorities and indicators, Level 4[39] has been reached. Yet, there are gaps in certain areas that warrant attention and effort (see Table 16).

Table 16: HFA Progress

Priority area	Progress
Priority 1: **Ensure that disaster risk reduction is a national and a local priority with a strong** **Institutional basis for implementation**	▪ National policy and legal framework for disaster risk reduction exists with decentralised responsibilities and capacities at all levels (L4) ▪ Dedicated and adequate resources are available to implement disaster risk reduction plans and activities at all administrative levels (L4) ▪ Community Participation and decentralisation is ensured through the delegation of authority and resources to local levels (L4) ▪ A national multi sectorial platform for disaster risk reduction is functioning (L4)
Priority 2: **Identify, assess and monitor disaster risks and enhance early warning**	▪ National and local risk assessments based on hazard data and vulnerability information are available and include risk assessments for key sectors (L3) ▪ Systems are in place to monitor, archive and disseminate data on key hazards and vulnerabilities (L3) ▪ Early warning systems are in place for all major hazards, with outreach to communities (L4) ▪ National and local risk assessments take account of regional/trans boundary risks, with a view to regional cooperation on risk reduction (L4)
Priority 3: **Use knowledge, innovation and education to build a culture of**	▪ Relevant information on disasters is available and accessible at all levels, to all stakeholders (through networks, development of information sharing systems

[39] In the HFA Monitor progress is benchmarked on a scale of 1 (low progress) to 5 (good progress), complemented by means of verification and a qualitative description.

safety and resilience at all levels	etc) (L4) ▪ School curricula, education material and relevant trainings include disaster risk reduction and recovery concepts and practices (L4) ▪ Research methods and tools for multi-risk assessments and cost benefit analysis are developed and strengthened (L4) ▪ Countrywide public awareness strategy exists to stimulate a culture of disaster resilience, with outreach to urban and rural communities (L4)
Priority 4: Reduce the underlying risk factors	▪ DRR is an integral objective of environment related policies and plans, including for land use natural resource management and adaptation to climate change (L4) ▪ Social development policies and plans are being implemented to reduce the vulnerability of populations most at risk (L4) ▪ Economic and productive sectorial policies and plans have been implemented to reduce the vulnerability of economic activities (L4) ▪ Planning and management of human settlements incorporate disaster risk reduction elements, including enforcement of building codes (L4) ▪ Disaster risk reduction measures are integrated into post disaster recovery and rehabilitation processes (L4) ▪ Procedures are in place to assess the disaster risk impacts of major development projects, especially infrastructure (L4)
Priority 5: Strengthen disaster preparedness for effective response at all levels	▪ Strong policy, technical and institutional capacities and mechanisms for disaster risk management, with a disaster risk reduction perspective are in place. (L4) ▪ Disaster preparedness plans and contingency plans are in place at all administrative levels, and regular training drills and rehearsals are held to test and develop disaster response programmes (L4) ▪ Financial contingency and reserves mechanisms are in place to support effective response and recovery when required (L3) ▪ Procedures are in place to exchange relevant information during hazard events and disasters, and to undertake post-event reviews (L4)

Source: Mauritius National progress report on the implementation of the Hyogo Framework for Action (2011-2013)

The progress reached and the remaining constraints are briefly summarized below:

Priority for action 1: Although substantial achievement has been attained in terms of national policy, there are recognized limitations in key aspects, such as financial resources and/or operational capacities. There are well defined regulatory provisions for managing disaster risk but enforcement is still a challenge because of the absence of a legal framework. Budget allocation to risk reduction is mostly ad hoc depending on the need at both the national and sub-national level. Local Authorities, Municipal and District Councils have legal responsibility to manage and reduce risks at the local level. However, the enforcement of the regulations remains a challenge at this level, too.

Priority for action 2: Quantitative data on the extent of damages caused by any hazard have not been systematically archived in a central data bank. However some data, for example in the agricultural sector exist at various institutions level. Cross-sectoral linkages, namely economic, social and environmental impacts also have still to be quantitatively assessed. While the Mauritius Meteorological Services maintains a 24/7 watch for all hazards likely to affect Mauritius, capacity is lacking at the moment to develop and implement flash flood warning.

Priority for action 3: There is not yet a national disaster information system publicly available. At the moment most disaster data are scattered at different ministries and departments. With the setting up of a Disaster Management Centre, a central disaster database is expected to be created - including both natural and man-made hazards. In terms of general public awareness, the science behind all natural hazards likely to affect

Mauritius is now taught at both primary and secondary education. Yet, additional training materials and further public awareness need to be developed for torrential rains, landslide, oil spill and tsunami.

Priority for action 4: Though hazard information exists, it has not yet been translated into integrated policies across all sectors. The issue of climate change and climate variability is now gradually being integrated in sustainable development policies, especially within the Maurice Ile Durable Project. Government is making an effort to see that human settlements are planned correctly and take into consideration disaster risk and the enforcement of building codes. Besides, there are general regulations (such as environmental impact assessments), including disaster risk reduction measures in the development of major infrastructures. However, the enforcement of these regulations is not always stringent.

Priority for action 5: There are Emergency Operations Procedures in place for all the major hazards likely to affect the Republic of Mauritius. The lack of resources is a major challenge, namely in the implementation and the prohibitive cost of new technology for disaster risk management. In terms of fund for post disaster recovery and rehabilitation processes, there are mainly the Prime Minister's Relief Fund and a fund for the Small Farmers. Other funds are set up mainly on an ad-hoc basis when a severe disaster occurs. Relief assistance is provided only on an ad hoc basis to those individual in need. The impossibility to relocate those in affected areas is equally a challenge. Regular economic analyses of events would be beneficial to inform hazard and risk impact modelling, recovery planning, and cost-benefit analysis for risk reduction proposals. The impact of disaster on gender aspects may need to be further documented.

References

Mauritius National progress report on the implementation of the Hyogo Framework for Action (2011-2013)

5. DRR/DRM/CCA in Public Investment Planning[40]

This chapter provides an overview of the current status of public investment planning related to disaster risk reduction/management and climate change adaptation in Mauritius. It moreover contains a summary of the findings of the three types of analyses conducted under the initiative; namely the Risk Sensitive Budget Review (RSBR), CATSIM analysis and the Cost Benefit Analysis. Main stakeholders are identified after such analysis description.

A. Current Status of DRR/DRM/CCA in Public Investment Planning

Risk assessment is required for public investment project selection. There are clear guidelines for risk evaluation prior to project implementation in the Investment Project Process Manual (IPPM) of 2008 and also in the Public Private Partnership (PPP) Guidance Manual of 2006. Although disaster risks are not addressed explicitly, the IPPM for instance requires the identification of risks (completion, effective demand, technological, operation and maintenance, price inflation) at the stage of filling the 'Project Request Form'. The Manual also specifies that it is the responsibility of every Public Body to carry out feasibility and cost benefit analyses for infrastructure project proposals. As such, CBA is commonly used in implementing public projects. All projects above Rs 25 million (USD 0.8 million) require a preliminary study and all projects above Rs 100 million (USD 3.2 million) require a feasibility study and a Cost Benefit Analysis. The Public Private Partnership (PPP) Guidance Manual of 2006, for its part, makes mention of the necessity to assess the 'value money' of proposed PPP projects. The value for money assessment takes into account benefits such as reduced overall costs through project life span, a better allocation of risks, faster implementation, the improved quality of services and the generation of additional revenue. However, there has been no implementation of Cost Benefit Analysis (CBA) for DRR/M project to date, per se, in 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.

In fact, it is important to highlight that risk-sensitive investment is made indirectly in Mauritius. Many public infrastructure projects address risk reduction, but not directly, except for a few definite projects, such as those concerning investment in water management and preventive infrastructure. The construction of drains, cleaning of rivers, reforestation and coastal zone management are indirectly recognized as DRR expenditures. Several ministries and institutions are involved in such major public investments, including the Ministry of Environment and Sustainable Development, the Ministry of Infrastructure and the National Development Unit, etc.

Critical infrastructure

Public assets include real property (buildings, roads, ports, airports) and contents property (surgical equipment, computers). Routine government investment in infrastructure can be split into four main pillars, namely: economic infrastructure; investments in the productive and human capital; environmental infrastructure; and critical social investments. The most critical infrastructures include public schools, hospitals, roads, the port and the airport. Other important assets include office buildings, housing owned by Government as well as infrastructure under construction or recently completed.

40 This chapter was drafted by Pamela Leste De Perindorge.

There is no specific critical infrastructure protection plan. There is also to-date no catastrophe insurance for public assets. By not insuring its assets, Government seeks to reduce investment insurance premiums and meet the cost of replacement or rehabilitation in the aftermath of disasters. Reconstruction is mostly tackled in a timely and urgent manner to minimise disruption and restore public services.

There is no privately-run critical infrastructure but there are state-owned enterprises which operate and manage public utilities such as water, electricity and waste water (Central Water Authority, Central Electricity Board and Mauritius Wastewater Authority). Electricity production for instance is carried out by independent large (bagasse and coal) and small (especially renewable solar and wind) producers but they are not involved in transmission or distribution. The Mauritius Port Authority and the Airport of Mauritius Co. Ltd (AML) are moreover respectively responsible for managing the port and airport areas. They all insure their assets.

Private companies have a key role in implementing public infrastructure projects (*i.e.* construction) and they are required to contract an insurance company to cater to any risk that may occur (including natural hazards) during this process.

B. Contingency Finance Mechanisms

Government will take not only the legal and explicit liability, but also the implicit liability where Government is expected to intervene promptly to provide relief and recovery to the affected (damaged and destroyed housing, loss of property). There are a few finance mechanisms for managing disasters, summarized in Table 17. These mechanisms mainly address recovery and reconstruction costs. Thereafter follows a discussion of the main measures listed.

Table 17: Finance mechanisms for disaster management

EX-ANTE MECHANISMS	
Contingency budget line	There is an item voted for 'contingencies and reserves' appropriated every year in the Programme Based Budget (PBB) to cater for any urgent need.
Contingency funds	There is no cumulative fund exclusively earmarked for disasters. However, there is a Prime Minister's Relief Fund that provides assistance to victims of accidents, injuries or severe hardship.
Insurance	There are some insurance. Central Government does not insure its assets. State owned enterprises insure their assets (e.g. Central Electricity Board (CEB) for electricity infrastructure). Sugar industry has a long established insurance system for sugar cane planters. Sugar Industry Fund Board provides covers to all insured (compulsory for planters and millers) for losses in sugar cane production arising from disasters such as cyclones, drought and excessive rainfall (http://www.sifb.biz/)
Others	Corporate and population contributions
EX-POST MECHANISMS	
Diverting funds from other budget items	This is feasible.
Imposing or raising taxes	Not a socially acceptable measure after a disaster has struck.
Taking a credit from the Central Bank (either prints money or depletes foreign currency reserves)	Not for government
Borrowing by issuing domestic bonds	Possible
Accessing international assistance	There has been no need recently, given the economic status of Mauritius. However, international assistance can be obtained whenever it is beyond the national capabilities to manage a disaster or an emergency situation.
Borrowing from multilateral institutions	Possible but not done directly for disaster management
Issuing bonds on the international market	Possible but not done directly for disaster management

Source: Author

- Contingency budget line: Government makes use of the 'contingencies and reserves' catered under Sub Programme 989 which is meant for unforeseen circumstances that budgeted programmes cannot address. It is not limited to natural hazards, but it does include disasters or other emergencies requiring exceptional expenditure. As such, this 'contingency fund' was used to cater for flood relief and response in 2013, or landslide management in 2014 (at Macondé) and for mosquito-borne viral disease Chikungunya in 2006. The amount set aside for "contingencies and reserves" for the year 2014 is Rs 1.6 billion (USD 52 million), which represents 1.4% of the PBB. The ceiling for every fiscal year is 2% as per the Finance Audit Act.

- Relief Fund: In addition to the General Relief fund mentioned above, there is the Prime Minister's Cyclone Relief Fund, a special fund to provide financial assistance to the affected by cyclones.

- 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[41].

- The Sugar Insurance Fund Board (SIFB) is a form of 'contingency finance mechanism' as it provides covers to all insured planters 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.

- Government has moreover on several occasions, made available special schemes, which are operated by the Development Bank of Mauritius (DBM) to tackle problems faced by small planters (other than sugar cane). These include a combination of grants and soft loans (concessional rates of interest and moratorium periods). Other emergency relief assistance is provided on an *ad hoc* basis to individuals in need.

Private insurance market

There are over 10 insurance companies selling insurance products for life and non-life. Non-life insurance includes property, vehicles, liability, marine and aviation. The principal insurance companies include Mauritius Union, Swan Insurance, British American Insurance, State Insurance Company of Mauritius Ltd (SICOM), Mauritian Eagle, and Jubilee Insurance. While it is compulsory to insure vehicles (all risks or third party), contracting an insurance policy for property is optional except for loans that require an insurance (for the duration of the loan). In the aftermath of 2013 floods, an average of 44% of total motor claims and 65% of total non-motor claims were recoverable from reinsurers (Financial Services Commission).

C. Economic analysis to support risk sensitive pubic investment planning

Based on the philosophy explained in the introduction chapter, three types of economic analysis were conducted. A summary of analysis follows for the Risk-Sensitive Budget Review, the Macro/CATSIM assessment and the Micro/Cost Benefit Analysis. Each of the theoretical and technical elements is also described in greater detail in corresponding Annexes A, B and C.

[41] http://www.areu.mu/SchemesInTheAgriculturalSector-Inside-Test12.pdf

C.1. Summary of the Risk-Sensitive Budget Review
(See also Annex A for theoretical and technical backgrounds and a detailed case study)

Overview: The Risk-Sensitive Budget Review (RSBR) aims to apply the DRM Marker method to identify the degree to which government has budgeted or/and invested in DRR/DRM/CCA. To that effect, the budgets of key Ministries and Departments have been analysed to mark those projects whose "significant" (but not main) objective is DRR and those projects specifically addressing DRR, which would not have been undertaken without the "principal" DRM objective.

In addition to categorizing the budget/expenditure for different projects, functions and administration activities as Significant or Principal, they were classified into four distinct categories of disaster risk management, namely, Risk Prevention/mitigation, Preparedness, Response/Relief and Reconstruction.

Scope: Table 18 below summarizes the scope of the budget review.

Table 18: Scope of the risk sensitive budget review

Year	2013 and 2014
Coverage	Particular attention to the Ministries and Departments listed hereunder: ▪ Prime Minister's Office (especially the NDRRM Centre) ▪ Meteorological Services ▪ The Police Force ▪ Ministry of Public Infrastructure /The National Development Unit ▪ Ministry of Environment and Sustainable Development ▪ Ministry of Public Utilities ▪ Ministry of Local Government and Outer Islands (esp. Mauritius Fire and Rescue Service) ▪ Ministry of Social Security ▪ Ministry of Finance and Economic Development.
Budget or expenditure	Both
Current or Capital	Both were examined.
Targeted hazards	Cyclone, heavy rains, flood, landslide, drought, fire, epidemics

Source: Author

Results: With respect to current budget/expenditure, an initial high level analysis of the PBB Budget (wide approach) revealed that the total investment in DRM possibly stands at Rs 17 billion (USD 550 million), which is equivalent to 16% of the total PBB in 2013. A more in-depth analysis (considered the 'narrow' approach to budget review) was then carried out, covering roughly 50 programs. DRM has been marked for programs totalling Rs 4.4 billion (USD 140.9 million) for 2013 and Rs 5.8 billion (USD 186.8 million) for 2014, which is respectively 4.2% and 5.1% of the total PBB.

A marking of "Principal" was attributed to 3.2% of the total PBB in 2013; this figure rose to 4% in 2014. The proportion of efforts marked "Significant" increased from 1.0% in 2013 to 1.1% in 2014. Combining all marked efforts from 2013 and 2014, it surfaces that 74.1% of the DRM portfolio is invested in prevention/mitigation followed by 23.6% in preparedness, and 2.1% in reconstruction.

The review of capital investment, using the Public Investment Sector Programme (PISP) Budget, 2013-18, shows that about Rs 23.2 billion (USD 750.8 million) or 9.2% of the Project Value of the PISP is related to DRR/DRM over the period 2014-2018. It is estimated of those DRM-marked, 78% of projects are marked as Significant and 22% are Principal. The total amount that is marked as DRM is Rs 3.8 billion (USD 122.2 million) in 2013 and 4.2 billion (USD 135.9 million) in 2014. The total of DRM marked envelopes, as proportion of total PISP, has increased from 14.6% in 2013 to 15.7% in 2014. Combining all marked efforts from 2013 and 2014, it surfaces that 75% of the DRM portfolio is invested in prevention/mitigation followed by 21% in preparedness, and 5% in reconstruction.

Both current and capital budget/expenditure for DRM in 2013 and 2014 are summarized in

Table ***19***.

Table 19: DRM/CCA investments across 4 components in 2013-2014 (Unit: USD million)

Budget allocations per Risk Management phase/category	Significant	Principal	Total	Percentage
Prevention/mitigation (1)	135	302	436	74.3%
Preparedness (2)	110	22	132	22.4%
Response (3)	1	-	1	0.1%
Reconstruction (4)	10	9	19	3.2%
Total budget allocations	256	333	588	**100%**
Share of total budget	3%	4%	7%	

Source: Ministry of Finance and Budget / adapted by author

Component 2 of the project determined an average annual loss of USD 87 million to tropical cyclonic winds. A simple comparison of estimated AAL to the most current annual investment in DRR indicates a **positive balance**: greater investment than expected loss in the present year (Table 20). It surfaces that there is no financial gap to meet potential losses from natural hazards. However, it is important to keep in mind that AAL is only estimated for tropical cyclonic wind risk and go back to the actual marked activities to determine their link to cyclonic wind risk. If this investment could be reasonably linked to tropical cyclonic wind risk reduction, it would seem to offset the AAL by many years.

Table 20: Checking the gap: DRM budget, loss and risk

	DRM investment (budget) Average in 2013 and 2014	AAL (tropical cyclonic wind and earthquake only)	Loss, 1980-2014 (1,105 of data cards)
Value	USD 161.5 million	USD 87 million	USD 59 million (Annual average: USD 4.5 million)
Status		NO GAP	NO GAP

As reference, loss data were also compared to the budget. Again this comparison shows a positive balance. While the DRR budget for current investment totalled USD 186.8 million in 2014, capital investment earmarked was USD 135.9 million. Total investment exceeds even the total loss over the period 1980 to 2014.

Although this is only a very simple and straightforward example that cannot be extrapolated to other hazards or years, it serves to underscore the utility of both the AAL/past loss data and the budget review as a combined tool to move Mauritius towards risk-sensitive public investment in light of their most important natural hazards.

It is important to note at the very outset that the structure of budget by type of expenditure and programmes, rather than specific projects, constituted a difficulty when attempting to mark a specific programme as contributing to DRM. As most programmes or even sub-programmes consist of multiple objectives and activities, to retrieve and consolidate the information related to DRM is a very delicate task. Views can in fact diverge and result in a different analysis.

The classification of budget or expenditure into the categories of prevention/mitigation, preparedness, relief/response and reconstruction, is a challenging task. For an objective analysis, it is recommended that the classification be first discussed and agreed within a working group composed of representatives from the different ministries concerned guided by the NDRRMC. The group discussion should also ensure the active participation of all relevant entities. Such an exercise may help to discern any other programme that is related to DRR, DRM and CCA and that is not visible in the budgeted programme title and objective themselves.

To have a better view of public investment in DRR/DRM/CCA, it is recommended to apply the DRM marker for all Ministries and public organisations. This entails continuous capacity building at technical and institutional level to effectively use the DRM marker. To encourage further investment in prevention, mitigation and preparedness, it is suggested that a defined proportion of investment of the PBB and PISB (for example 4 or 5%) be devoted to DRR by all Ministries and Government departments.

C.2. Summary of Macro-Analysis / CATSIM
(See also Annex B for theoretical and technical backgrounds and a detailed case study)

Overview: CATSIM analysis evaluates the ability of governments to manage potential fiscal and economic risk arising from tropical cyclone winds and earthquakes. The Government is generally not responsible to provide all reconstruction needs because private households and businesses will assume responsibility of their own reconstruction needs. Therefore, we assume that the government will take the following responsibility in case of a disaster:

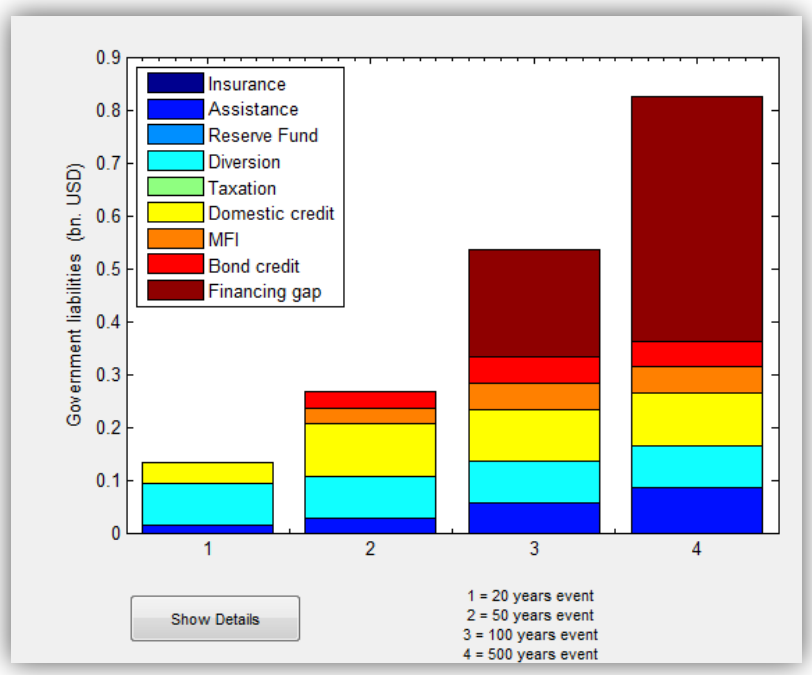
- The Mauritius government will be responsible to finance reconstruction of public assets, including roads, bridges, schools and hospitals, etc. (Explicit liability)
- The Mauritius government will extend partial support for private relief and recovery including provision of support to the poor (Implicit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

AAL was assumed to be USD 58 million. Total contingent liabilities for Mauritius Government were estimated as USD 21.1 billion based on capital stock data. Then, the options to finance reconstruction and recovery were examined with the same assumptions applied across IOC countries. In a conservative case, USD 278 million was estimated to be assured through diversion from budgets, domestic bonds and credit and international market borrowing.

Combining direct risk and fiscal resource availability information compiled, we then estimated the governments' potential fiscal resources gap year—the return period at which the government will face difficulty in raising sufficient funds for reconstruction.

Results: Mauritius was found to face a fiscal resources gap at year 62 (CAPRA estimate). Based on the loss distribution available from Hochrainer-Stigler (2014), a fiscal resource gap year was estimated at 87 years. Based on the CAPRA estimate, the reconstruction and recovery capital needs are estimated at: USD 134 million (20 year event), USD 268 million (50 year event) and USD 536 million (100 year event) and USD 826 million (500 year event). Budget diversion and domestic credit constitute a larger portion of reconstruction and recovery costs where approximately 66% and 33% of the costs will be financed through these means for the 50 year and 100 year events (Figure 47). The financing gaps are expected to increase to USD 203 million in the 100-year event and USD 463 million in the 500-year event.

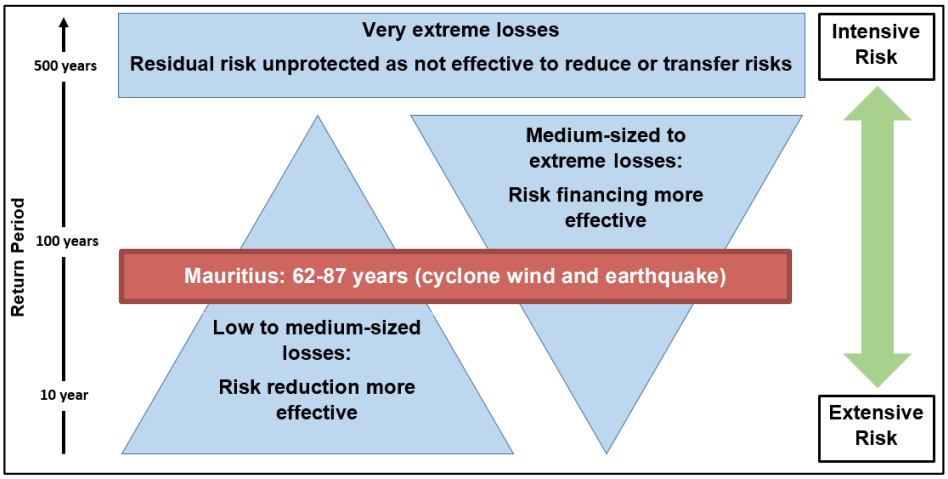
Figure 47: Resources gap year analysis for Mauritius



Source: IIASA

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 48). The CATSIM analysis conducted from Steps 1 to 3 has illustrated the need for improved management of disaster risk in Mauritius. The combination of risk reduction and risk financing will be most effective to manage fiscal risk from cyclone wind and earthquake risks. Mauritius does not have specific budget lines allocated for disaster risk reduction nor a contingency budget that can be carried-over across fiscal years, hence the establishment of a reserve fund where a certain percentage of unspent money can be used for DRR investment activities may *provide* good risk management strategies that can cover the mid-layer of risk.

Figure 48: Risk layering approach



Source: IIASA

The present study identified data gaps and sources of uncertainty regarding fiscal risk assessment. 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.

Risk assessments of additional hazards including cyclone (rain/storm surge) and floods are certainty needed to conclude on a more comprehensive assessment of fiscal risks that Mauritius faces.

Given the relatively short period of data availability, high uncertainty can be expected of catastrophic risks with return periods of above 500. It is advisable, therefore, further data collection, validation and analysis performed in an iterative fashion to reduce the range of uncertainty.

A technical and institutional support package is necessary to establish iterative risk management system in Mauritius and other IOC countries (Table 21). In terms of technical needs, knowledge regarding probabilistic risk assessment and economic assessment tools (CATSIM) would be needed along with general awareness of risk related concepts and statistics. Given the limited availability of risk experts in IOC countries, a regional approach to training and capacity building (*e.g.* regional workshop for training of trainers/ regional sharing of risk knowledge experts, etc.) may be an effective way to leverage local capacity and resources. Institutional support for iterative management should be embedded in the existing DRR/CCA policy framework of Mauritius.

It is important to discuss and update fiscal resilience parameter and value at critical time, for example, when administration changes or after disaster. Financing mechanism for disaster management (see Table 16 in Chapter 5) should be checked regularly. Defining government liability more concretely is also recommended.

Some of the important policy questions to ask in Mauritius would be:

- What is the desirable level of fiscal preparedness in the country? What would be the policy goal in mid to long-term (maintain or reduce fiscal gap etc)?
- How can you balance the need for risk reduction and risk-transfer?
- What are the priority areas of action regarding DRR in your country?
- What are tangible milestones and goals in the DRR priority areas in your country?
- What further risk assessment is needed to achieve the goals of DRR priority areas in your country?

Table 21: Identified data gaps, technical and institutional capacity needs

Data needs:	-Risk information regarding additional hazards such as flood, cyclone (rain & storm surge), drought will improve the scope of analysis -Uncertainty regarding larger return period events is high given the relatively short period of data availability (In Component 1, loss data was collected since 1980). Further data collection will improve accuracy especially for higher return period events
Technical capacity needs:	-Technical training on risk assessment and economic modelling including CAPRA and CATSIM training. -Further sensitization of risk-based thinking. General familiarity of risk based terms such as the annual average loss, the probable maximum loss, exceedance probability must be explained to decision-makers.
Institutional capacity needs:	-Coordination, where both risk and socio-economic data are jointly collected and managed by relevant agencies (DRM agency plus Ministry of Finance). -Clarity on the specification of the role of each agency in data collection and analysis to avoid the duplication of the efforts.

Source: IIASA

C.3. Summary of Probabilistic CBA

(See also Annex C for theoretical and technical backgrounds and a detailed case study)

Overview: 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. In this initiative, probabilistic CBA was applied to account for the benefits of risk

reduction. The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment. We utilized data produced in component 2.

Case study of housing retrofitting against cyclonic wind: Probabilistic Cost- Benefit Analysis was performed regarding wind-retrofitting options in Mauritius. Given the large proportion of housings made of concrete and that concrete housings are already the most wind vulnerable, relative to the other housing types, we have implemented CBA focused on non-concrete structures, and performed sensitivity analysis on an alternative option to retrofit all housings. Assuming that all residential housings in Mauritius are in the category of medium design quality and retrofitting results in high design quality, retrofitting iron and wood housings is found to be the most cost-efficient option resulting in B/C ratios of 2.80 and 1.92 respectively (Table 22). While retrofitting all housing results in a substantial annual benefit of approximately USD 40.0 million, this option will only be cost efficient if retrofit costs are below 5% of housing values (at a 5% discount rate). While this probabilistic CBA was performed for an illustrative purpose only, data on the specific materials and resources available in Mauritius would aid in determining a more accurate retrofitting cost and contribute to allow better results.

Table 22: CBA for retrofitting different housing types (at 10% cost and 5% discount rate) (in USD)

Option	Iron	Concrete	Wood	All
NPV	15,931,293	-213,653,567	4,225,899	-193,347,156
B/C	**2.80**	0.49	1.92	0.56

It is important to keep in mind that the present assessment did not take into account many of the indirect and intangible losses, such as loss due to business interruption and any reduction in land values that may result due to frequent disasters. These are clear limitations of this current analysis and further studies are certainly needed to improve the accuracy and comprehensiveness of our analysis.

D. Stakeholders in mainstreaming DRR/DRM/CCA in public investment planning

The main stakeholders for the process of enhancing risk-sensitive public investment include the Prime Minister's Office, the Ministry of Finance and Economic Development as well as all other Ministries that run programmes related partially or fully to disaster risk prevention, risk reduction, preparedness, relief and response and reconstruction. These other ministries would include Police and Coast Guard, Fire Services, Meteorological Services, Local Government, Ministry of Public Infrastructure (Roads & Drainage), Ministry of Public Utilities (Water and Electricity) and Ministry of Health.

The emphasis has been laid on public investment and therefore public sector in this initiative, but NGOs, the media or external organisations regularly intervening in the preparedness or relief phases are also important.

6. POLICY RECOMENDATIONS[42]

The 'IOC-UNISDR project was an opportunity for Mauritius and four other countries of the Indian Ocean to develop a strategy for Financial Protection against Catastrophic Risks. The achievements under the three components of the project have been numerous. It contributed to building a database of disasters that occurred in the country between 1980 and 2013. A total of 1,105 data cards were compiled and the main finding was that more than 80% of economic loss was due to cyclone.

Using specific software and simulation models, the team also proceeded to the evaluation of tropical cyclonic wind risk. The Annual Average Loss (AAL) stands at USD 86.91 million and the Probable Maximum Loss (PML) reaches USD 1,094 million for a 50-year return period, growing to USD 1,726 million for a 100-year return period and USD 2,773 million for a 500-year return period.

The third component of the study focused on public investment planning. In that context, the team conducted a Risk Sensitive Budget Review, making use of the DRM Marker, to identify those programmes and efforts that are related to DRM either in a 'significant' or a 'principal' manner.

The application of the CATSIM model helped to shed further light on the fiscal resource gap for the country. It showed that the return period for which government will face difficulty in raising sufficient funds for reconstruction (fiscal resources gap years) stands between 62 years and 87 years. Moreover, a Probabilistic Cost Benefit Analysis (CBA) was carried out as a showcase to demonstrate the cost effectiveness of investing in DRR and DRM in the particular context of islands prone to disasters. The CBA scenario investigated for tropical cyclones showed the level of retrofitting at which the country would benefit from investments in improving its existing buildings.

A number of recommendations have also surfaced from the study, ranging from capacity building to institutional strengthening and financial investment. The recommendations are described below, in no particular order of priority or ranking. They aim to improve DRM/DRR/CCA at national level and at strengthening public investment planning.

1) Understanding disaster risk and enhancing risk awareness

The ability to better understand risk will certainly lead to improved disaster risk management. The disaster loss database compiled under the project should be continuously improved and updated. A more comprehensive database on disasters prior to 1980 and at least from 1960 would strengthen the following risk assessment and economic analyses. The database should contain a compilation of events and also of estimated economic loss. The database should be centrally coordinated, while all stakeholders would send any relevant information in a timely manner to the responsible agency, namely the NDRRMC.

Further analyses can be conducted using CAPRA and CATSIM and/or other similar disaster risk modelling software. The analyses that were limited to tropical cyclonic wind should be extended to other more pertinent hazards, including floods, torrential rains, flash floods, drought, fires etc. Adequate training should also be provided to operate and interpret the models.

Further studies and research on DRR/CCA should be encouraged and national academics and/or students can conduct them. Universities in the country should be encouraged to propose modules of study on disasters and climate change with particular emphasis on islands' contexts. Sharing of and learning from the results can promote even better preparedness and risk management. Further regional collaboration on DRR/CCA is suggested and can involve stakeholders from all sectors including private operators and the civil society.

It is also recommended to assess the costs and benefits of improved design (for reducing vulnerability to natural hazard and climate change) for new public buildings and infrastructure. The different methodologies that have provided results worldwide can hence be adopted, namely Cost Benefit Analysis, Cost Effectiveness Analysis and Multi Criteria Analysis. The same techniques can be adopted for evaluating adaptation scenarios.

Technical capacity may be lacking in Government bodies to identify DRR projects with accuracy. There are many projects that are not directly related to DRR though they may contribute to disaster risk mitigation. On a number

[42] This chapter was drafted by Pamela Leste De Perindorge.

of occasions, the manner in which the budget items are classified renders identification very difficult if not impossible especially when using common resources within a Ministry or Department.

Another set of difficulties is associated with conducting analyses with sophisticated tools such as CATSIM, CAPRA or advanced economic techniques such as probabilistic CBA. Technical staff in the relevant ministries and departments needs adequate training to be able to conduct and update such analyses in a recurrent and regular manner.

A website should be set up (preferably hosted by the NDRRMC) providing useful information to the public in general and in simple language on Policies, Plans, Strategies and actions. The website will also provide links to existing websites (*e.g.* Indian Ocean Commission, Meteorological Services, Ministry of Environment and Sustainable Development). Information can also be in the form of videos and pictures. The aim should be to improve preparedness but also to disclose information on past events and their impacts.

An important initiative should be to further raise public awareness and improve the understanding of hazards at all levels among the population at large. Several avenues are to be explored here including the educational curriculum, the media, social networks as well as ICT.

2) Strengthening governance and institutions to manage disaster risk

It is crucial to strengthen capacity building for DRR and CCA at the technical level. Know-how on latest techniques or methods of analysis can be further transferred from international organisations like UNISDR, IIASA to our local resource persons.

More human, technical and financial resources should be allocated for DRR/DRM. The NDRRMC to start with, needs to be adequately structured and staffed to effectively implement its objectives.

As suggested by 'The Climate Change Adaptation Policy Framework', a coordinated approach should be adopted to CCA and DRR/DRM. This implies agreeing on an institutional framework to effectively handle the challenges posed by natural hazards and climate change. It is a priority to enact the Draft Climate Change Bill and the NDRRMC Bill, two legislations that would definitely give more impetus to initiatives that help cope with disasters and climate change.

It is recommended to apply the DRM marker to all Ministries and public organisations. This will not only identify current or past investments but more importantly will encourage further investment in prevention, mitigation and preparedness. Similarly, all Local Authorities should consider mainstreaming DRR and DRM into their budgets.

Although the NDRRMC acts as a central coordinating mechanism, it is not responsible for investment (identification, implementation and monitoring). It is important to establish clear mandates and allocation of responsibilities and tasks for the different stakeholders concerned.

With a view to ensure adequate risk assessment in public or private projects, clear guidelines should be implemented for conducting risk assessment with respect to disasters and climate change.

With a view to improve the resilience of buildings and infrastructure *vis a vis* natural hazards and climate change, support should be given to the development and implementation of new codes and guidelines under the 'Building Control Act 2012'. Their adequate enforcement should also be ensured so as to make buildings and infrastructure less vulnerable.

3) Investing in economic and fiscal resilience

Government should be encouraged to take a 'risk layer based ' approach in which resources are allocated based on the varying levels of risk facing the country, with a priority given to reducing existing risk and preventing the new risk generation. The use of CATSIM assessment is recommended to support decision-making.

To improve financial resilience and bridge the fiscal resource gap, Government should consider combination of the different financing mechanisms that can best address DRR/CCA for intensive hazards. This can include securing a line of international credit that can be timely disbursed if the need arises. This will facilitate a timely response and recovery and potentially minimise fatality and injury to humans or destruction and damage to

physical and natural assets. Similarly, the country must be able to secure international assistance when a major catastrophe strikes and where it is beyond domestic ability to cope.

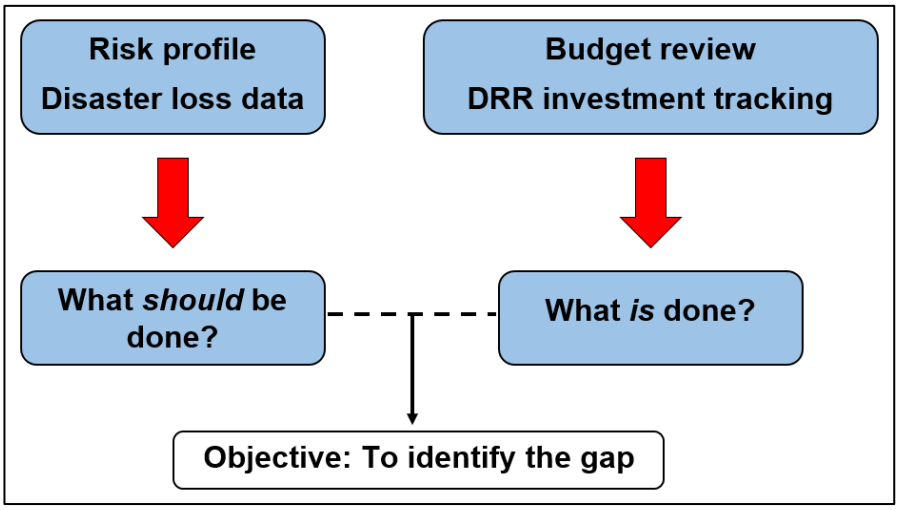
Private households in particular should be encouraged to insure their houses and assets with a view to reduce their vulnerability to disasters. Because the insurance products are available on the market, the penetration rate should be increased. This measure will reduce the pressure on government to address relief and rehabilitation. In the same line, development partners could be solicited to make CCA/DRR loans available to the more vulnerable households at preferential rates to increase housing resilience and resistance.

Annex A. Risk-Sensitive Budget Review (RSBR)[43]

A. Overview

The objective of the Risk-Sensitive Budget Review (hereafter called budget review) is to explore the gap between risk level and DRR investment (Figure 49). While CATSIM analysis outlined in Annex B will identify the financial gap year by comparing risk and financial capacity of the country, 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 49: 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.

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 23 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 23: 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

[43] Sections A-C of this chapter were drafted by Kazuko Ishigaki (UNISDR) and Section D was drafted by Pamela Leste De Perindorge.

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

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.

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[44]. 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. Therefore, the DRM Marker, with some adjustment, was applied to Mauritius.

B. DRM Marker

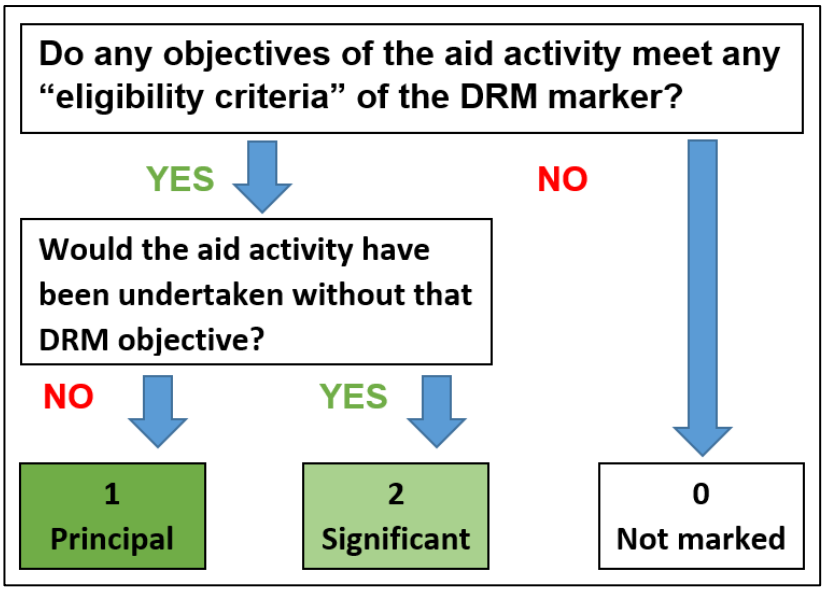
The DRM marker allows (a) capturing "embedded" investment by distinguishing between stand-alone versus mainstreamed DRR investment (*e.g.* retrofitting in school renovation program), (b) strengthening the ability to analyse, measure and report activities in DRR, and (c) improving regulatory conditions 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 50). 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[45]). 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"[46].

[44] The Rio Marker monitors CCA aid activity since 2011. DRM Marker is proposed using the similar methodology.
[45] 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
[46] 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.

Figure 50: 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 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.

C. The budget review methodology: Application of DRM marker

In applying the methodology of the DRM Marker in a risk-sensitive budget review, the following three steps were taken (Figure 51, 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 51: Risk sensitive budget review process

STEP 1: Define what should be monitored/counted.

- **a. Coverage: national level, local level, state owned corporation, etc.**
- **b. Budget or Expenditure?**
- **c. Current and/or capital?**
- **d. Targeted hazards?**

STEP 2: Mark and Tag Budget items

- **a. Mark each line item as Principal (2) Significant (1) or leave unmarked.**
- **b. Tag all marked items where they make the greatest contribution.**
  - **Risk Prevention/Mitigation**
  - **Preparedness**
  - **Response**
  - **Reconstruction**

STEP 3: Count and analyse (*e.g.* comparison with risk, trend analysis)

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[47].

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).

[47] 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.

D. The risk sensitive budget review in Mauritius

D.1. Scope of analysis

The scope of the budget review is defined as follows (Table 24):

Table 24: Scope of budget review

Year	2013 and 2014
Coverage	Particular attention to the Ministries and Departments listed hereunder: ▪ Prime Minister's Office (especially the NDRRM Centre) ▪ Meteorological Services ▪ The Police Force ▪ Ministry of Public Infrastructure /The National Development Unit ▪ Ministry of Environment and Sustainable Development ▪ Ministry of Public Utilities ▪ Ministry of Local Government and Outer Islands (esp. Mauritius Fire and Rescue Service) ▪ Ministry of Social Security ▪ Ministry of Finance and Economic Development.
Budget or expenditure	Both
Current or Capital	Both were examined.
Targeted hazards	Cyclone, heavy rains, flood, landslide, drought, fire, epidemics

Year/Period

Recurrent budget and expenditure is analysed for the period 2012-2016, namely expenditures for fiscal years 2010-2013 and the three subsequent years' estimates/planned budget as set out in the yearly Programme Based Budgets.

Capital budget and expenditure has been analysed from the Public Investment Sector Programme (PISP) Budget; it covers the period 2012-2018.

Coverage

The budget review explored Central Government, Ministry of Local Government, as well as local authorities and state owned enterprises. A wide spectrum of ministries and state bodies are either directly or implicitly concerned in this analysis.

The short listing of ministries or bodies retained for the budget review has been done after consolidating the views of the NDRRMC and Ministry of Finance and Economic Development. However, for a more effective review and given resource and time constraints, the scope of the review was limited.

The below are ministries, departments and public sector bodies that definitely have an impact on DRR (Table 25). As there are over 50 programmes to be reviewed for DRM, the focus for this first round (see "Narrow Level" analysis below) was placed on the more pertinent programmes as follows:

Table 25: Impact of Governmental institutions on DRR

Sector	Programme
Prime Minister's Office	National Disaster Risk Reduction and Management Center (NDRRMC)
Police Force	Defence, Disaster Management and Emergency Rescue
Meteorological Services	Meteorological Services
Public Infrastructure/The National Development Unit	Community-Based Infrastructure and Public Empowerment Land Drainage and Watershed Management
Environment and Sustainable Development	Improvement/Upgrading/Rehabilitation of Beaches Maintenance of Rivers/Canals Sustainable Development Climate Change

Public Utilities	Power Services Water Resources
Social Security	Social Aid
Local Government and Outer Islands	Fire Fighting and Rescue and Fire Prevention
Finance and Economic Development	Income Support Programme for the Poor Social Protection and Inclusion

Budget or Expenditure

Both budget and expenditure are examined. The figures for 2013 relate to estimated expenditure. The 2014 figures are mostly budget figures except for contingency expenditure that occurred during the year.

Capital (investment) or Current

Both recurrent and capital budget/expenditures are examined. For capital projects, the following have also been explored:

- Rodrigues
- Mauritius Fire and Rescue Service under the Ministry of Local Government and Outer Islands

Budget documents employed

The two sets of Government documents available for national current and capital budget/expenditure are the Programme Based Budget (PBB) and the Public Investment Sector Programme (PISP):

Programme-Based Budgeting (PBB) was introduced in Mauritius in 2008. It provides for the annual expenditure by Government and takes into account the Macro-Fiscal Framework and a Medium Term Expenditure Framework. PBB approaches the budgetary process from a performance based multi-annual exercise that "links the funds appropriated by the National Assembly to outputs (the goods and services produced by Government) and outcomes (the changes observed by citizens in their life, over time, as a result of the supply of these goods and services)" as defined in the PBB manual. The PBB is a most vital tool for the planning function of Ministries/Departments and it has through the years contributed to enhancing transparency and accountability in the use of public funds. Typically, the PBB covers three years. Hence, the 2014 PBB budgets/expenditures include estimates for 2014 and planned figures for 2015 and 2016. In each PBB, figures for the past year are also included for comparison (*i.e.* the 2014 PBB thus includes 2013 expenditures as well).

The documents used for the purpose of the "Wide-3 digit" analysis presented below were the PBB 2014, the PBB 2013, the PBB 2012 and the PBB 2011. These altogether provide a time series data for 2010 to 2016.

The Public Investment Sector Programme (PISP) provides a framework that outlines the way public sector infrastructure investment decisions and policies are planned, financed and implemented. It comprises a 5 - Year pipeline of public sector investment projects for funding through Government budgetary resources, state - owned institutions, loans and grants from development partners. Hence, the latest PISP 2014-18 cover 2011 to 2018, that is, actual expenditure for 2011 and 2012, estimates for 2013 and 2014 and projections for 2015, 2016, 2017 and 2018.

The recurrent or capital expenditure is based on a 'Chart of Accounts' (COA), which provides a common classification system for different categories of expenditure under different programmes for all ministries and departments. Each programme is broken down into items of expenditure *e.g.* compensation of employees (21), goods and services (22), social benefits (27), acquisition of non-financial assets (31) etc.

Process

The methodology for conducting this analysis comprised a desk review of budgets and expenditures by sector, as well as consultations with key ministries/bodies such as the NDRRMC, the Ministry of Local Government, the Ministry of Environment and Sustainable Development, and the Ministry of Public Infrastructure. There was a regular and continuous collaboration with the Ministry of Finance and Economic Development.

D.2. RSBR Results: Current Expenditure

With a view to determine the total expenditure on DRM, two approaches were adopted. In Mauritius, we conducted two levels of analysis that we named 1.) Wide and 2.) Narrow. Results of both are described below.

Wide/ Summary Level (3 digits)

Firstly, a summary analysis was conducted on the Summary Budget (PBB). This summary provides information at the level of Programmes (*i.e.* 3-digits code) and is not adequately precise. From this first analysis, it surfaces that the total budget related to DRM attained Rs 17 billion (approximately USD 547 million), which is equivalent to 16% of the total PBB in 2013 (Table 26). It was impossible at this level to determine the exact nature of expenditure, in terms of risk prevention/mitigation, preparedness, response/relief and reconstruction. For programmes like the Prime Minister's Office, Rodrigues Development or the Meteorological Services, it was hard to determine the portion that is attributed to disaster or risk management. These items could not therefore be marked to avoid inevitable excessive over-estimation. The significant increase in 2013 can be explained by the substantial investment by the Ministry of Public Infrastructure in the aftermath of severe floods that occurred on 30th March 2013.

Table 26: Wide DRM Marking (Current). (Unit: USD Million)

	2010 Actual	2011 Actual	2012 Actual	2013 revised estimates	2014 estimates	2015 Planned	2016 Planned
Total - Marked - 1 "Significant"	229	223	292	472	284	293	285
Total - Marked - 2 "Principal"	43	70	54	77	124	101	82
GRAND TOTAL PBB	272	294	346	549	408	394	366
Total Marked as a % of Grand Total	10%	10%	12%	16%	11%	10%	9%
% Annual change		*8%*	*19%*	*59%*	*-26%*	*-4%*	*9%*

Source: Author based on PBB

Narrow/In-depth Level (5 digits and more)

A more in-depth analysis was then carried out at sub-classification level (5 digits and more, covering roughly 50 programs listed in the scope above for 2013 and 2014 budgets). This approach is considered the 'narrow' approach to budget review.

DRM has been marked for efforts totalling Rs 4,381 million (USD 141 million) for 2013 and Rs 5,773 million (USD 187 million) for 2014, which is respectively 4.2% and 5.1% of the total PBB. A marking of "Principal" was attributed to 3.2% of the total PBB in 2013; this figure rose to 4% in 2014. The proportion of efforts marked "Significant" increased from 1.0% in 2013 to 1.1% in 2014 (Table 27).

Table 27: Narrow DRM Marking (Current). (Unit: USD Million)

DRM Marking in USD million	2013			2014		
	Principal	Significant	Unmarked	Principal	Significant	Unmarked
Prime Minister's Office	-	0.16	-	-	-	-

Police Force	-	23.83	-	-	31.90	-
Meteo	6.94	-	-	12.76	-	-
Public Infrastructure	19.26	7.26	-	14.25	0.33	-
Environment	3.87	0.23	-	5.16	0.87	-
Public Utilities	67.85	-	-	101.71	-	-
Local Government and Outer Islands	11.22	-	-	13.04	-	-
Social Security	-	0.69	-	-	3.23	-
Finance and Economic Development	-	-	-	-	2.99	-
Sum	109.1	32.2		146.9	39.3	
% of PBB	**3.2%**	**1.0%**		**4.0%**	**1.1%**	
Total Marked (%)	**141**		*4.2%*	**186**		*5.1%*
GRAND TOTAL PBB	**3379**			**3668**		

Source: Author based on PBB

Examples of most important programmes (marked as 'Principal') include water resources under Public Utilities; land community-based infrastructure under Public Infrastructure or the current budget for the Mauritius Meteorological Services. Programmes marked as 'Significant' include 'Defence, Disaster Management and Emergency Rescue' by the Police Force and 'Land Drainage and Watershed Management' by the Ministry of Public Infrastructure.

This narrow review also afforded us a more careful exploration of the components of DRM that the marked efforts contributed to most substantially. Combining all marked efforts from 2013 and 2014, it surfaces that 74.1% of the DRM portfolio is invested in prevention/mitigation followed by 23.6% in preparedness, 2.1% in reconstruction, and only 0.2% in relief (Table 28).

Table 28: Narrow DRM Tagging of Current Expenditure by DRM Sub-category. (Unit: USD Million)

DRM Marking per Component, in USD million	2013-14 Average: Disaster Risk Reduction		2013-14 Average: Disaster Management	
	Prevention/ Mitigation	Preparedness	Relief	Reconstruction
Prime Minister's Office	-	0.1	-	-
Police Force	-	27.9	-	-
Meteo	-	9.9	-	-
Public Infrastructure	20.6	-	-	-
Environment	0.8	0.8	-	3.4
Public Utilities	84.8	-	-	-
Local Government and Outer Islands	12.1	-	-	-
Social Security	1.6	-	0.3	-
Finance and Economic Development	1.5	-	-	-
% of Total DRM-Marked for 2013/14 (Average)	**74.1%**	**23.6%**	**0.2%**	**2.1%**
GRAND TOTAL PBB				

Source: Author based on PBB

Programmes undertaken by the Ministry of Public Infrastructure (land drainage and watershed management) and the Ministry of Public Utilities (with respect to water and electricity supply) are mainly classified as

prevention/mitigation here. Preparedness includes expenditure by the Police Force and the Meteo Services (in terms of equipping). One example for 'relief' is the expenditure made in terms of 'payment vouchers' made to over 200 families who had been the affected of the 2013 floods. Reconstruction during this period mainly involved the rehabilitation of coastal zones prone to sea erosion, largely attributed to sea level rise/climate change. The latter are extensive risks, and are often not considered as "disasters" on the same basis as flood or cyclone.

D.3. RSBR Results: Capital Investment

The next step was a review of capital investment, using the Public Investment Sector Programme (PISP) Budget, 2013-18. The total capital expenditure for 2013 reached Rs 26,297 million (USD 846 million) and is projected to increase to Rs 28,544 million (USD 924 million) in 2018. The project value for 2014-2018 is Rs 251,204 million (USD 8,130 million). Using the DRM Marker as a tool, it can be approximated that public investment for DRM in the most recent year (2014) amounts to Rs 5,773 million (USD 186.8 million) from the current budget (PBB) while for capital projects, public investment planned for 2014 stood at Rs 4210 million (USD 136.2 million).

Table 29 shows the investments marked as Principal (2) or Significant (1) as per the DRR/DRM Marker. It shows that about Rs 23.2 billion (USD 751 million) or 9.2% of the PISP value is related to DRR/DRM over the period 2014-2018. It is estimated of those DRM-marked, 78% of projects are marked as Significant (*e.g.* the acquisition of meteorological equipment and the purchase of rescue vehicles/ equipment) and 22% are Principal (*e.g.* the rehabilitation works for landslide management).

Table 29: DRM marking of capital investment (Unit:USD Million)

PISP: Grand Total USD 8103 million	Total Project	2013	2014
Total - Marked - 1 "Significant"	583	77	106
Total - Marked - 2 "Principal"	165	47	30
Total Marked DRM as % of the PISP	9.20%	14.60%	15.70%

Source: Author based on PISP

Table 30: DRM Marking of Capital Expenditure

DRM Marking in USD million	2013			2014		
	Principal	Significant	Unmarked	Principal	Significant	Unmarked
Prime Minister's Office	0.05	-	-	0.65	-	-
Meteorological Services	-	0.39	-	-	10.23	-
Ministry of Local Government and Outer Islands	-	0.28	-	-	0.32	-
Rodrigues Regional Assembly	-	2.23	-	-	3.68	-
Police Force	-	24.63	-	0.03	18.61	-
Fire Stations	-	2.34	-	-	2.39	-
Public Infrastructure	0.11	-	-	2.73	-	-
Road Decongestion Programme	-	-	-	-	0.32	-
Civil Aviation	-	6.45	-	-	8.65	-
CEB Projects	-	0.68	-	-	0.81	-
Ministry of Environment and Sustainable Development	46.77	4.07	-	26.45	5.70	-
Water Resources Unit	-	36.19	-	-	55.23	-
Sum	46.9	77.3		29.9	105.9	
% of PISP	**5.5%**	**9.1%**		**3.5%**	**12.2%**	
Total Marked (%)	**124.2**		*14.6%*	**135.8**		*15.7%*
GRAND TOTAL PISP	**848**			**865**		

Source: Author based on PISP

Combining all marked efforts from 2013 and 2014, it surfaces that 75% of the DRM portfolio is invested in prevention/mitigation followed by 21% in preparedness, and 5% in reconstruction (See Table 30) As relief and reconstruction are typically reserved only for the aftermath of emergencies (*i.e.* a cyclone), this distribution is readily defended by the number of disasters that occurred during this time frame[48].

For capital investment, it has not been possible to identify investment as 'relief'. The boundary between relief and reconstruction is not very well defined and expenditure is not centrally monitored while much of the liability and hence disbursement falls in the private sector. Such has been the case for property and asset damage recovered under insurance claims in the aftermath of the floods that occurred in March 2013.

While most capital projects have been preventive in nature (*e.g.* fire station construction and upgrading, acquisition of fire-fighting and rescue equipment and vehicles), there are instances where projects have been undertaken to rehabilitate damage caused by landslides and coastal erosion (for instance rockfall at Macondé and the upgrading/rehabilitation of rivers and beaches). Other examples of investments for preparedness include the implementation of an Emergency Alert System, the acquisition of vehicles and communication equipment for disaster management and emergency rescue.

Table 31: DRM Tagging of Capital Investment by Category (Unit: USD Million)

DRM Marking per Component, in USD million	2013-14 Average: Disaster Risk Reduction		2013-14 Average: Disaster Management	
	Prevention/ Mitigation	Preparedness	Relief	Reconstruction
Prime Minister's Office	0.3	-	-	-
Meteorological Services	-	5.3	-	-
Ministry of Local Government and Outer Islands	0.3	-	-	-
Rodrigues Regional Assembly	3.0	0.0	-	-
Police Force	-	21.6	-	-
Fire Stations	2.4	-	-	-
Public Infrastructure	0.1	-	-	1.4
Road Decongestion Programme	0.2	-	-	-
Civil Aviation	7.6	-	-	-
CEB Projects	0.7	-	-	-
Ministry of Environment and Sustainable Development	37.0	-	-	4.5
Water Resources Unit	45.7	-	-	-
% of Total DRM-Marked for 2013/14	75%	21%	0%	5%
GRAND TOTAL PISP				

Source: Author based on PISP

[48] The list of disasters that hit Mauritius in 2013-14 includes the following:

- 13 February 2013 - Torrential rain
- 30 March 2013 - Flash flood
- 21-29 October 2013 - Landfill fire at Mare Chicose
- 14 November 2013 – Heavy rainfall
- 27 November 2013 – Heavy rainfall
- 19 December 2013 – Cyclone Amara (Rodrigues)
- 01 January 2014 – Cyclone Bejisa
- 05 February 2014 – Tropical Storm Edilson
- 14 March 2014 – Torrential rain (Rodrigues)
- 21 March 2014 – Heavy rainfall
- 26 April 2014 - Rockfall at Macondé along the coastal road at Baie du Cap

There were also a few small-scale incidents (*e.g.* chemical spills) in work places and a few fire outbreaks in sugar cane fields (where the cause is not always clear cut).

Both current and capital budget/expenditure for DRM in 2013 and 2014 are summarized in table Table 32.

Table 32: DRM/CCA investments across 4 components in 2013-2014 (Unit: USD million)

Budget allocations per Risk Management phase/category	Significant	Principal	Total	Percentage
Prevention/mitigation (1)	135	302	436	74.3%
Preparedness (2)	110	22	132	22.4%
Response (3)	1	-	1	0.1%
Reconstruction (4)	10	9	19	3.2%
Total budget allocations	256	333	588	**100%**
Share of total budget	3%	4%	7%	

Source: Ministry of Finance and Budget / adapted by author

D.4. Gap between loss, risk and DRM budget

Components 2 of the project determined an AAL of USD 86.91 million to cyclonic wind in Mauritius, representing 8.26‰ of exposed assets, 0.04% of Gross Fixed Capital Formation, and 0.01% of GDP. The overall estimated investment in DRM/CCA identified in Mauritius through the above budget review is USD 141 million for 2013 and USD 187 million for 2014 for the current expenditure/budget and USD 126.2 million in 2013 and 136.2 million in 2014 for the capital expenditure/budget. Annual average of both current and capital budget/expenditure in 2013 and 2014 is USD 161.5 million (Table 33).

Table 33: DRM budget, loss and risk

	DRM investment (budget), average in 2013 and 2014	AAL (tropical cyclonic wind only)	Loss, 1980-2014 (1,105 of data cards)
Value	USD 161.5 million	USD 86.91 million	USD 59 million (Annual average: USD 4.5 million)

A simple comparison of AAL to the most current annual investment in DRM indicates a **positive balance: greater investment each studied year than expected loss.** It surfaces that for 2014 there is not a financing gap to meet potential losses from DRR/DRM. However, it is important to keep in mind that AAL is only estimated for tropical cyclonic wind risk and to go back to the actual marked activities to determine their link to cyclonic wind risk. If the studied investments had no discernable link to cyclones, of course, these statements would have limited value.

As reference, loss data were also compared to the budget. Again this comparison shows a positive balance. While the DRR budget for current investment totalled USD 186.8 million in 2014, capital investment earmarked was USD 135.9 million. Total investment exceeds even the total loss over the period 1980 to 2014.

Although this is only a very simple and straightforward example that cannot be extrapolated to other hazards or years, it serves to underscore the utility of both the AAL/past loss data and the budget review as a combined tool to move Mauritius towards risk-sensitive public investment in light of their most important natural hazards.

D.5. Challenges experienced in conducting risk sensitive budget review

In Mauritius, public investments in DRM are not directly identifiable *per se* but investments are integrated within the budget of ministries/ institutions such as the Ministry of Public Infrastructure and the National Development Unit, the Ministry of Environment and Sustainable Development, the Meteorological Services or the Ministry of Public Utilities. The 62-78% each year of total marked elements being “significant” (as opposed to “primary”)

indicates a horizontally integrated investment in DRR, reflecting a positive move towards mainstreaming DRR. The most direct public investment would include the NDRRMC that is under the aegis of the Prime Minister's Office, and the Meteorological Services.

It is important to note at the very outset that the structure of budget by type of expenditure and programmes, rather than specific projects, constituted a difficulty when attempting to mark a specific programme as contributing to DRM. As most programmes or even sub-programmes consist of multiple objectives and activities, to retrieve and consolidate the information related to DRM is a very delicate task. Views can in fact diverge and result in a different analysis.

The classification of budget or expenditure into the categories of prevention/mitigation, preparedness, relief/response and reconstruction, is a challenging task. For an objective analysis, it is recommended that the classification be first discussed and agreed within a working group composed of representatives from the different ministries concerned guided by the NDRRMC. The group discussion should also ensure the active participation of all relevant entities. Such an exercise may help to discern any other programme that is related to DRR, DRM and CCA and that is not visible in the budgeted programme title and objective themselves.

To have a better view of public investment in DRR/DRM/CCA, it is recommended to apply the DRM marker for all Ministries and public organisations. This entails continuous capacity building at technical and institutional level to effectively use the DRM marker. To encourage further investment in prevention, mitigation and preparedness, it is suggested that a defined proportion of investment of the PBB and PISB (for example 4 or 5%) be devoted to DRR by all Ministries and Government departments.

D.6. Next step to be considered: Other Levels and Categories

State Owned Enterprises

There are a few state-owned enterprises. The ones that relate most to DRR are the Central Water Authority (CWA) and the Central Electricity Board (CEB). The CWA's objective is to ensure and improve regularity and security of supply of water; while the CEB is mandated to "prepare and carry out development schemes with the general object of promoting, coordinating and improving the generation, transmission, distribution and sale of electricity". They play a major role in providing reliable utilities and infrastructure that resist to damages that may be caused by natural hazards such as cyclones and floods. The capital projects of both these state owned enterprises are also reflected in the Programme Investment Sector Programme (PISP).

The CWA is responsible for the treatment and distribution of potable water in Mauritius. The CWA has driven several major investments in exploring new water sources, upgrading and extending pipes networks in various parts of the country and bringing potable water to the greatest number of people. The Service Reservoirs are instrumental in sustaining supply and altogether provide a total storage capacity of 238,000 cubic metres scattered all around the island. The CWA is also involved in actively implementing demand management measures, especially at a time where climate change has showed that average annual precipitation is declining. The management of water in periods of drought additionally concerns the CWA. It is however difficult to estimate the share of investment that relates significantly to disaster risk management.

Table 34: Central Water Authority's funding of capital projects 2013-2015 (USD million)

	2013	2014	2015
Loans	12.3	49.6	55.6
Grants	2.8	3.0	3.1
CWA Own Funds	15.3	12.7	7.6
Total Capital Investment	30.4	65.3	66.3

The CEB's accounts for 2010 state that capital expenditure amounted to Rs 4,247 million (USD 134.4 million). While generating and supplying energy, maintaining a highly reliable transmission network that is resistant to disaster risks also concerns the CEB. In the aftermath of calamities such as cyclones and floods, it has to provide quick response to re-establish electricity the most quickly possible so as to minimize losses to society and the economy. However, here again, it is difficult to estimate the share of investment that relates significantly to DRM.

Local Authorities

As Local Government becomes more involved in DRR and DRM, it is recommended that such expenditure is mainstreamed into the budgets of Local Authorities and be made visible in the accounts.

With respect to Local Government, there are 12 local authorities (five Municipal Councils and seven District Councils) each with a budget in which grants from central government constitutes a fair share (see also Chapter 1). In general it can be highlighted that local authorities obtain at least 50% of their finances from central government grants. It is also true that projects carried out by local authorities, for example, related to road drainage is relatively minor. Most of the major drainage works are being implemented at central government level.

Local authorities have set up Local Disaster Risk Reduction (DRR) and Management Committees to manage DRR in the respective localities. The financial statements available for a few local authorities were reviewed. A review of their accounts, however, does not clearly show the investment that can be marked for DRM. Accounts of other Local Authorities were not available to enable further analysis.

Taking the example of Black River District Council, the total expenditure for 2012 amounted to Rs 177.5 million (USD 5.8 million), of which Rs 126.3 million (*i.e.* 71%) was obtained from Government Grants. It can be noted that Rs 51.8 million (USD 1.7 million) is related to the provision and maintenance of community based amenities.

Port Louis has by far the largest budget of all Local Authorities. The City of Port Louis, had a total income Rs 680.7 million (USD 23.2 million) in 2011, out of which Rs 371.8 million (*i.e.* 55%) was obtained from Government Grants. The extent of its expenditure shows little of expenditure marked as DRM (less than 1.5%). Its expenditure on the provision and maintenance of community based amenities reached Rs 142.60 million (USD 4.8 million), of which Rs 7.7 million (USD 0.3 million) was allocated to Roads, Drains and Bridges.

External finance

International donors and financial institutions finance various projects implemented by Government. Sources of funds include lines of credits, loans and grants. Many of them are already reflected in the PISP. It is worth mentioning the Global Environment Fund (GEF), the *Agence Française de Développement,* the United Nations (UNDP, UNEP), the European Union (EU), the African Development Bank (ADB) and the World Bank (WB).

The **Global Environment Fund (GEF):** Mauritius has received grants from the Global Environment Fund (GEF) for co-financing national projects. During the current GEF-5 replenishment period (July 2010 – June 2014), Mauritius received an indicative allocation to formulate and execute projects for USD 5.1 million in biodiversity, USD 2 million in climate change, and USD 0.8 million in land degradation. It can be noted that the climate change related projects aim at reducing greenhouse gases emissions by shifting away from traditional fossil fuels. Current GEF projects in Mauritius include: Expanding Coverage and Strengthening Management Effectiveness of the Terrestrial Protected Area Network on the Island of Mauritius, Sugar Bio-Energy Technology, TT-Pilot (GEF-4): Removal of Barriers to Solar PV Power Generation in Mauritius, Rodrigues and the Outer Islands; Biodiversity Restoration, Partnerships for Marine Protected Areas in Mauritius; Removal of Barriers to Energy Efficiency and Energy Conservation in Buildings; Sustainable management of Persistent Organic Pollutants in Mauritius, Restoration of Round Island.

Agence Française de Développement (AFD): The AFD has approved in December 2013, a credit line of around 50 million Euros (approximately Rs 2 billion) as budget support for the funding of sustainable development projects in the energy sector. The loan will support the Government of Mauritius' efforts towards diversifying the energy sector and to develop and promote energy regulation projects as well as renewable energy.

UN: The UN has been providing continuous support to strengthen the capacity of the Mauritius Government and civil society to achieve continued growth and sustainable development. Projects related somehow to DRM and have been recently implemented/are being implemented include:

- Social Inclusion and Empowerment Project, co-financed by UNDP for USD 300,000
- UN Women for USD 110,000

- Climate Change Adaptation Programme in the coastal zone of Mauritius, with USD 8.4 million from the Adaptation Fund Board including a 4-year Coastal Adaptation Project.

Reference

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

Annex A-1. CHECKLIST for a risk-sensitive budget review

CHECKLIST to CONDUCT a RISK-SENSITIVE BUDGET REVIEW (RSBR)

1. DETERMINE WHAT SHOULD BE COUNTED

a. IDENTIFY YEAR / PERIOD that is appropriate and feasible

EXAMPLE: last fully-completed year or current year underway

ADVICE: Start with a single year, add other periods later, as feasible.

b. DETERMINE COVERAGE

EXAMPLE: all public sector (general and state corporations) or only General budget (central and/or sub-national budgets)

ADVICE: All public sector is desirable, but start with central budget and budget of national disaster management entity before moving onto other budgets. Smaller countries should be able to review all.

c. IDENTIFY BASIS FOR REVIEW

EXAMPLE 1: budget or expenditure?

ADVICE: if difference between two is large, go with expenditure; if small, go with budget.

EXAMPLE 2: investment (capital) and/or consumption (current)?

ADVICE: ideal to use both, usually reported separately in budget

2. OBTAIN COPIES of budgets covering all elements determined above

EXAMPLE: hard-copy or electronic copy—with 'objectives' stipulated per line item in enough detail to conduct next steps

ADVICE: review / study guidance for DRM Marker, taking note of the "eligibility criteria" discussion on pp3-4: (Review document entitled: DAC Working Party on Development Finance Statistics, A Proposal to Establish a Policy Marker for DRM in the OECD DAC Creditor Reporting System, 2014)

3. MARK and TAG BUDGETARY ELEMENTS

a. DRM MARKING: go through the budget(s) line by line, asking the question(s) at each line:

• "do any objectives of the budgeted activity meet any 'eligibility criteria' of the DRM marker?

• "If yes, would the budgeted activity have been undertaken without that DRM objective?"

ADVICE: Using spreadsheet, record total of the budget activity in three categories: Principle (2), Significant (1) and not marked (0) for easy summing

b. DRM TAGGING: go through the budget(s) again line by line, to categorize each MARKED activity by scheme in 3a above: "what percentage of total MARKED items fit best under prevention/mitigation, preparedness, relief and reconstruction?"

ADVICE: Work with DRM entity in your country to determine the best categorization

EXAMPLE: the most common standard is: 1. Prevention/mitigation, 2. Preparedness, 3. Response and 4. Reconstruction

4. CALCULATE AND COMPARE DRM INVESTMENT

a. Sum DRM/CCA investment per marker and DRM sub-category

b. Calculate gap by comparing sum with Risk/Loss data (Comp 1/2)

c. Document lessons learned

d. Time allowing, repeat all of the above with additional years, budgets, sectors, etc.

Annex B: Macro / CATSIM Assessment[49]

A. Overview

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 model has been applied to Madagascar in 2011 and to several other countries.

The CATSIM model consists of five-steps (See Table 35): 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. In this initiative, we utilized the data collected in Components 2 to the maximum degree.

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.

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.

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.

Since Mauritius has not conducted CATSIM to date, as a first trial, this initiative has implemented only Steps 1 to 3.

[49] This chapter was drafted by Junko Mochizuki, Stefan Hochrainer, Keith Williges, and Reinhard Mechler, Risk Policy and Vulnerability Program, International Institute for Applied System Analysis (IIASA). Input was given by Mauritius team and UNISDR.

Table 35: 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
5. Risk Management/Reduction Option Assessment	To evaluate the risk management options

Source: Author

B. CATSIM analysis in Mauritius

Step 1: Direct Risk Assessment

This study evaluated the ability of government of Mauritius to manage potential fiscal and economic risk arising from tropical cyclonic wind and earthquake combined. Probabilistic risk assessment using the CAPRA GIS software shows that Mauritius faces considerable disaster risk relative to the size of their economy.

This study evaluated fiscal resource gap using both current CAPRA estimates and statistical estimates available from Hochrainer-Stigler et al. (2014). In general, the estimates based on CAPRA GIS shows higher loss estimates than those of Hochrainer-Stigler et al. (2014) (Table 36).

Table 36: Estimated PML at varying return periods (in USD million)[50]

Return period	CAPRA estimate	Hochrainer-Stigler et al. 2014
5	54.6	-
10	133.8	-
20	257.9	207.2
50	489.7	415
100	1,020.2	614
500	1,565.3	1,300
1000	2,049.1	-
AAL	58	-

Source: Author

The government is generally not responsible to provide all reconstruction needs because private households and businesses will assume responsibility of their own reconstruction needs. We assume that the governments assume the following responsibility in case of a disaster:

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

Total contingent liabilities of Mauritius Government were estimated as outlined in

[50] The data collected from Component 2 were later revised to reflect new GAR 15 methodology. Chapter 2 was revised to update the data, but given short time frame, we could not reiterate the CATSIM assessment based on new data. The inconsistency with Chapter 2 stems from this issue.

Table 37.

Item	Value in USD billion	References
Total Capital Stock	42.1	Penn World Table (2014)
Public Capital (a)	12.6	Assumed as 30% of total capital stock based on Hochrainer-Stigler (2012)
Private Capital	29.5	Assumed as 70% of total capital stock based on Hochrainer-Stigler (2012)
Relief Spending (b)	8.4	Assumed as 20% of total capital stock based on Hochrainer-Stigler (2012)
Governments Total Liability (a+b)	21.1	N/A

Table 37: Estimated Government Contingent Liability

Source: Author

Step 2: Fiscal Resilience Assessment

The options to finance reconstruction and recovery may be divided into: i) ex-ante and ii) ex-post resources depending on whether arrangements are made prior to or after a disaster event. 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 this study, we have estimated fiscal resources availability based on available economic and fiscal statistics. Table 38 provides an overview of the estimated availability of ex-post resources such as international assistance, budget diversion, domestic bonds and credit, and international / multilateral financial institution (MFI) bonds.

We did not consider the tax option because this is largely considered as infeasible or undesirable option by Mauritius. We also did not consider ex-ante options because of data availability issues.

Table 38: Estimated Ex-post Fiscal Resources Availability

Sources	Assumptions	Value
International Donor Assistance	10.4% of public liability based on international average[51]	10.4% of liability
Diversion from budget	5%>deficit, then 0 5%<deficit, then 5% of total revenue	USD 79.7 million
Domestic Bonds and Credit	1% of gross domestic credit from private bank	USD 98.5 million
MFI/ International bond market borrowing	SDR allocation	USD 99.6 million
Total excluding international assistance		USD 278 million

Source: Author

Assumptions for fiscal resource availability

International assistance

International assistance, the amount of money made available to a country post-event in the form of donations from other countries and aid organizations, is assumed to be 10.4% of damages, based on regression analysis of historic data from Freeman et al (2002).

Diversion from budget

Budget diversion, representing the amount of funding from the central government's budget which can be re-directed and focused towards recovery, is assumed to be only possible if a government has a budget surplus or small deficit. For this analysis, we assume that countries with a 5% or larger budget deficit relative to GDP are unable to divert funding; as Mauritius does not fit this criteria, available funds for diversion are calculated as 5% of the government's total revenues. Data for this calculation are obtained from the World Bank's World Development Indicators.

Domestic bonds and credit

After an event, a nation has the possibility of trying to finance recovery via domestic credit, either by printing money, issuing bonds, or borrowing from domestic sources. A pitfall to this avenue of funding is the risk of increasing the total stock of domestic credit, which could crowd out private sector credit and lead to more monetary expansion and increasing inflation (World Bank, 2011). For this reason, we assume that a government will be limited in this regard to a maximum of 1% of gross domestic credit from private banks, the data being sourced from World Bank Development Indicators. There is high uncertainty whether the domestic credit market can be accessed and these estimates deserve further verification.

Multi-lateral financial institution (MFI) / International bond market borrowing

A further option for financing reconstruction and recovery comes from borrowing on international markets and from multi-lateral financing institutions. The International Monetary Fund's Special Drawing Rights (SDRs), which represent an international reserve asset, is used as a baseline estimate for how much international funding could be available post-event. SDRs are based on four currencies (the euro, Japanese yen, pound sterling, and U.S. dollar), and can be exchanged for usable currencies (IMF, 2014).

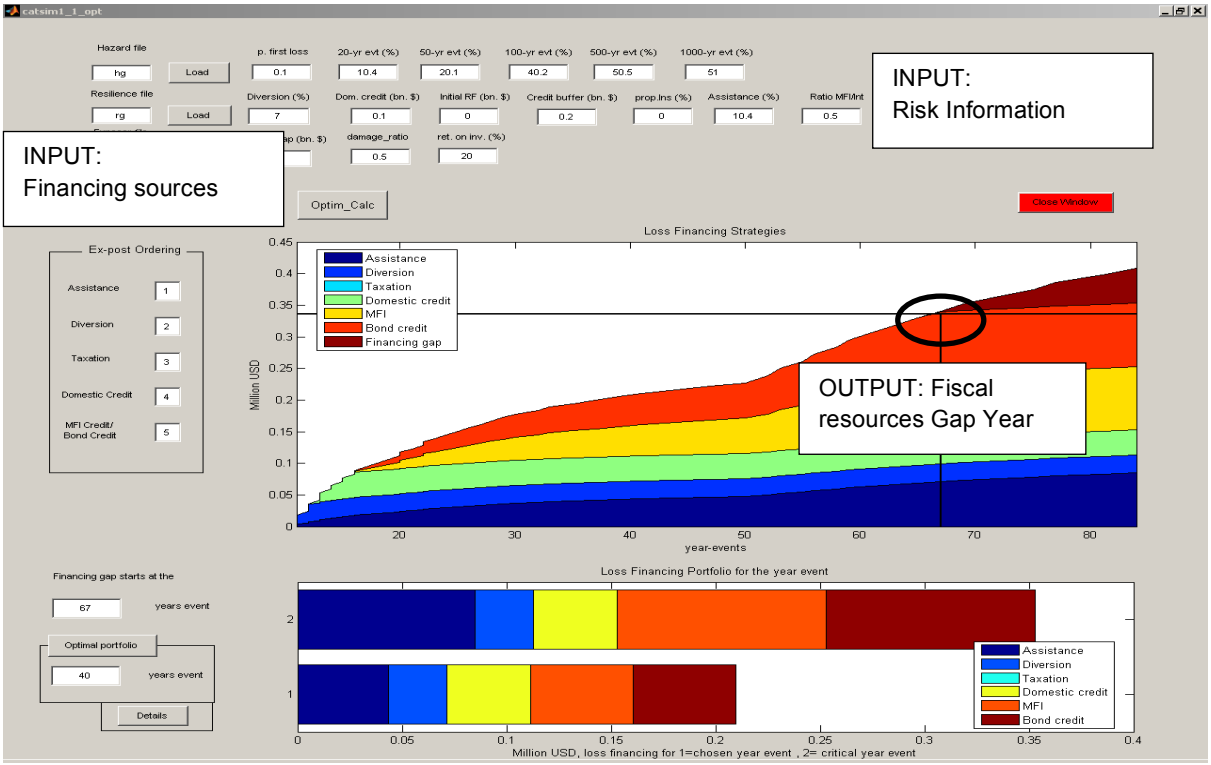
[51] This value depends on the size of disaster. Therefore, we do not have any single value. In CATSIM, the availability for each scenario is calculated using this percentage.

Step 3: Estimating potential "fiscal resources gap"

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 52). Given the considerable uncertainty regarding risk estimates, the result should be interpreted with caution and further studies are certainly advisable to validate assumptions in Steps 1 and 2.

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.

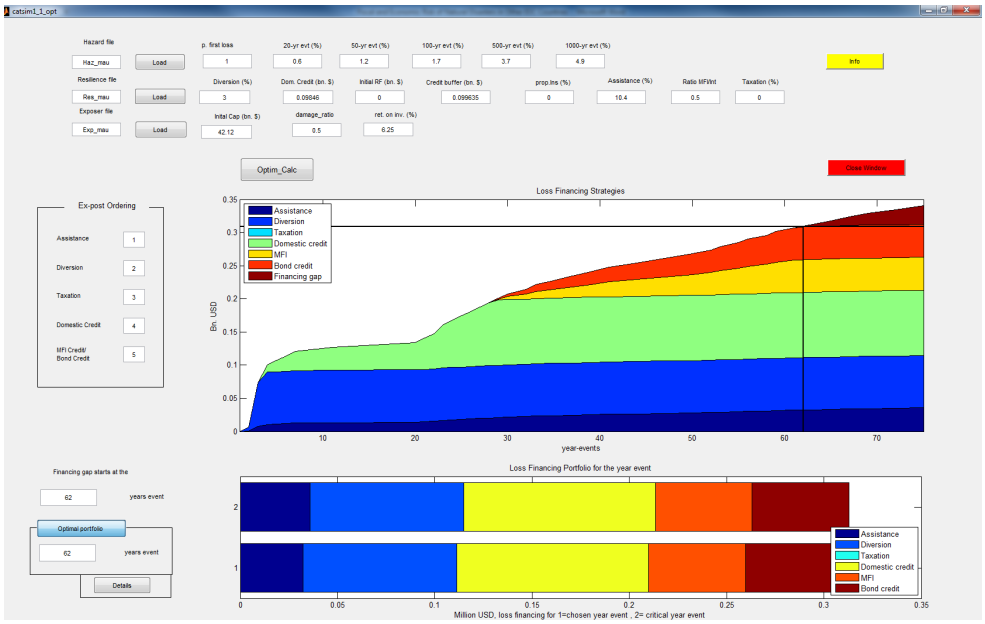
Figure 52: Display of results of fiscal resources gap year



Source: Author

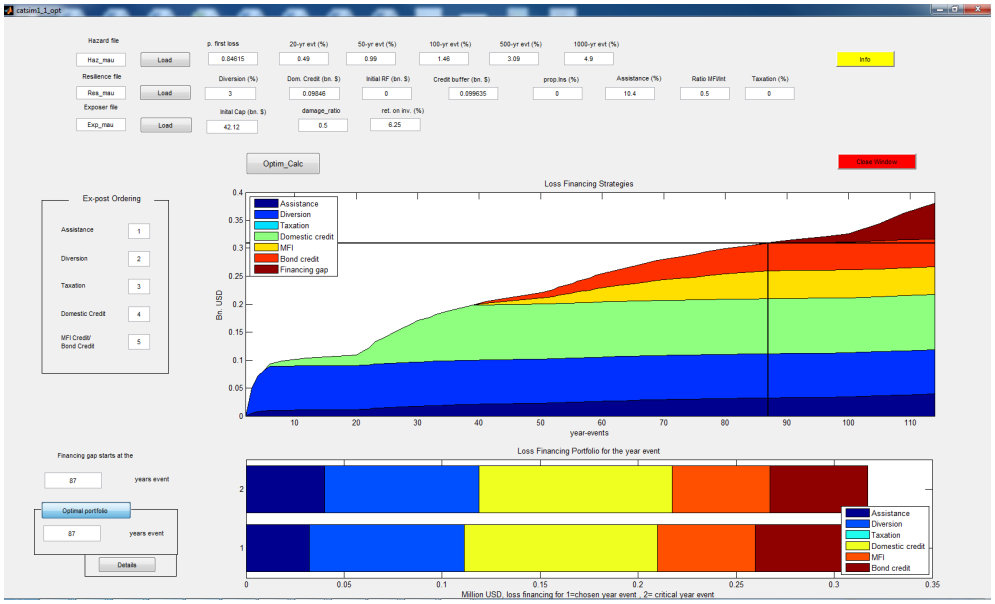
Assuming an AAL of USD 58 million (0.43% of GDP), Mauritius was found to face a fiscal resources gap at year 62 (CAPRA estimate) (Figure 53). Based on the loss distribution available from Hochrainer-Stigler (2014), a fiscal resource gap year was estimated at 87 years (Figure 54). Based on the CAPRA estimate, the reconstruction and recovery capital needs are estimated at: USD 134 million (20 year event), USD 268 million (50 year event) and USD 536 million (100 year event) and USD 826 million (500 year event). Budget diversion and domestic credit constitute a larger portion of reconstruction and recovery costs where approximately 66% and 33% of the costs will be financed through these means for the 50 year and 100 year events. The financing gaps are expected to increase to USD 203 million in the 100-year event and USD 463 million in the 500-year event (Figure 55).

Figure 53: Fiscal resources gap year estimate for Mauritius (CAPRA estimate)



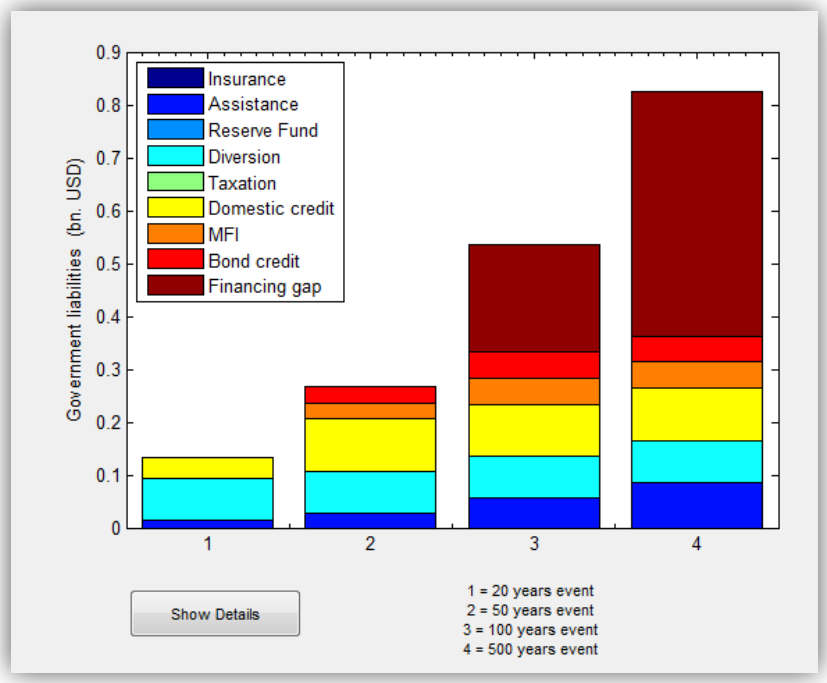
Source: Author

Figure 54: Fiscal resources gap year estimate for Mauritius (Based on Hochrainer-Stigler et.al. 2014)



Source: Author

Figure 55: Fiscal resource gap for Mauritius

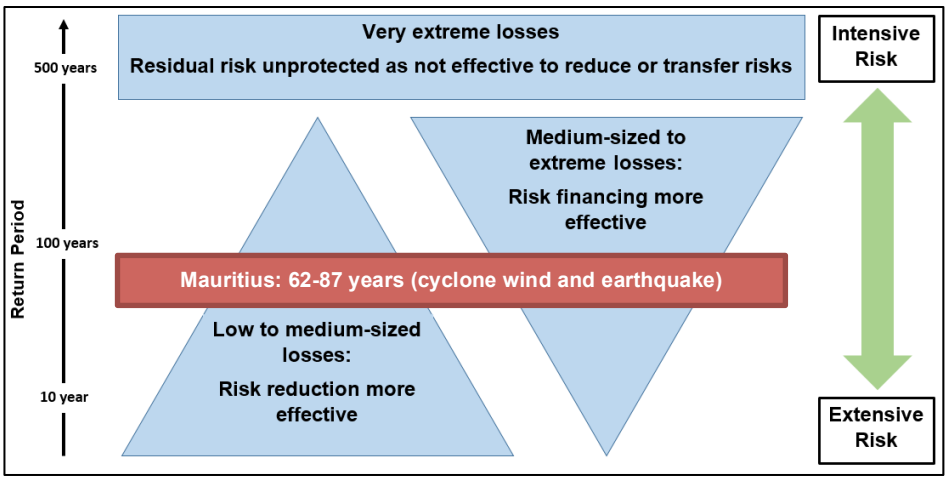


Source: Author

Conclusion: Toward risk layered approach

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 56). The CATSIM analysis conducted from Steps 1 to 3 has illustrated the need for improved management of disaster risk in Mauritius. The combination of risk reduction and risk financing will be most effective to manage fiscal risk from cyclone wind and earthquake risks. Mauritius does not have specific budget lines allocated for disaster risk reduction nor a contingency budget that can be carried-over across fiscal years, hence the establishment of a reserve fund where a certain percentage of unspent money can be used for DRR investment activities may provide good risk management strategies that can cover the mid-layer of risk.

Figure 56: Risk layering approach



Source: Author

Further challenge: Data gaps and way forward

The present study identified data gaps and sources of uncertainty regarding fiscal risk assessment. 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.

Risk assessments of additional hazards including cyclone (rain/storm surge) and floods are certainty needed to conclude on a more comprehensive assessment of fiscal risks that Mauritius faces.

Given the relatively short period of data availability, high uncertainty can be expected of catastrophic risks with return periods of above 500. It is advisable, therefore, further data collection, validation and analysis performed in an iterative fashion to reduce the range of uncertainty.

A technical and institutional support package is necessary to establish iterative risk management system in Mauritius and other IOC countries (Table 39). In terms of technical needs, knowledge regarding probabilistic risk assessment and economic assessment tools (CATSIM) would be needed along with general awareness of risk related concepts and statistics. Given the limited availability of risk experts in IOC countries, a regional approach to training and capacity building (*e.g.* regional workshop for training of trainers/ regional sharing of risk knowledge experts, etc.) may be an effective way to leverage local capacity and resources. Institutional support for iterative management should be embedded in the existing DRR/CCA policy framework of Mauritius.

It is important to discuss and update fiscal resilience parameter and value at critical time, for example, when administration changes or after disaster. Financing mechanism for disaster management (see Table 16 in Chapter 5) should be checked regularly. Defining government liability more concretely is also recommended.

Some of the important policy questions to ask in Mauritius would be:

- What is the desirable level of fiscal preparedness in the country? What would be the policy goal in mid to long-term (maintain or reduce fiscal gap etc)?
- How can you balance the need for risk reduction and risk-transfer?
- What are the priority areas of action regarding DRR in your country?
- What are tangible milestones and goals in the DRR priority areas in your country?
- What further risk assessment is needed to achieve the goals of DRR priority areas in your country?

Table 39: Identified data gaps, technical and institutional capacity needs

Data needs:	-Risk information regarding additional hazards such as flood, cyclone (rain & storm surge), drought will improve the scope of analysis -Uncertainty regarding larger return period events is high given the relatively short period of data availability (In Component 1, loss data was collected since 1980). Further data collection will improve accuracy especially for higher return period events
Technical capacity needs:	-Technical training on risk assessment and economic modeling including CAPRA and CATSIM training. -Further sensitization of risk-based thinking. General familiarity of risk based terms such as the annual average loss, the probable maximum loss, exceedance probability must be explained to decision-makers.
Institutional capacity needs:	-Coordination, where both risk and socio-economic data are jointly collected and managed by relevant agencies (DRM agency plus Ministry of Finance). -Clarity on the specification of the role of each agency in data collection and analysis to avoid the duplication of the efforts.

Source: Author

Reference

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Hochrainer-Stigler, S., Mechler, R., Pflug, G., & Williges, K. (2014). Funding public adaptation to climate-related disasters. Estimates for a global fund. *Global Environmental Change*. doi:10.1016/j.gloenvcha.2014.01.011

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Annex C: Micro / Cost-Benefit Analysis (CBA)[52]

A. Overview

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 CATSIM 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 40). 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 40: Cost benefit analysis at different scopes

Product	Objectives	Resource requirements
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.

[52] Sections A and B of this chapter were drafted by Kazuko Ishigaki (UNISDR). The Section C was drafted by Callahan Egan, Junko Mochizuki, Stefan Hochrainer and Reinhard Mechler, Risk Policy and Vulnerability Program, International Institute for Applied System Analysis (IIASA).

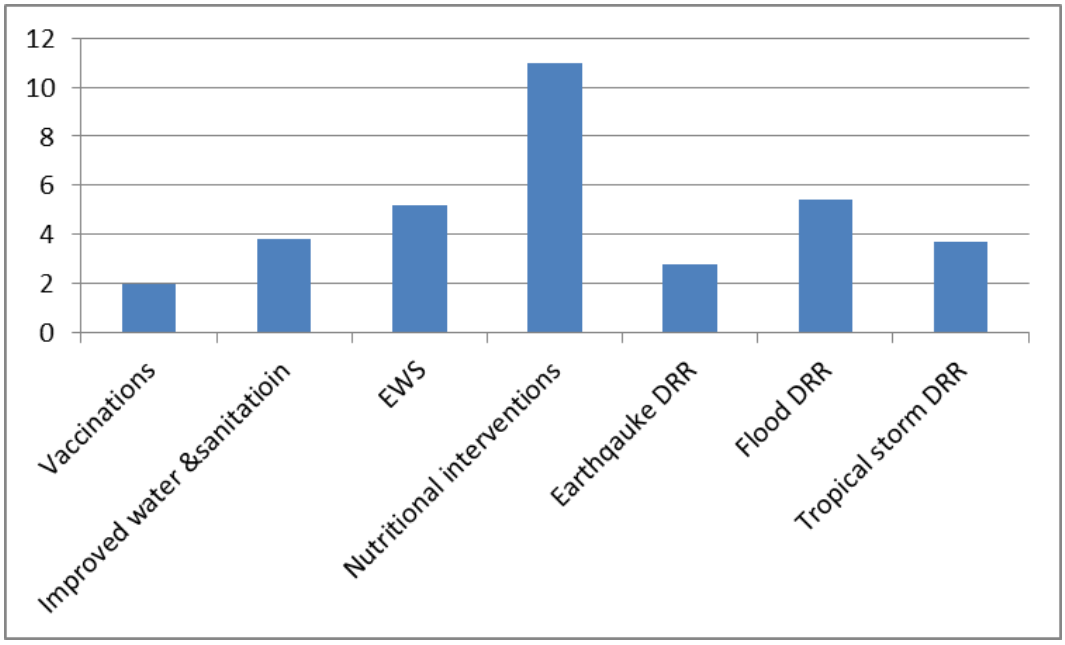
However, there are complex methodological problems that survive to date with no consensus of even modern economists (*e.g.* how to set the discount rate? How to assign monetary value to immeasurable, intangible items?). Furthermore, there are concerns regarding who conducts the CBA in order to retain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

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.

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 57 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 57: Benefit to cost ratio of DRR policies



Source: Wethli 2013 cited by the World Bank

In this initiative, probabilistic CBA was 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*?".

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 41). Now that more countries have risk profiles, more accurate forward-looking benefit estimation is increasingly possible.

Table 41: 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.

In this initiative in the IOC region, forward-looking CBA was applied for Madagascar and Mauritius and backward-looking CBA was applied for Seychelles, Union des Comores and Zanzibar.

B. Methodology of CBA

CBA generally gets through five steps (Figure 58). 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 58: 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)

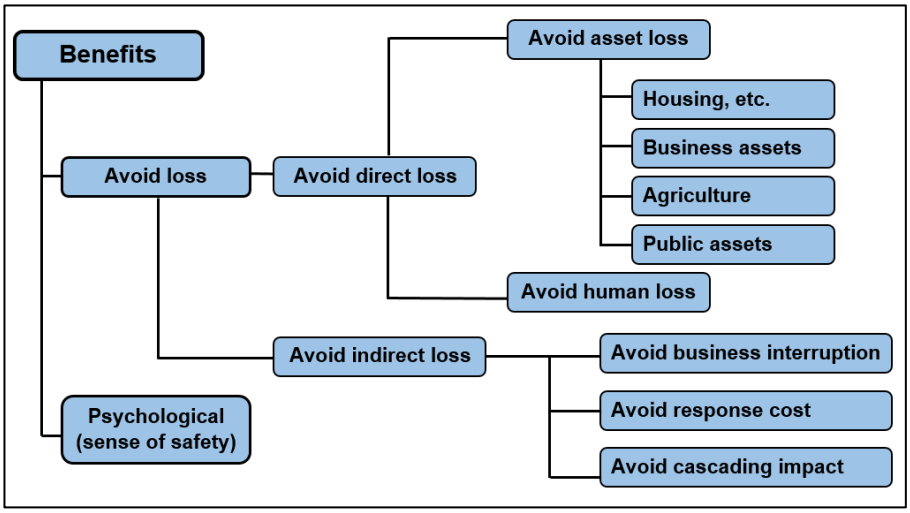
STEP 4: Sensitivity Analysis

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 59).

Figure 59: Expected benefits from DRR investment



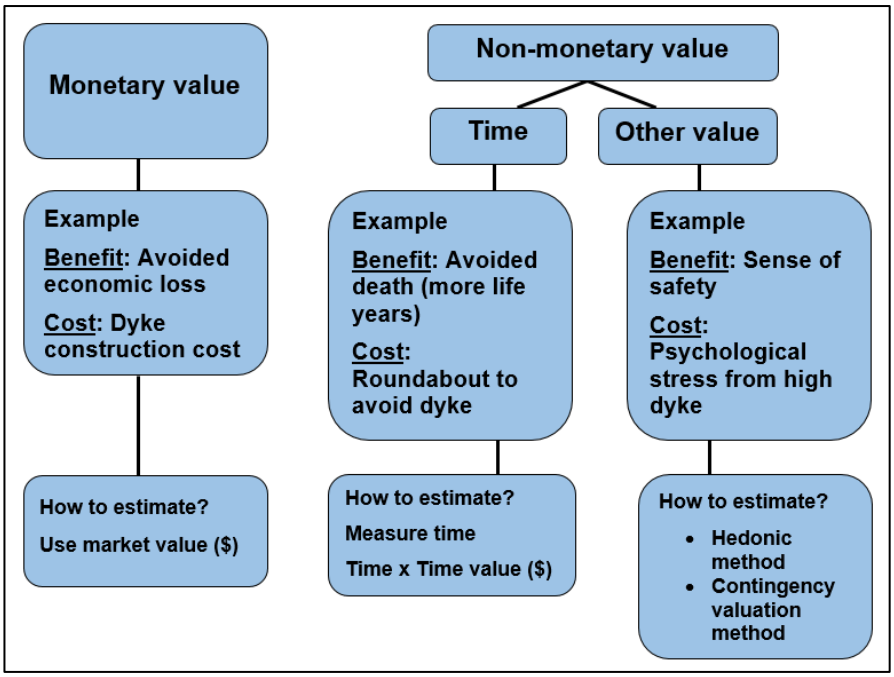
Source: Author

In estimating benefit, a main challenge is to assign monetary values to each expected benefit (Figure 60). If the benefits and costs have monetary values, the government can use them[53]. 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.

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

Figure 60: 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 61). However, this is nonetheless a meaningful first step, because physical loss often needs to be recovered by reconstruction, which is very costly.

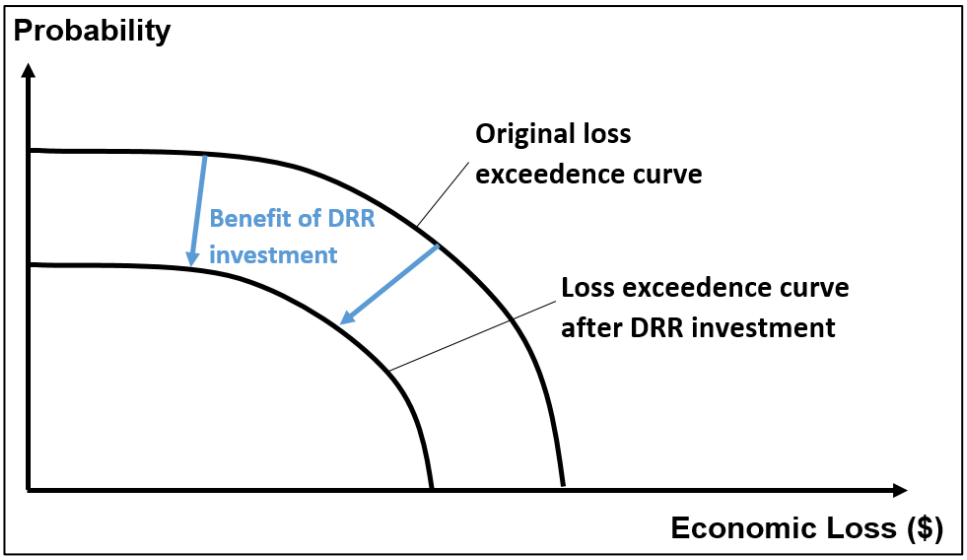
The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment (Figure 59). In case of forward-looking CBA, the data can be input into software such as CAPRA to estimate the AAL before and after investment. In case of backward-looking CBA, AAL before and after investment is calculated by using statistical methods (Simpson rule[54]).

[54] 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= (p1-p2)*((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.

Figure 61: 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[55]. 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.

In CBA for public project, social discount rates are often defined by government (Table 42). 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 42: 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

[55] 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.

EU	3.5%	Social time preference
UK	3.5%	Social time preference
France	4%	Social time preference

Source: Author based on Satoru Otani 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.

C. CASE STUDY: Housing retrofitting against cyclonic wind

I. Selection of Scenario

We estimate the net benefits of retrofitting housings of different categories against wind and cyclonic wind damage in Mauritius and compare the Benefit-Cost (B/C) ratios among several retrofitting scenarios. The general methodology for conducting cost-benefit analysis laid out by Mechler (2005) was followed. Given there is probabilistic risk assessment of cyclone wind using hazard, exposure and vulnerability information, it was decided to implement **forward-looking** probabilistic CBA.

The scenario is selected based on the availability of risk data that Component 2 produced. In Component 2, risk of cyclone (wind) scenario was estimated. We therefore selected cyclone (wind) and based on discussion with Mauritius team, we selected its impact on housings.

Housings in Mauritius fall into three categories: concrete (95%), iron or tin panel (4%), and wood (1%) as of 2011 (Republic of Mauritius, 2011). Given the large proportion of housings being made of concrete and that concrete housings are already the most wind vulnerable relative to the other housing types, we have performed CBA and sensitivity analysis on individual housings type as well as the aggregate of retrofitting all housing types to evaluate benefits to both concrete and non-concrete buildings. Assumptions of the retrofitting are described below.

II. Key Assumptions

1. Housing quality

We adopt the following assumptions for wind retrofitting:

- All housings in Mauritius are in the category “medium design quality” according to the Global assessment report 2013 (GAR, 2013)
- Retrofitting the housings would result in a shift of the housings to “high design quality”. This results in a shift in the wind vulnerability curve.

Table 43 shows the associated loss of buildings with “Medium design quality”, assumed to be present quality of housings in Mauritius. Concrete housings are fully robust against cyclones of category 2 and below with minimal damages in case of category 3 and 4 cyclones. On the other hand, iron and tin housings are identified to be highly vulnerable, with almost full destruction in case of category 3 and 4 cyclones. While the number of non-concrete housing units is small relative to one of concrete units (only 4% of land area and 3% of economic value of the entire residential sector are from non-concrete structures), retrofitting of these groups should be given a priority due to higher vulnerability.

Table 43: Mean damage percentage to housing units per type and per category of cyclone (Medium design quality)

	Category of the cyclone (wind speed range in kph)			
Type of the housing	1 (118-153)	2 (154-177)	3 (178-210)	4 (211-249)
Iron and tin housings	26	66	96	100
Wood housings	1	4	16	55
Concrete housings	0	0	1	6

Source: INGENIAR (2014)

Table 44 shows the losses associated with housing type and cyclone strength after retrofitting to meet the standards of "high design quality". These figures come from the vulnerability curves available in the GAR 2013.

Table 44: Mean damage percentage to housing units with "high design quality" according to the GAR 2013

	Category of the cyclone (wind speed range in kph)			
Type of the housing	1 (118-153)	2 (154-177)	3 (178-210)	4 (211-249)
Iron and tin housings	8	36	80	99
Wood housings	0	1	6	26
Concrete housings	0	0	1	2

Source: UNISDR, 2013

2. Retrofitting Costs

There is no readily available cost estimate of wind retrofitting options in Mauritius, thus we made rough estimates based on existing literature. Estimates from different literature suggest retrofitting typically costs anywhere from 1-20% of the housing value (Gujarat 2001; Li, Stewart, 2011, Stewart, Rosowsky, Huang, 2003; Pinelli, Torkian, Gurley, Subramanian, Hamid, 2009). This variation of cost is represented below in the sensitivity analysis. Table 45 below shows the estimated total cost of retrofitting each structure type as individually as well as aggregated cost of all three housing types based on different costs assumptions.

Table 45: Total cost of retrofitting iron, wood and concrete housings (in USD)

Cost	iron	wood	Concrete	all
3%	2,651,700	1,373,400	126,633,600	130,658,700
5%	4,419,500	2,289,000	211,056,000	217,764,500
10%	8,839,000	4,578,000	422,112,000	435,529,000
15%	13,258,500	6,867,000	633,168,000	653,293,500

Source: Author

3. Time factors

3.1 Discount rate

There has been no official social discount rate in Mauritius. Therefore, we start with an initial assumption of 5% (International Monetary Fund, 2013) but apply different rates in sensitivity analysis.

3.2 Increase in exposed assets

As the retrofitting will only strengthen existing housings in Mauritius, it is assumed that future housings built would not benefit in any way from the retrofitting. The characteristics of retrofitting policy are different from infrastructure or community project in which the benefits spread and influence external factors. Therefore it can be assumed that the benefits will remain at the values specified in Table 41 despite increase or decrease of exposed assets due to socio-economic trends.

3.3 Project span

Since retrofitting is a one-time intervention, we assume for now that there is no maintenance cost. We assume the lifetime of the retrofit to be 30 years.

III Results

1. Benefits

Benefits of retrofitting have been assessed using the CAPRA GIS risk software (CAPRA-GIS). Hazard, exposed asset, and vulnerability files were eventually obtained and run in CAPRA to determine the Annual Average Loss (AAL). The vulnerability inputs were then adjusted for residential building made of wood, iron and concrete to represent the downward shift in vulnerability after retrofitting. Since these were the only curves adjusted, the difference between AAL after adjusting the vulnerability curves and the original AAL can represent the annual benefit of retrofitting. Table 46 shows this benefit in terms of reduced AAL for retrofitting iron housing only, wood housing only, concrete housing only, and all housing types. Figure 62 shows the shift in loss-return period curves[56] representing the reduction in vulnerability as a result of the retrofitting.

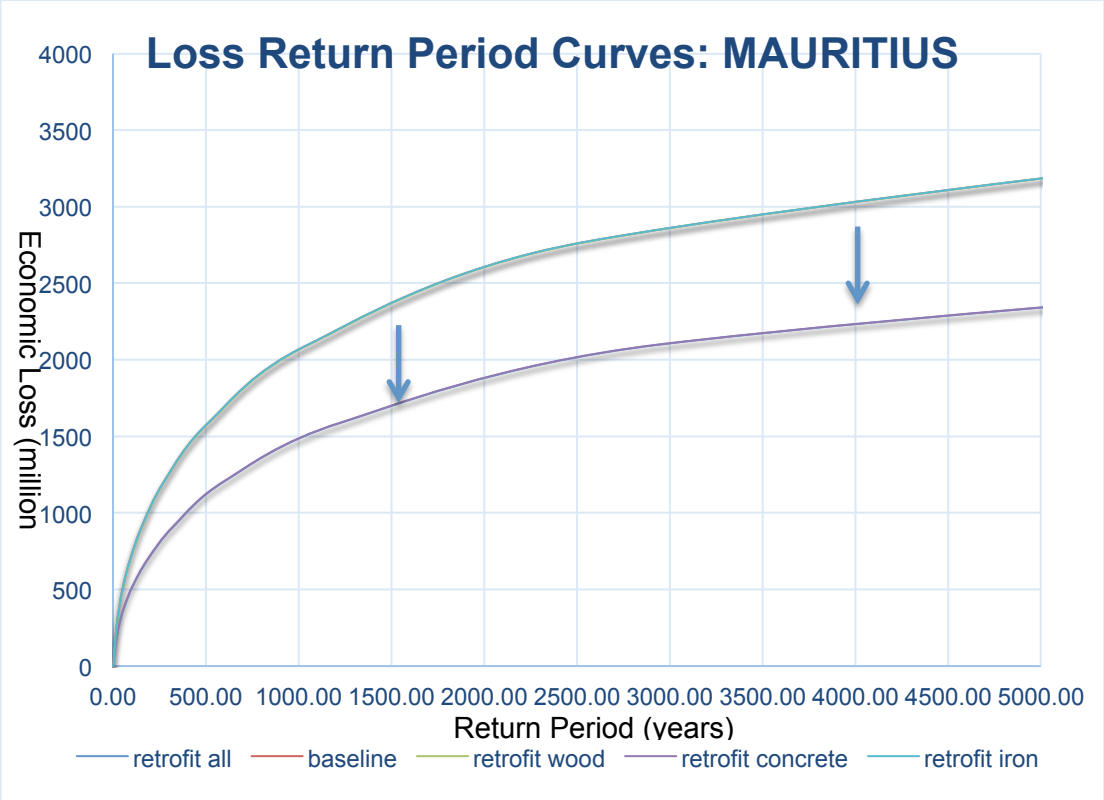
Table 46: Annual benefit of retrofitting (in USD million)

AAL pre-retrofit (AAL1)	Option of retrofitting	AAL post retrofit (AAL2)	Benefits of retrofit (AAL1-AAL2)
55.68	Iron only	54.02	1.66
	Wood only	55.09	0.59
	Concrete only	41.71	13.97
	All	39.45	16.23

Source: Author

[56] Loss return period curve is inverse presentation of loss exceedance curve.

Figure 62: Loss Return Period Curves Pre and Post Retrofitting



Source: Author

2. Net Present Value

Table 47 shows the results of the CBA for retrofitting iron housings at the cost of 10% of the housing value and a 5% discount rate. As can be seen the net present value (NPV) of the project is positive, suggesting a cost efficient project. Table 48, Table 49, Table 50, and Table 51 show the results of sensitivity analysis with regards to project cost discount rate and project lifespan.

Table 47: Cost benefit Analysis with 10% retrofit cost and 5% discount rate for Iron housings (amounts in USD)

Calendar	Project year	Benefits (no exposure increase)	Costs (10% of housing value)	Net benefits	Discounted benefits (5%)	Discounted net benefits (5%)
2013	1	0	8,839,000	-8,839,000	0	-8,839,000
2014	2	1,660,000	0	1,660,000	1,577,000	1,577,000
2015	3	1,660,000	0	1,660,000	1,498,150	1,498,150
2016	4	1,660,000	0	1,660,000	1,423,242	1,423,242
2017	5	1,660,000	0	1,660,000	1,352,080	1,352,080
2018	6	1,660,000	0	1,660000	1,284,476	1,284,476
2019	7	1,660,000	0	1,660,000	1,220,252	1,220,252
2020	8	1,660,000	0	1,660,000	1,159,239	1,159,239
2021	9	1,660,000	0	1,660,000	1,101,277	1,101,277
2022	10	1,660,000	0	1,660,000	1,046,214	1,046,214

2023	11	1,660,000	0	1,660,000	993,903	993,903
2024	12	1,660,000	0	1,660,000	944,208	944,208
2025	13	1,660,000	0	1,660,000	896,997	896,997
2026	14	1,660,000	0	1,660,000	852,147	852,147
2027	15	1,660,000	0	1,660,000	809,540	809,540
2028	16	1,660,000	0	1,660,000	769,063	769,063
2029	17	1,660,000	0	1,660,000	730,610	730,610
2030	18	1,660,000	0	1,660,000	694,079	694,079
2031	19	1,660,000	0	1,660,000	659,375	659,375
2032	20	1,660,000	0	1,660,000	626,406	626,406
2033	21	1,660,000	0	1,660,000	595,086	595,086
2034	22	1,660,000	0	1,660,000	565,332	565,332
2035	23	1,660,000	0	1,660,000	537,065	537,065
2036	24	1,660,000	0	1,660,000	510,212	510,212
2037	25	1,660,000	0	1,660,000	484,701	484,701
2038	26	1,660,000	0	1,660,000	460,466	460,466
2039	27	1,660,000	0	1,660,000	437,443	437,443
2040	28	1,660,000	0	1,660,000	415,571	415,571
2041	29	1,660,000	0	1,660,000	394,792	394,792
2042	30	1,660,000	0	1,660,000	375,052	375,052
2043	31	1,660,000	0	1,660,000	356,300	356,300
total		49,800,000	8,839,000	40,961,000	24,770,293	**15,931,293**

Table 48: CBA for retrofitting different housing types (at 10% cost and 5% discount rate) (in USD)

Option	Iron	Concrete	Wood	All
NPV	15,931,293	-213,653,567	4,225,899	-193,347,156
B/C	**2.80**	0.49	1.92	0.56

Table 49: B/C ratio: Sensitivity analysis with regards to project cost (at 5% discount rate)

Option	Iron	Concrete	Wood	All
3%	9.34	1.65	6.41	1.85
5%	5.60	0.99	3.85	1.11
10%	**2.80**	0.49	1.92	0.56
15%	1.87	0.33	1.28	0.37

Table 50: B/C ratio: Sensitivity analysis with regards to discount rate (at 10% cost)

Option	Iron	Concrete	Wood	All
0%	5.63	0.99	3.87	1.12
2%	4.18	0.74	2.87	0.83
5%	**2.80**	0.49	1.92	0.56
7%	2.21	0.39	1.52	0.44
10%	1.62	0.29	1.11	0.32
15%	1.06	0.19	0.72	0.21

Table 51: B/C ratio: Sensitivity analysis with regards to the project lifespan (at 10% cost and 5% discount rate)[57]

option	iron	concrete	wood	all
10 years	1.43	0.25	0.98	0.29
20 years	2.29	0.40	1.57	0.46
30 years	**2.80**	0.49	1.92	0.56

3. Conclusions

While the lack of locally specific cost estimates prohibits detailed analysis of wind-retrofitting interventions, a tentative conclusion suggests that retrofitting iron and wood housings is the most cost-efficient option due to the high wind vulnerability of this type of housing. While retrofitting all housings do result in substantial annual benefit of approximately USD 40 million, this option will only be cost efficient if retrofitting costs are below 5% of housing values (at 5% discount rate). Data on the specific materials and resources available in Mauritius would aid in determining a more accurate retrofit cost.

It is important to keep in mind that the present assessment did not take into account many of the indirect and intangible losses, such as loss due to business interruption and any reduction in land values that may result due to frequent disasters. These are clear limitations of this current analysis and further studies are certainly needed to improve the accuracy and comprehensiveness of our analysis.

[57] Mauritius consultant pointed out that project lifespan of over 30 years with regards to iron housings is not realistic given the short life cycle of iron sheets used for the low-income housing.

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Annex D: Workshops and Meetings in IOC region

Inception meeting

Dates: 15-17 April 2013

Venue: ICCS, Seychelles

Host: Ministry of Environment

UNISDR staff in charge: Julio Serje, Kazuko Ishigaki, Manuela Di Mauro

Participants: 34

Component 1: capacity building for national disaster loss database

Comoros national workshop:

Dates: June 11-13, 2013

Venue: Hotel Retaj

Host: the Civil Protection and the Ministry of Environment.

UNISDR staff in charge: Sylvain Ponserre and Julio Serje

Participants: 25

Seychelles national workshop:

Dates: 14 - 19 Jul 2013.

Venue: Seychelles Fishing Authority, Division of Risk and Disaster Management (DRDM)

Host: the Division of Risk and Disaster Management (DRDM)

UNISDR staff in charge: Sylvain Ponserre

Participants: 22

Madagascar national workshop:

Dates: 28 Jul - 01 Aug 2013.

Venue: Hotel Colbert

Host: The "Cellule de Prévention et Gestion des Urgences"(CPGU)

UNISDR staff in charge: Sylvain Ponserre

Participants: 36

Mauritius national workshop:

Dates: 24 - 29 Aug 2013.

Venue: Indian Ocean Commission headquarters

Host: Ministry of Environment

UNISDR staff in charge: Sylvain Ponserre

Participants: 40

Zanzibar national workshop:

Dates: 11-14 June 2013

Venue: Zanzibar Ocean View Hotel

Host: NBI Office

UNISDR staff in charge: XXXXX

Participants: 37

Component2: Capacity building for Probabilistic Risk Assessment:

First regional workshop

Dates: 21-23 October 2013

Venue: Indian Ocean Commission headquarters, Mauritius

Host: Ministry of Environment

UNISDR staff in charge: Manuela Di Mauro, Mabel Cristina Marulanda Fraume (consultant)

Participants: 40

Second regional workshop

Dates: 20-22 November 2013

Venue: Indian Ocean Commission headquarters, Mauritius

Host: Ministry of Finance

UNISDR staff in charge: Mabel Cristina Marulanda Fraume (consultant)

Participants: 22

Third regional workshop

Dates: 19-21 March 2014

Venue: Indian Ocean Commission headquarters, Mauritius

Host:

UNISDR staff in charge: Mabel Cristina Marulanda Fraume (consultant)

Participants: 31

Mauritius national workshop:

Dates: 17-18 February 2014

Venue: Indian Ocean Commission Secretariat

Host:

UNISDR staff in charge: Mabel Cristina Marulanda Fraume (consultant)

Participants: 10

Seychelles national workshop:

Dates: 23-27 June 2014

Venue:

Host: The Division of Risk and Disaster Management (DRDM)

UNISDR staff in charge: Mabel Cristina Marulanda Fraume (consultant)

Participants:

Component 3: economic analysis and public investment planning

First regional workshop

Dates: 24-26 June, 2014

Venue: ICCS, Seychelles

UNISDR staff in charge: Kazuko Ishigaki, Lezlie Moriniere (consultant)

Host: Ministry of finance

Participants: 15

Second regional workshop

Dates: 20-22, October, 2014

Venue: Indian Ocean Commission headquarters, Mauritius

Host: Ministry of Finance

UNISDR staff in charge: Kazuko Ishigaki, Lezlie Moriniere (consultant)

Participants: 19

Zanzibar national workshop:

Dates: 10 December, 2014

Venue: Zanzibar Ocean View Hotel

Host: Department of Environment

UNISDR staff in charge: Kazuko Ishigaki, Lezlie Morinière (consultant)

Participants: 30

Seychelles national workshop:

Dates: 02-03 Feb 2015
Venue: Conference Center
Host: Ministry of Finance
UNISDR staff in charge: Kazuko Ishigaki, Julio Serje, Lezlie Moriniere (consultant)
Participants: 30

Comoros national workshop:

Dates: 05-06 Feb 2015

Venue: Direction générale de la Sécurité Civile

Host: Direction générale de la sécurité civile

UNISDR staff in charge: Julio Serje, Lezlie Morinière (consultant)

Participants:55

Madagascar national workshop:

Dates: 28-30 Feb 2015

Venue: STC

Host: Ministry of Finance

UNISDR staff in charge: Kazuko Ishigaki, Lezlie Morinière (consultant)

Participants: 30

Mauritius national workshop:

Dates: tbc

Venue: tbc

Host: tbc

UNISDR staff in charge: tbc

Participants: tbc

UNISDR Working Papers on
Public Investment Planning and Financing Strategy for Disaster Risk Reduction

1. Public Investment Planning and Financing Strategy to Reduce and Mange Disaster Risk: Review of Mauritius, February 2015

2. Public Investment Planning and Financing Strategy to Reduce and Mange Disaster Risk: Review of Madagascar, February 2015

3. Public Investment Planning and Financing Strategy to Reduce and Mange Disaster Risk: Review of Seychelles, February 2015

4. Public Investment Planning and Financing Strategy to Reduce and Mange Disaster Risk: Review of Union des Comores, February 2015

5. Public Investment Planning and Financing Strategy to Reduce and Mange Disaster Risk: Review of Zanzibar, February 2015

6. Public Investment Planning and Financing Strategy to Reduce and Mange Disaster Risk: Review of South-West Indian Ocean Region, February 2015

The series offers analysis and policy guidance to national governments and other stakeholders to strengthen public investment planning and financing strategy to reduce and manage disaster risk. These reviews are part of a larger body of UNISDR work on disaster risk reduction, including loss database building, global probabilistic risk assessment, HFA Monitor and others. This work includes both theoretical reports and reports on specific countries or regions.

Contents:

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