Review of Madagascar

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

February 2015

UNISDR
The United Nations Office for Disaster Risk Reduction

Please cite this paper as:
UNISDR Working Papers on Public Investment Planning and Financing Strategy for Disaster Risk Reduction: Review of Madagascar, 2015, UNISDR. Geneva.

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Public Investment Planning and Financing Strategy
for Disaster Risk Reduction

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UNISDR Working Papers on
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.

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List of Acronyms

AAL	Annual Average Loss
CAPRA	Comprehensive Approach for Probabilistic Risk Assessment
CATSIM	CATastrophe SIMulation
CBA	Cost Benefit Analysis
CCA	Climate Change Adaptation
CPGU	Cellule de Prévention et Gestion des Urgences
DRM	Disaster Risk Management
DRR	Disaster risk Reduction
EIA	Environmental Impact Assessment
EU	European Union
GAR	Global Assessment Report on Disaster Risk Reduction
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
HFA	Hyogo Framework for Action
ICT	Information and Communication Technologies
IIASA	International Institute for Applied System Analysis
IMF	International Monetary Fund
IOC	Indian Ocean Commission
NGO	Non-Governmental Organization
NPV	Net Present Value
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

Acknowledgements

This report was produced by the United Nations Office for Disaster Risk Reduction (UNISDR) in co-operation with the Ministry of Finance and Budget and the Indian Ocean Commission (IOC) under the "ISLANDS programme for Financial Protection against Climatic and Natural Disasters". Special thanks are given to Mr. Rakotomanana Andrianaivo Régis, the Chief of the Macroeconomic Framework Department of the Ministry of Finance and Budget of Madagascar, Mr. Christophe Legrand and Mr. Philippe Boulle from IOC as well as to national teams' members from the different ministries involved.

This report was mainly drafted by Mr. André Pierre Lazamanana, consultant in Madagascar, and by Ms. Kazuko Ishigaki (UNISDR) who also coordinated the overall development of this report. Substantial help to the drafting process (especially Annex A) was provided by Ms. Lezlie Moriniere. Annexes B and C were drafted by Ms. Junko Mochizuki, Mr. Stefan Hochrainer, Mr Reinhard Mechler, Mr. Keith Williges (Annex B only) and Callahan Egan (Annex C only) of International Institute for Applied Systems Analysis (IIASA). Many valuable inputs were received from Mr. Sylvain Ponserre from UNISDR (disaster loss of Chapter 2) and Ms. Mabel Cristina Marulanda Fraume from UNISDR (disaster risk of Chapter 3). The overall project including organizing a series of workshops was coordinated by Mr. Julio Serje (UNISDR). Ms. Lezlie Moriniere edited the publication.

UNISDR is grateful to the European Commission (Directorate-General for Development and Cooperation) for its financial contributions.

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 (Component 1), a total of 1,378 data cards on disaster events and losses between 1980 and 2013 were registered in the national disaster loss databases. Economic loss totalled USD 8.8 billion (2012 constant price). Intensive cyclones contribute 85% of the total economic loss. If extensive and intensive cases are combined, 93% of economic loss was due to cyclones. In the following probabilistic risk analysis (Component 2), Average Annual Loss (AAL) for tropical cyclonic wind was estimated at USD 73.4 million, with a Probable Maximum Loss (PML) of USD 436 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 to be 24 years. This corresponds to the extensive risk layers (*i.e.* small-mid scale with high frequency) and means that Madagascar must prioritize risk reduction investment more than risk financing mechanism.

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 wood housings is the most cost-efficient option compared to the scenarios of retrofitting UM (semi-solid and solid) housings and retrofitting both wood and UM types. 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 24 million.

Based on these findings, current Disaster Risk Management (DRM) policy in Madagascar and especially public finance including DRR investment and risk financing mechanisms were examined. In spite of much progress in HFA implementation, no definite and systematic DRR investment policy exists in Madagascar. Several sectoral ministries make risk sensitive investment implicitly. Cost benefit analysis is not required in the budget request process and if implemented, does not take disasters risk into consideration. Critical infrastructure is not sufficiently protected against disaster risk. Contingency financing mechanisms are also under-developed. For example, Contingency Fund was totally depleted and not replenished.

To explore the financial aspects of DRM policy, Madagascar 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 1.9% of the capital budget (2010-14) was estimated to be invested in DRM. This corresponds to approximately USD 26.2 million on average. While the proportion invested in DRR (56% of total DRM budget averaged over the five years) is roughly equivalent to disaster management (44%), scrutiny reveals the highest investment is still attributed to disaster relief (5 year average of 36.3% compared to 20.2% for prevention/mitigation or 7.7% for reconstruction). This suggests the focus of DRM project in Madagascar is response and preparedness, and the country is dominated by paradigm of disaster management. Compared to AAL, this investment was negative balance (lower investment than expected loss each studied year), but Madagascar identified that budgets need to be linked to specific hazard (in this case tropical cyclone) for this

[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.

analysis to be more meaningful. A large part of the total budget is identified as “Principal” (DRR stand-alone programme/project).

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 Seychelles[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.

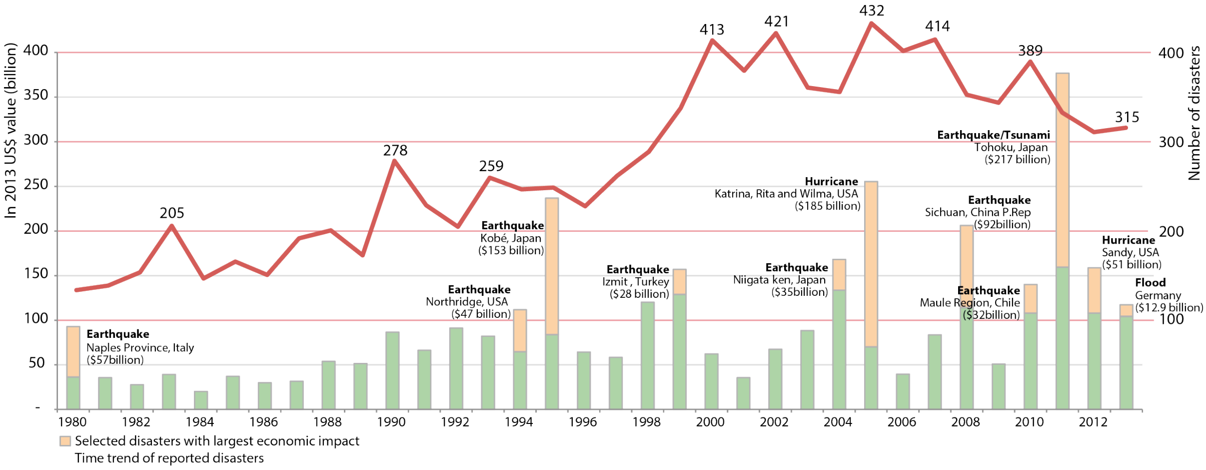
In this introductory chapter, the background, especially why we need risk-sensitive public investment, is explained. Then, the overall streamlined process from loss data analysis through probabilistic risk assessment into economic analysis is explained. Lastly basic concepts of economic loss are defined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

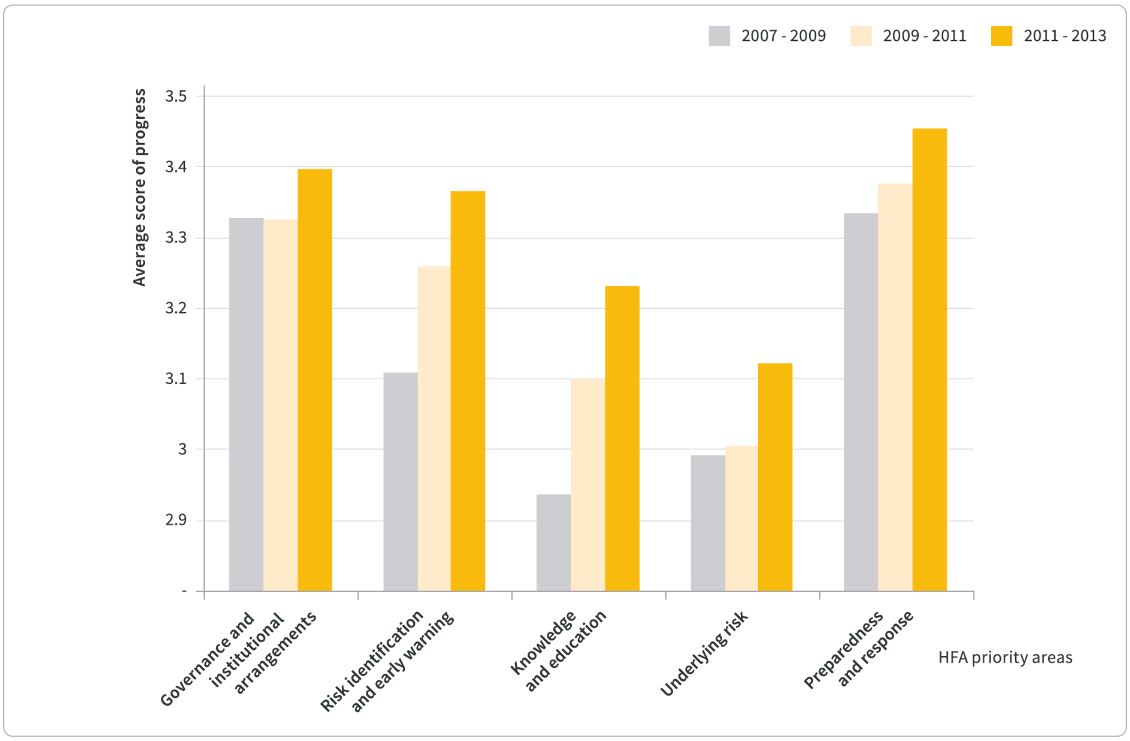
Why do we need to promote risk-sensitive public investment? First of all, economic loss due to disasters has been increasing in spite of substantial progress in DRR policies promoted by Hyogo Framework of Action (HFA) (Figure 1 and **Figure 2**). HFA priorities have been progressing in all areas mainly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

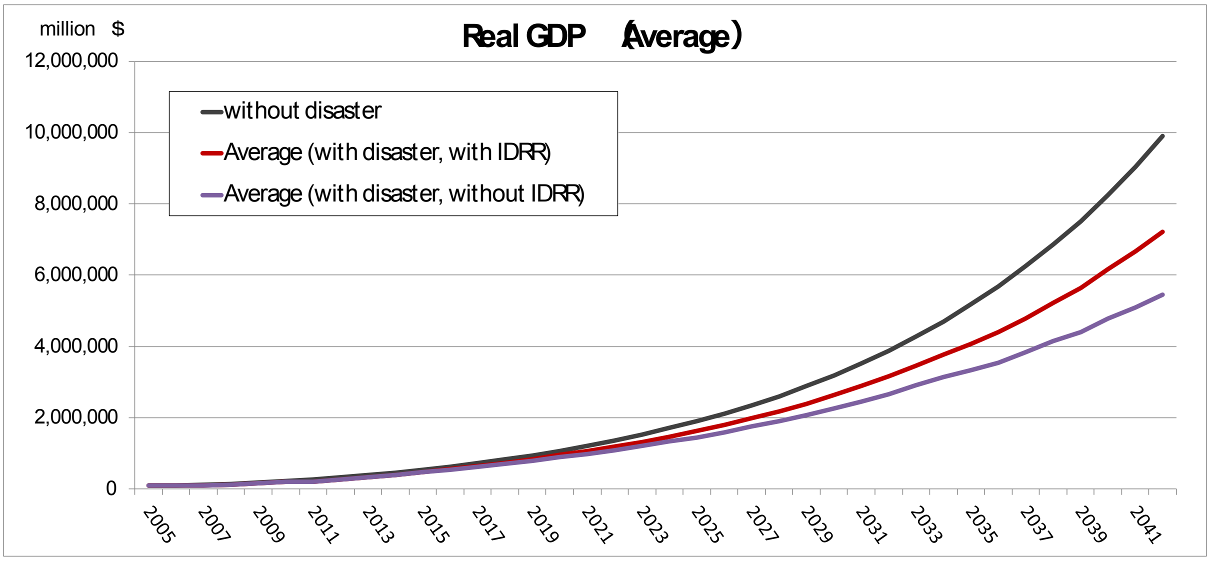
Figure 2: HFA Progress



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.

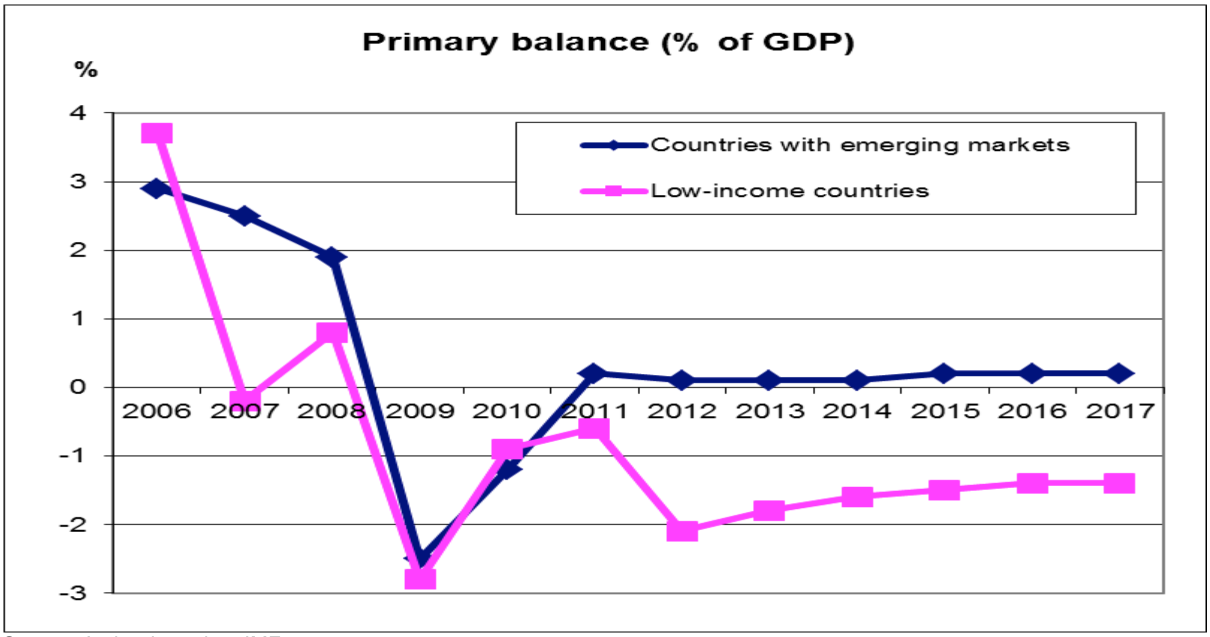
Figure 3: Pakistan GDP estimate, 2005-2041



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]

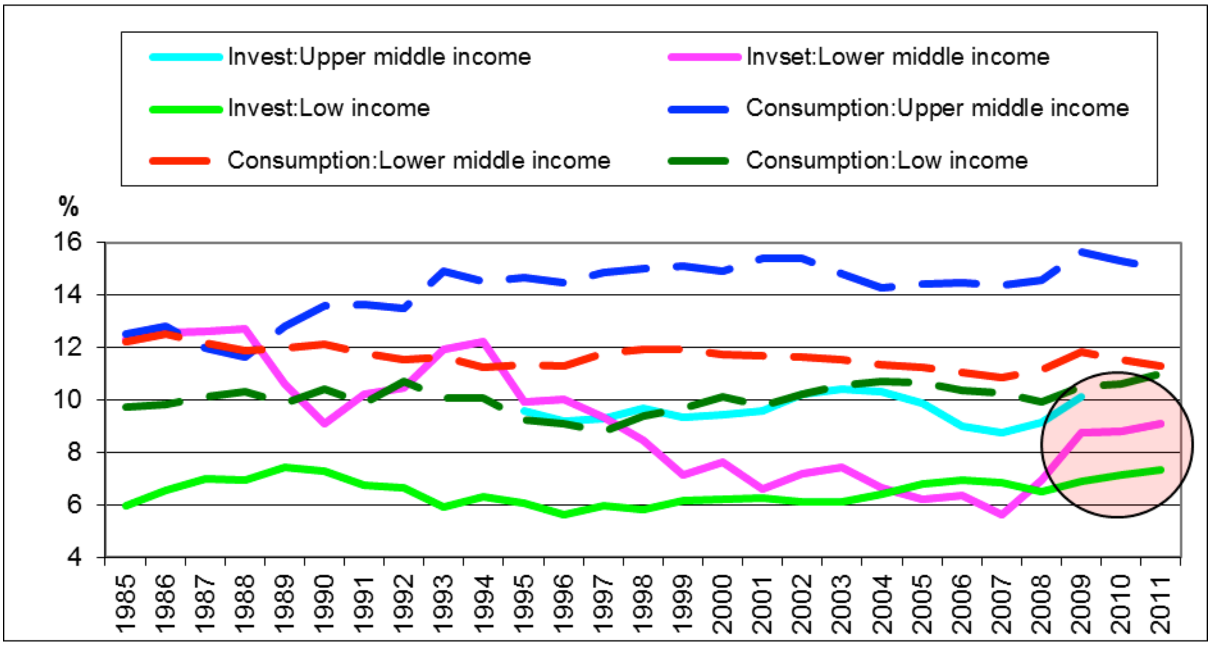


Source: Author based on IMF

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.

[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/.

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]).

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

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

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.

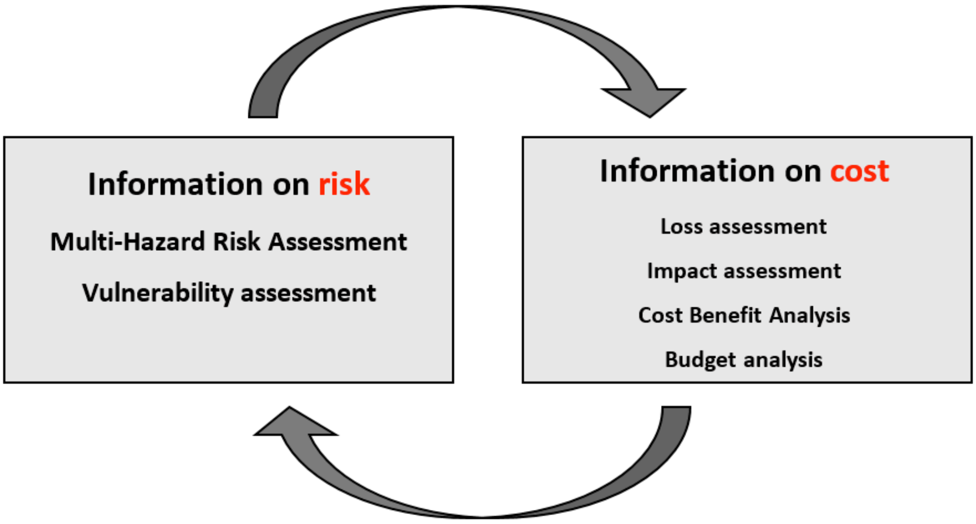
In case of catastrophe, horizontal risk transfer mechanisms such as insurance may often not be sufficient. DRR investment is, unlike risk transfer mechanism, considered inter-generational risk sharing. Following the definition of sustainable development by the Bruntland Committee, only development that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

[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 in order to invest in DRR? In other words, risk needs to be examined through a socio-economic lens in each country.

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

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

[8] HFA Report of Nepal, 20xx

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.

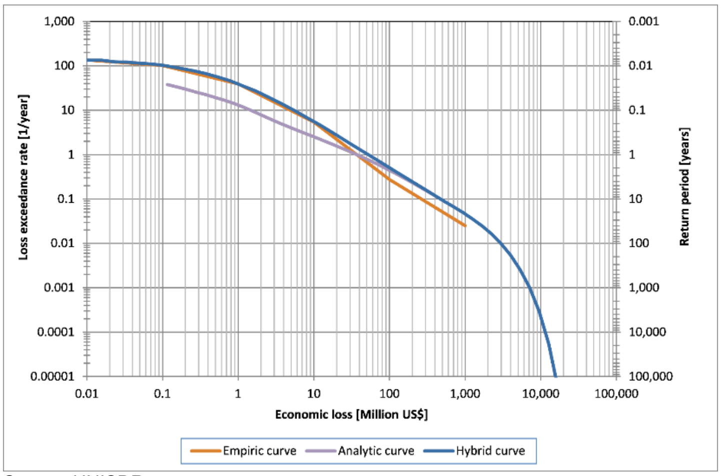
Figure 7: Overall design to support evidence based decision making

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.

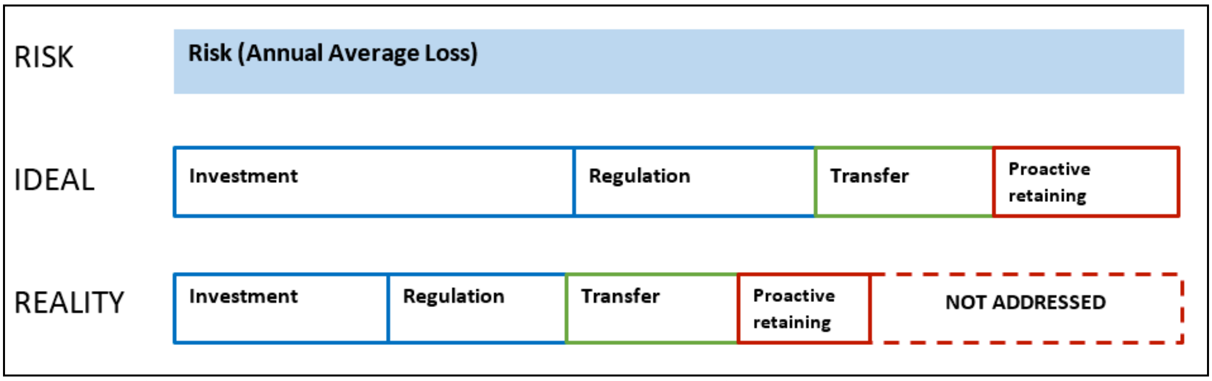
Figure 8: Hybrid loss exceedance curve



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

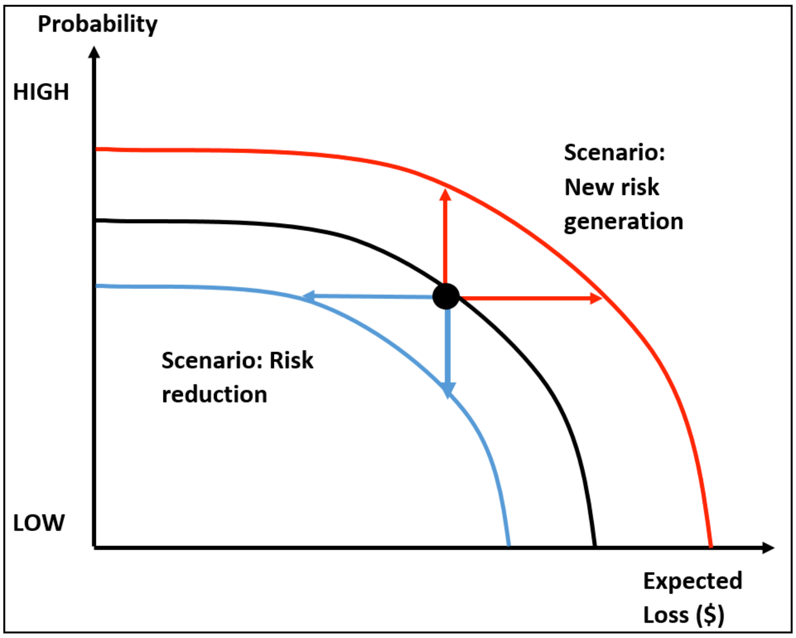


Note: Impact of investment usually lasts for certain project periods and therefore reduces AAL the following year.
Source: Author

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).

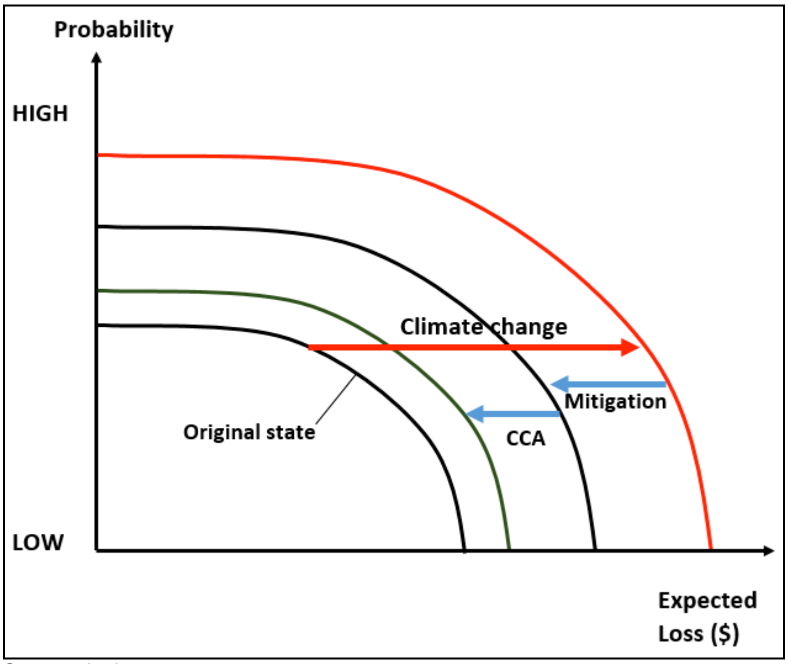
Figure 10: Shift of loss exceedance curve by DRR investment (blue) and new risk generation (red)



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 11. 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.

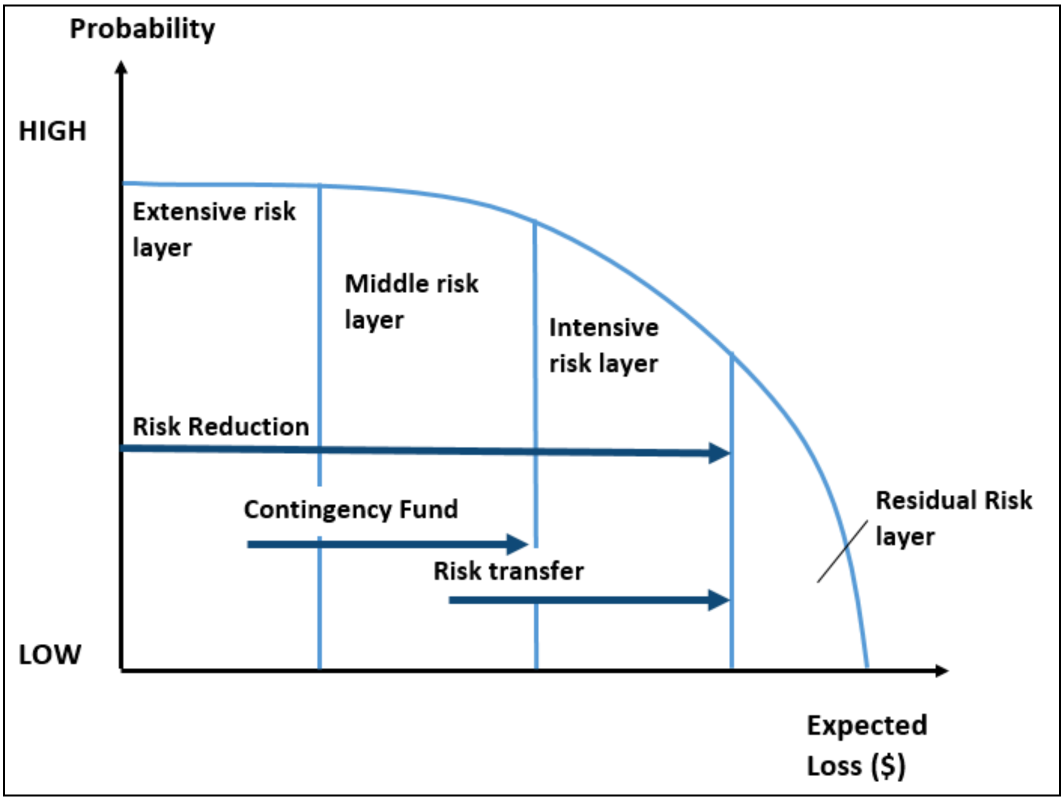
Figure 11: Climate change impact



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) all risk layers. However, in the intensive layer (low probability and high expected loss), risk reduction is often an unaffordable and prohibitive option. Regarding risk financing, contingency funds will be effective in middle risk layers. However, to prepare for intensive risk, risk transfer schemes, such as insurance, would be more cost-efficient. It is important to note that DRR efforts 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

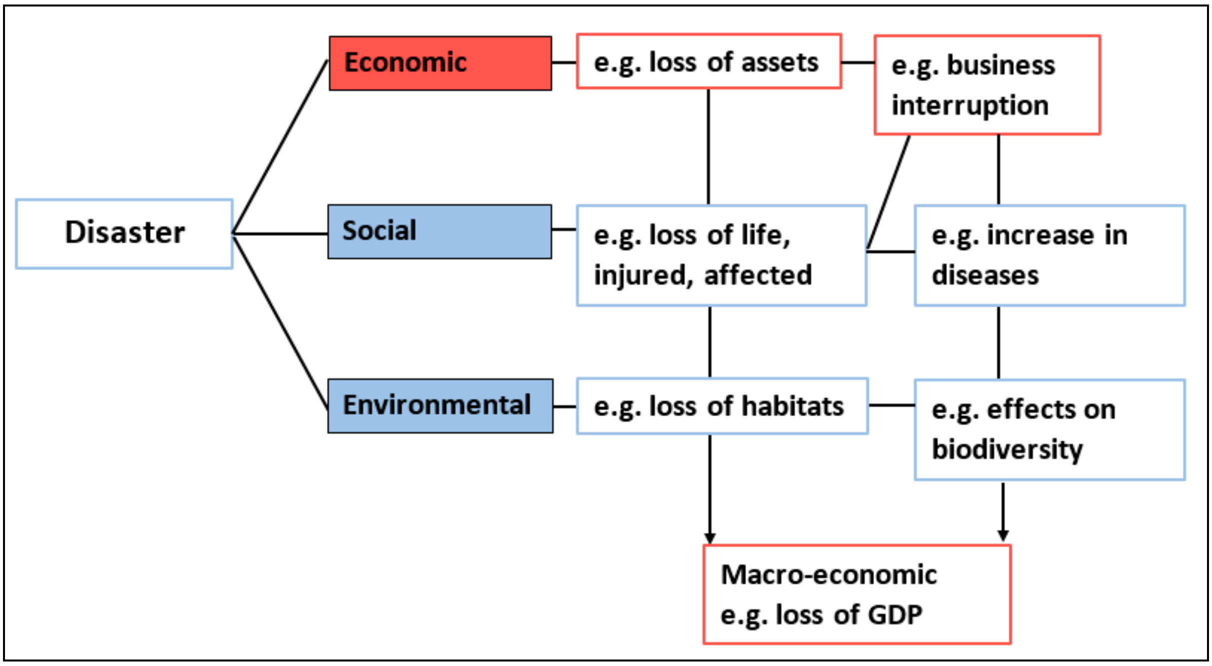


Source: Author

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

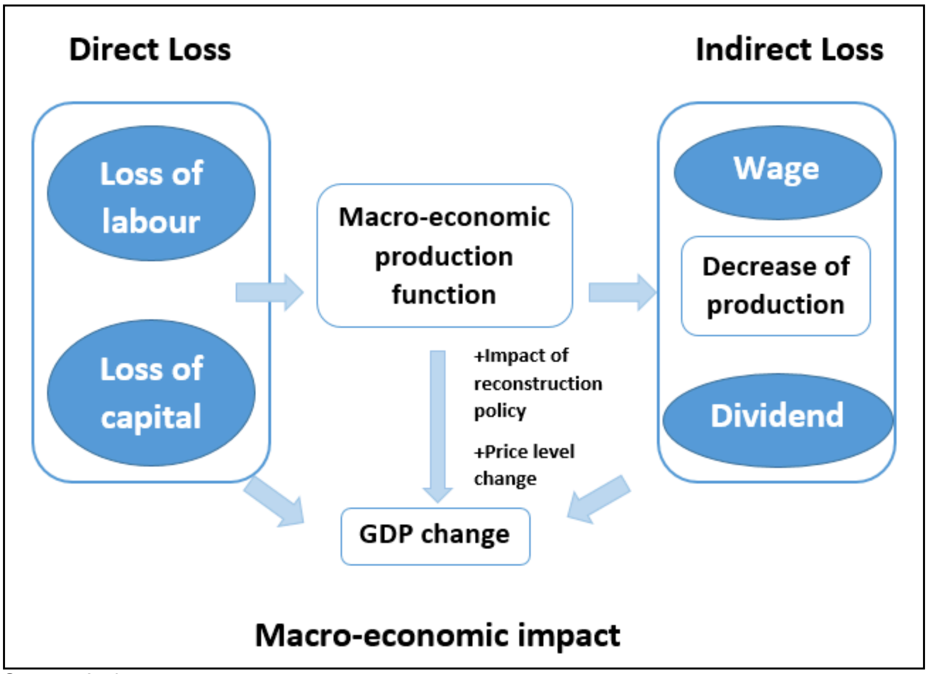


Source: Author

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 should be estimated as purchased value, book value[10] or replacement cost[11][12]?

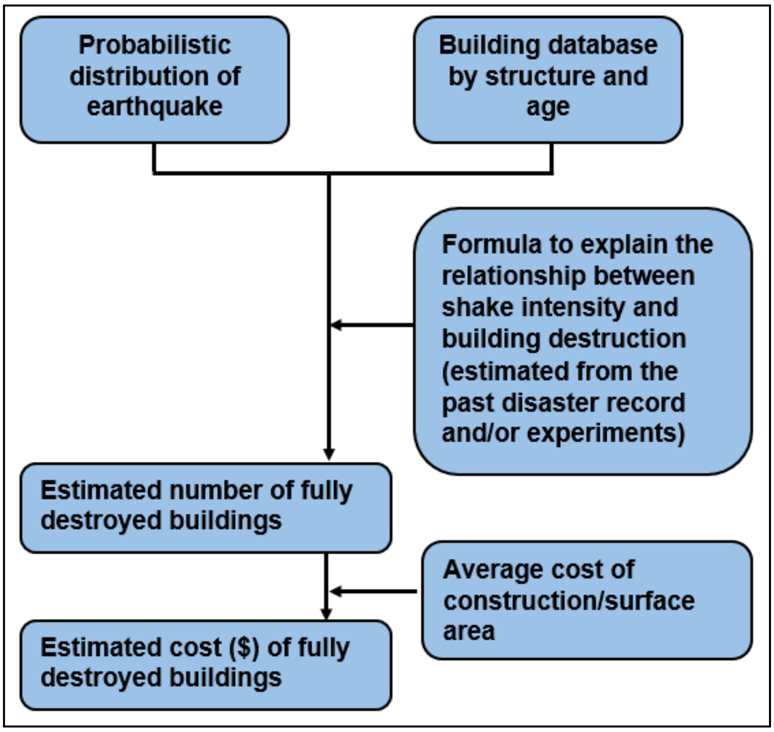
There is another important issue in measuring direct loss; "How to evaluate human loss?" There are some methodologies, for example, that evaluate human loss as lost income. However, this remains an on-going debate among economists because assigning monetary value to human life is an ethical issue, considered 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

[10] Book value means the current value of the asset on accounting book taking depreciation into consideration.
[11] Replacement cost can be cheaper than the price at which the asset was purchased. For example IT machines usually have become much cheaper during this decade. In this case, loss reported using purchased price means overestimation of the loss.
[12] 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.

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[13].

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[14]).

Figure 15: impact of earthquake on building



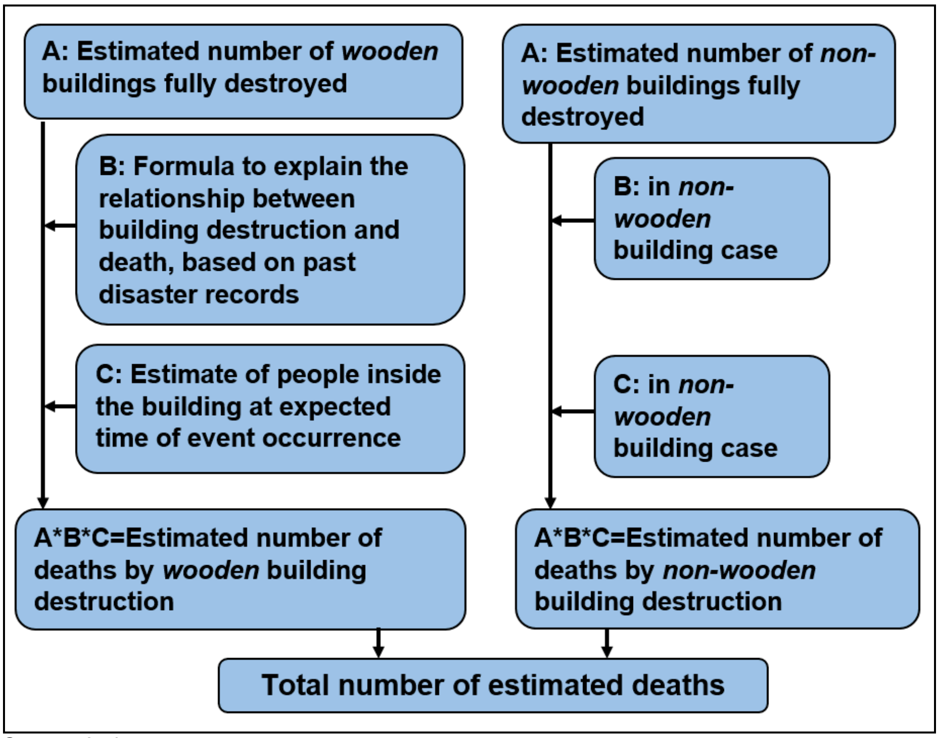
Source: Author

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).

[13] 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.

[14] 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[15]. Though these indirect losses might be seemingly measurable, it is difficult to isolate the impact of disaster from others, for example, global financial crisis[16]. 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, which can be positive or negative, for example, human suffering (negative) or increased sense of mutual help (positive). 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[17]. High interest rates will bring private investment demand down. Reconstruction activity through public spending might produce effective demand for depressed economy but might crowd out private investment in growing economy. To estimate macro-economic impact, it is important to model the causal relationship of all these factors. Macro-economic impacts such as GDP, inflation and trade balances will often persist for several years and should also be monitored over time. They are conventionally estimated within maximum of five years after disaster events.

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

[15] Decrease of production will impact the wage level and dividend level.
[16] 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.
[17] 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.

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

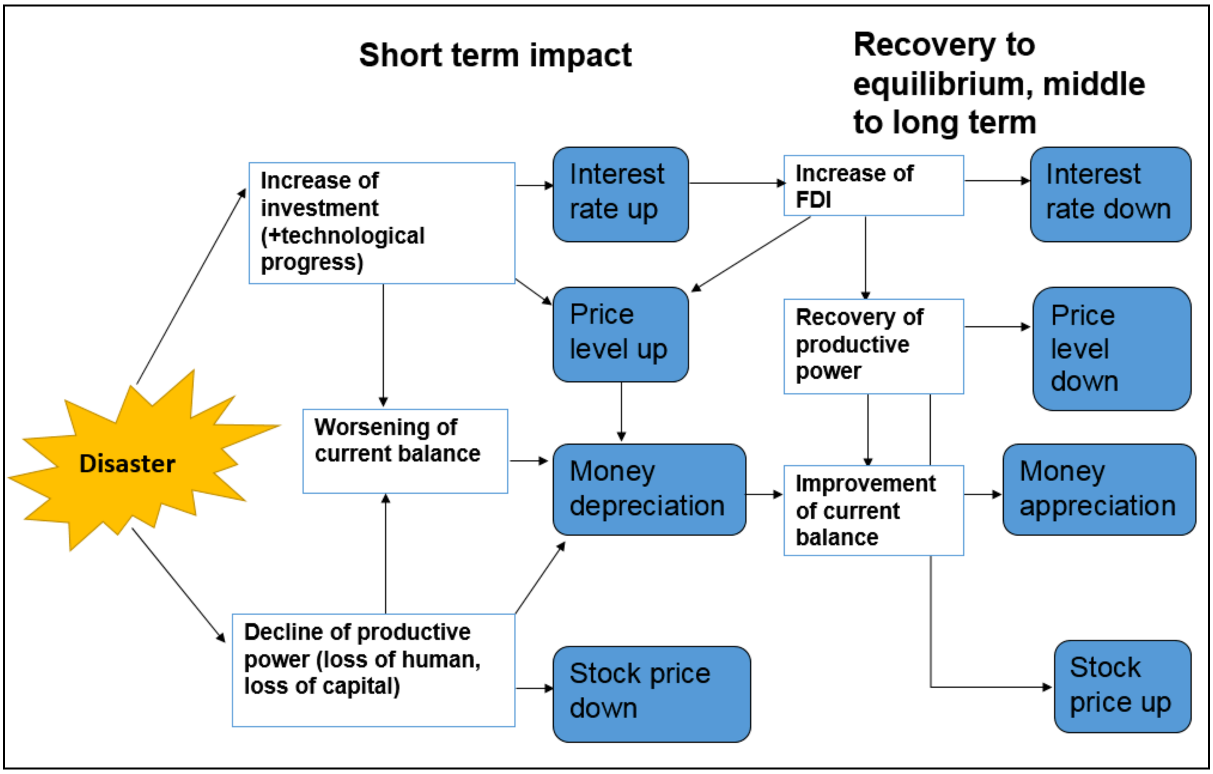
In analysing macro-economic impact, it is very important to analyse the impact from supply and demand sides and short and long-term perspective (Table 3). From supply side, decrease of production due to capital loss can be observed as a negative impact in the short term. However, in the long term, replaced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

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

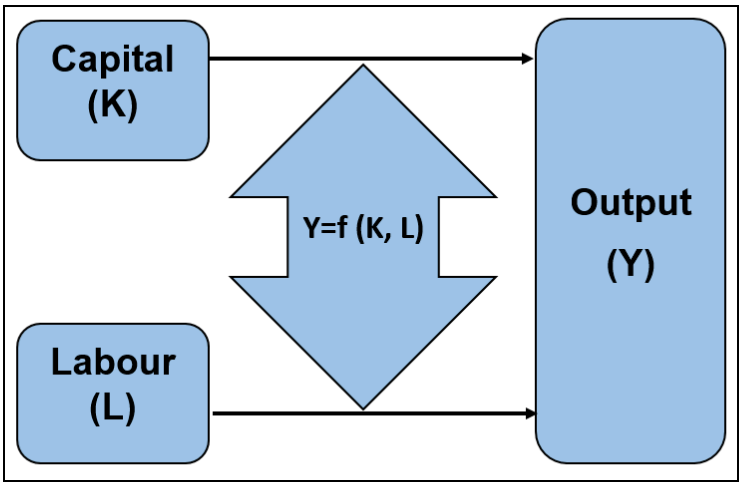
Figure 17: Example of economic modelling



Source: Author

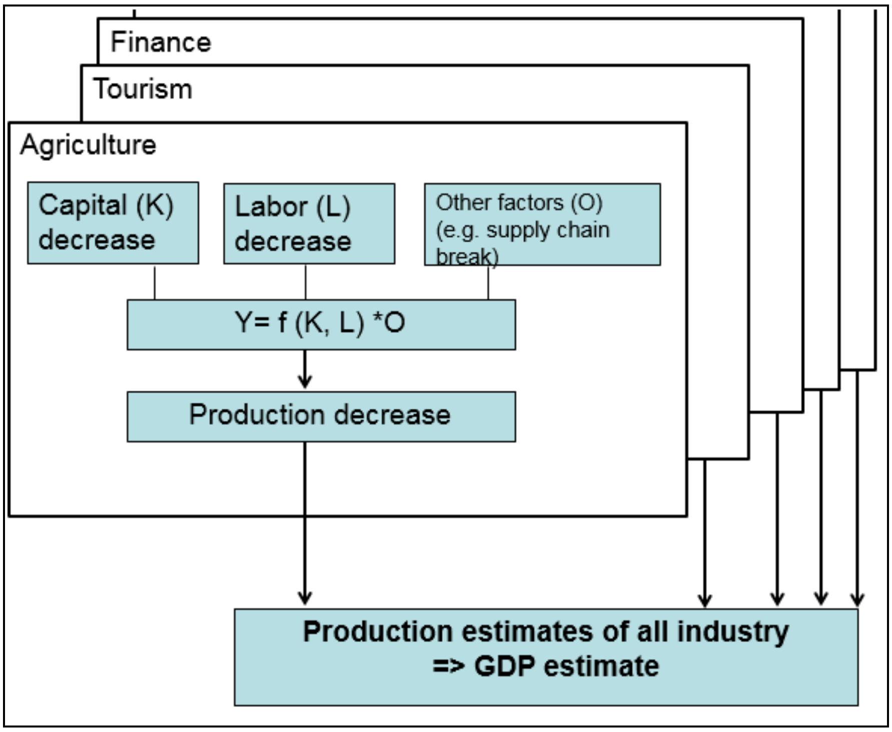
When macro-economic modelling is not available or a more micro-level approach is more practical, a sectoral-based approach might be preferable. The essence of estimating economic impact is in how disasters impact labour and capital --the two most important factors for economic growth (Figure 18). If 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).

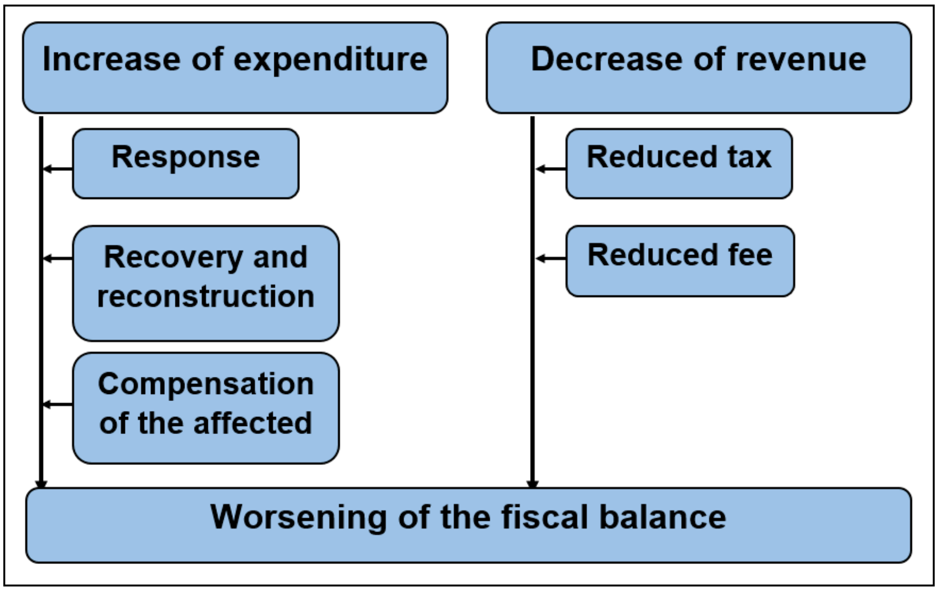
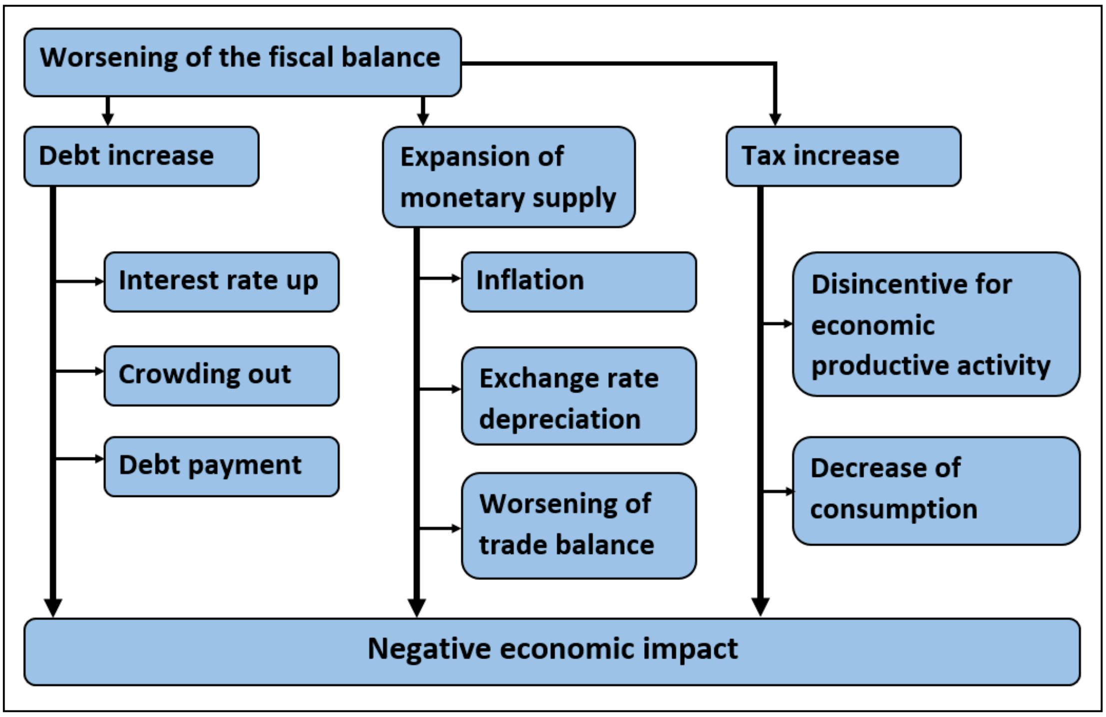


Figure 20: Fiscal impact of disasters

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[18]

Madagascar is an island country, located in the canal of Mozambique, in the South Western Indian Ocean area. Madagascar is the fourth largest island in the world with a total area of 587,040 square kilometres including the several peripheral little islands. It has a narrow coastal plain with a hot tropical climate, a range of temperate mountains and plateaus in the centre of the country and a narrow strip of rainforests on the eastern flank. The island has 4,828 square kilometres of coastline, and spans 1,500 km long and is around 500 km wide (Figure 22).

Figure 22: Map of Madagascar

Source: http://www.lib.utexas.edu/maps/africa/madagascar_physio-2003.pdf

A. Population

The population is estimated at 22.3 million of whom 22% live in urban areas (Table 3). Population density is relatively low with 35 people per square kilometre. In order of prominence, the main religions in Madagascar are Christian, Animism, and Islam.

The annual growth rate of population remains high reaching 2.7% in average during the last five years. The level of the life expectancy at birth could demonstrate underdevelopment because this parameter is 62.4 years for men and 65.3 years for women. The country is divided into twenty-two (22) regions. The most populated region is Analamanga where the capital city Antananarivo is located. Ihorombe is the region with the lowest population which is around 289 900 in 2012 (Table 4).

[18] This chapter was drafted by Pierre Lazamanana.

Table 4: Demographic Indicators for Madagascar

Population	
	Total 22.3 m (2012)
	Urban 22% (of total pop)
Population density (Pop/km2)	35
Literacy (2012)	
	Total 64.48 [%, > 15 years old]
	Men 67.41 [%, > 15 years old]
	Women 61.64 [%, > 15 years old]
Workforce (2012)	
	Agriculture 80.3 (% of total pop.)
	Industry 4.6 (% of total pop.)
	Services 15.1 (% of total pop.)
Life expectancy at birth (in years) (2012)	
	Total 63.8
	Men 62.4
	Women 65.3

Source: World Bank Development Indicator (http://data.worldbank.org/indicator/)

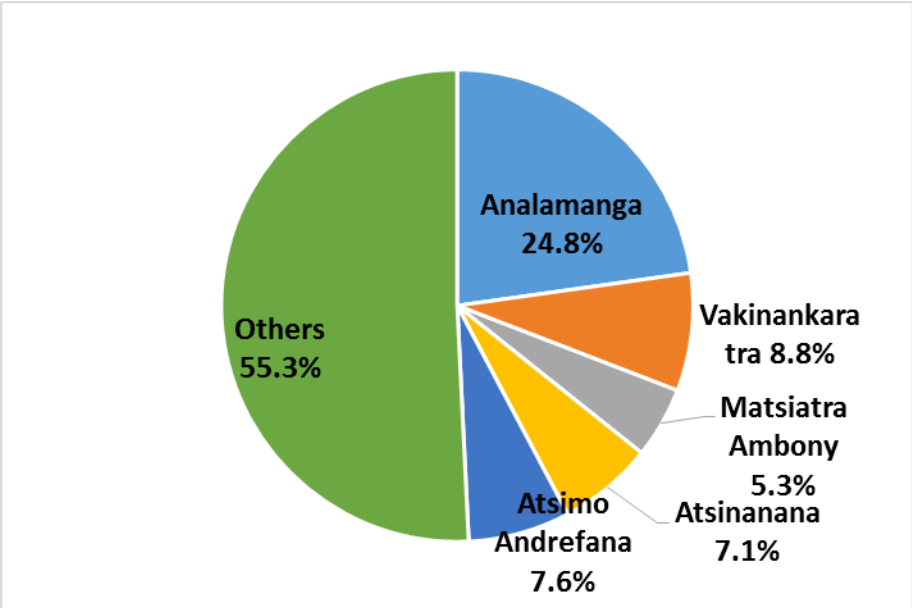
Table 5: Distribution of Population, 2012

Region	Population	Region	Population
Analamanga	2 720 600	AlaotraMangoro	1 115 000
Vakinankaratra	1 828 600	Boeny	758 200
Itasy	869 700	Sofia	1 226 500
Bongolava	490 600	Betsiboka	401 400
MatsiatraAmbony	1 315 700	Melaky	312 200
Amoron'i Mania	713 600	AtsimoAndrefana	1 471 800
VatovavyFitovinany	1 471 800	Androy	914 300
Ihorombe	289 900	Anosy	691 300
AtsimoAtsinanana	847 400	Menabe	669 000
Atsinanana	1 338 000	Diana	579 800
Analanjirofo	1 070 400	Sava	1 204 200
Total	22 300 000		

Source: National Institute of Statistics of Madagascar, 2012

The 22 administrative regions in Madagascar do not have the same size and they present varying social patterns and structures. The distribution of population by region in Madagascar, for example, is shown in Table 6 below.

Table 6: Distribution of urban population by region in Madagascar



Note: All provinces that have less than 5% of urban population are included in “Others”.
Source: National Institute of Statistics of Madagascar, 2010.

B. Political Structures

Madagascar obtained its independence from France in 26th June 1960. The new government in 2015 led by President Hery RAJAONARIMAMPIANINA and the Prime Minister KOLO Roger, has thirty-one ministries, listed in Table 7. The form of the government is a semi-presidential republic government. The popularly elected fixed term president exists alongside Prime Minister and Cabinet (who are proposed by the Parliament and named by the President according to the Constitution), responsible to the legislature. As far as the Legislature is concerned, the Parliament has two Houses, the Upper house Senate and the Lower house National Assembly.

Public institutions such as the Presidency of the Republic of Madagascar, the Constitutional High Court, the Prime Minister's Office and the Malagasy Reconciliation Council, play an important role in maintaining political stability in the country.

Table 7: Ministries in Madagascar

N°	Ministries	N°	Ministries
1	Ministry of Foreign Affairs	17	Ministry of Environment, Ecology and Forests
2	Ministry of National Defense	18	Ministry of Energy
3	Government Secretary of Constabulary	19	Ministry of Water
4	Ministry of Domestic Affairs and Decentralization	20	Ministry close to the Presidency of the Strategic Resources
5	Ministry of Public Security	21	Ministry of Public Works
6	Ministry of Justice	22	Ministry of Infrastructure, Equipment and territorial Planning
7	Ministry of Finances and Budget	23	Ministry of Transport and Meteorology
8	Ministry of Economy and Planning	24	Ministry of Post Office, Telecommunications and New Technologies
9	Ministry of Civil Service, Labour and Social Laws	25	Ministry of Public Health
10	Ministry of Industry, Development of the Private Sector and Small and Medium Sized Businesses	26	Ministry of Youth and Sports
11	Ministry of Tourism	27	Ministry of Population, Social Protection and Women Promotion
12	Ministry of Trade and Consumption	28	Ministry of National Education
13	Ministry of Communication, Information and Relations with Institutions	29	Ministry of Employment, Technical Education and Vocational Training
14	Ministry of Agriculture and Rural Development	30	Ministry of High Education and Scientific Research
15	Ministry of Livestock and Animal Protection	31	Ministry of Handicraft, Arts and Patrimony
16	Ministry of Halieutic Resources and Fisheries		

Source: Organic Law of Finance/2014 (www.mfb.gov.mg/)

C. Economic Structures

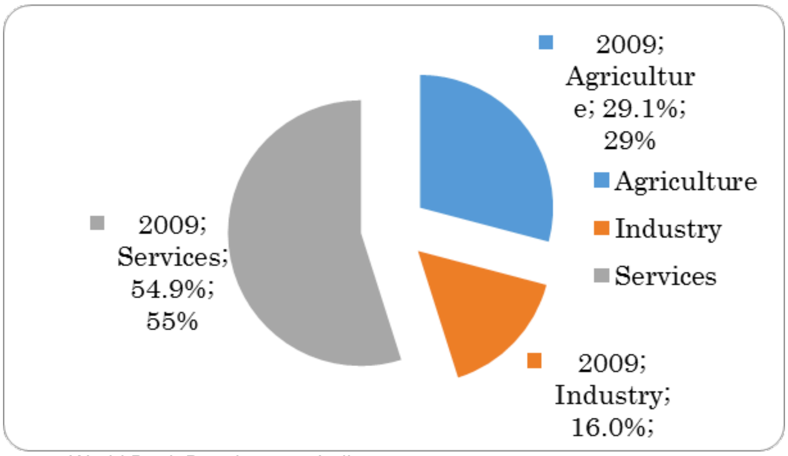
Among the five IOC entities, Mauritius has the highest GDP in real terms with USD 8.7 billion in 2013. Madagascar holds the second position because its GDP reached at USD 6.1 billion in the same year in real terms. It is noteworthy that although Madagascar has the largest landmass, it is not the most dynamic economically in the region. Regarding the evolution of the GDP, Madagascar's GDP was USD 5.8 billion in 2009 and has increased to USD 6.1 billion in 2013.

While in all other countries/islands in the IOC region the GDP per capita registered an increase between 2009 and 2013, in Madagascar the GDP per capita declined from USD 282 to USD 265 during this period.

The amount of the Gross Fixed Capital Formation reached USD 1.7 billion in 2009 in Madagascar.

The origin of GDP in Madagascar reveals that services are the main component (54.9% of the total). The agriculture sector comes in second place, with 29.1 % (Figure 23).

Figure 23: GDP by sector, 2009



Source: World Bank Development Indicator

Analysis of the structure of the industrial sector reveals that mineral products have the largest share of the industrial value-added with 24.4% in 2012. The textile industry and the clothing industry represent respectively 17.5% and 14.3%, in the same year (Figure 24).

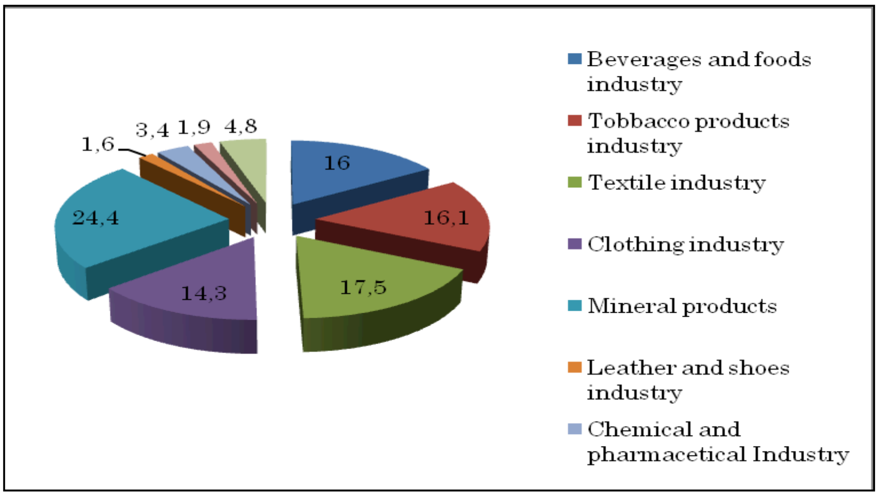


Figure 24: Value-added by industrial sector, 2012

Source: National Institute of Statistics of Madagascar/Economic Board/2012

The current account balance has been always a deficit in all IOC countries during the past five years. The current account deficit to GDP ratio was 6.9% for Madagascar in 2011, registering the most advantageous in the IOC region.
Figure 25 below shows that the trade balance remains negative in Madagascar because imports have exceeded exports during these past years. The gap between imports and exports was very deep in 2008 and 2009 due to the foreign direct investment firms in the mining sector that were established during this period. Those firms needed to invest significantly in costly imported equipment and machines.

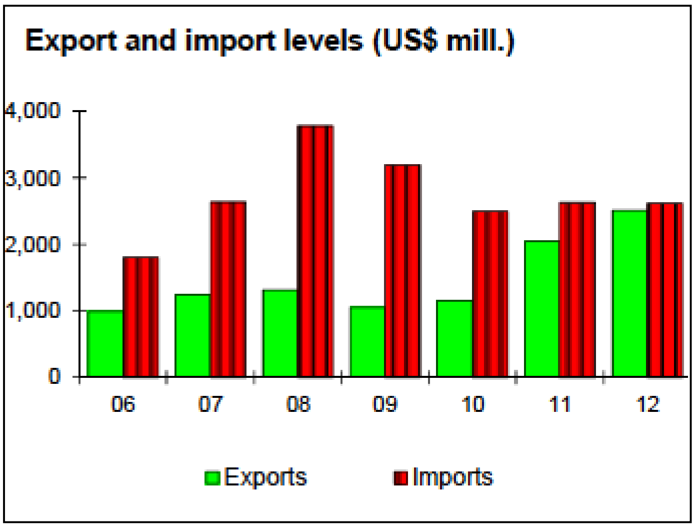


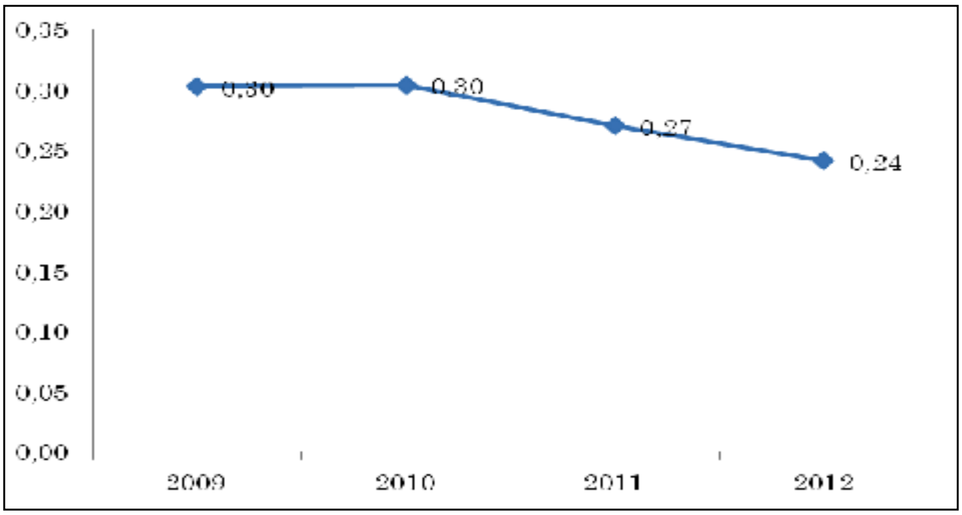
Figure 25: Import and Export levels, 2006-12

Source: World Bank Development Indicators

D. Public Finance

Figure 26 below affirms a budget deficit in Madagascar since 2009; the revenue to GDP ratio has exceeded expenditure to GDP ratio from that year.

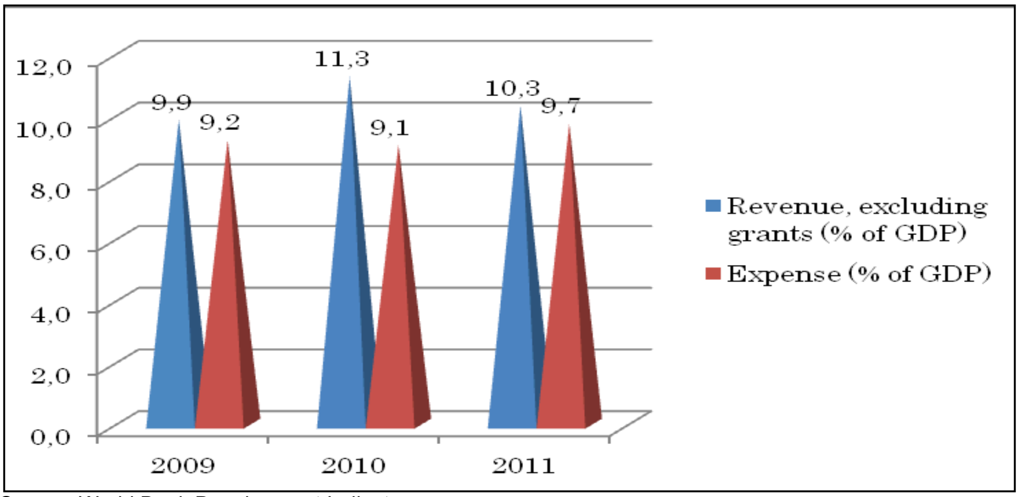
Figure 26: Revenue and expenditure, 2009-11



Source: World Bank Development Indicator

The analysis of the evolution of the grants shown in Figure 27 below confirms that the amount related to donor aid has declined since 2009, from USD 0.30 billion in 2009 to USD 0.24 billion in 2012. This trend is explained by the political crisis in the country since 2009.

Figure 27: Trends of donor aid, 2009-12, in USD billion real terms



Source: World Bank Development Indicator

The Organic Law on Finance Acts (*La Loi Organique sur les Lois des finances*) has been used as a framework when state agencies are preparing their budgets. This law mainly introduces the "Program Budget" into the Malagasy budgeting system, thereby describing and giving detailed costs of every activity or program that is to be carried out. The public budgeting process follows an annual cycle. National Budgets are usually formulated during the first semester and approved in October.

Each ministry defines its policies and priorities that should be approved at Ministry councils. The National Budget is within the Finance Act, which is approved by the Parliament Houses. The law and budgets are diffused in several formats: hard copy document and electronic format. As soon as the Finance Act is approved by the

Parliament, it is published on the Ministry of Finance and Budget website. Moreover, it is sent to all ministry offices.

In public investment schemes, the total amount of long term projects are divided proportionally to expectable annual achievement of the project and can be revised according to the inflation or the exchange rate evolution.

State authorities manage most of the infrastructure. Electric power supply is shared with private companies.

In terms of public investment and budgetary formulation, local level authorities highlight their priorities and plan their activities to central government. Then, the central ministry is accountable for budget project formulation that should be suggested to ministries councils. In fact, the decentralization application is not yet effective in the country.

E. Other Socio-Economic Elements

As far as the social indicators are concerned, they indicate an alarming situation given that the political crisis during 2009-2013 has worsened conditions in social sectors such as education, health or governance. **Error! Reference source not found.** below reveals key social indicators in Madagascar. Infant mortality rate averaged 58.2 per 1,000 live births in 2013. Children are vulnerable due to poor health protection, medicine inaccessibility and insufficient numbers of maternity hospitals. Also, the high rate of malnutrition, estimated at 36.8%, highlights the needs of Malagasy children for greater food security.

Furthermore, the illiteracy rate, currently at 33.5 % in 2012 for individuals over 15 years, shows that many efforts are still required in education and training. This situation explains the many challenges faced by government while operating in several areas, notably in disaster risk reduction.

Table 8: Socio-Demographic Indicators

Infant Mortality (2012)	
	Total 58.2 (per 1000 births)
	Men 62.3 (per 1000 births)
	Women 53.9 (per 1000 births)
Malnutrition (2012)	
	Infant 36.8 (% children<5 years old)
Illiteracy (2012)	
	Total 33.5 (% >15 years old)
	Men 32.6 (% >15 years old)
	Women 38.4 (% >15 years old)
People registered in primary school (2012)	
	Men 67.0 (%)
	Women 33.0 (%)
Age dependency ratio (2012)	Total 82.5 (%)

Source: World Bank Development Indicator

Infrastructure is not fully developed in the country (Table 9). The total length of roads in Madagascar was 18,214 kilometres in 2012. Only 6,077 kilometres of these are paved and the rest are unpaved and located within small rural municipalities. The number of the phone lines all around the island reached 8.7 million in 2012, of which 98.3% are mobile lines. Regarding airport infrastructure, 126 runways are located around the country, of which three have lengths exceeding 2,438 meters. Access to drinking water remains relatively low, at 48.1% and access to sewage system is only 13.7% (Table 10).

Table 9: Infrastructure indicators

INFRASTRUCTURE					
Phone lines (2012)			Roads (2012)		
Fixed 143,690		[units]	Total 18,214		[km]
Mobile 8,564,044		[units]	Paved 6,077		[km]
Airports (2012)			Unpaved 12,137		[km]
2438 - 3047 m:	3	[units]			
914 - 1523 m:	75	[units]			
< 914 m:	48	[units]			

Source: Civil Aviation of Madagascar

Table 10: Indicators on water access

SERVICES (2010)	
Access to drinking water 48.1	[% of Pop]
Access to sewage system 13.7	[% of Pop]
Freshwater used	
Agriculture 97.5	[% of Total]
Domestic 1.6	[% of Total]
Industrial 0.9	[% of Total]

Source: Jiro sy Rano Malagasy (Public Electricity and Water Corporation of Madagascar)

Given that Madagascar is an island, it is difficult to export or import electricity; electricity energy is produced mainly by the state corporation "Jiro sy Rano Malagasy" (JIRAMA). Furthermore, all amounts of petroleum are imported because Madagascar is not yet a petroleum producer even if research and exploration have started (Table 11).

Table 11: Indicators on energy resources

RESOURCES	
Electricity (2012)	
Production 1.4	[Billions kWH]
Consumption 1.0	[Billions kWH]
Exportation 0.00	[kWH]
Importation 0.00	[kWH]
Petroleum (2012)	
Production 0.00	[bbl/day]
Consumption 14258.6	[bbl/day]
Exportation 0.00	[bbl/day]
Importation 14709.5	[bbl/day]

Source: Jiro sy Rano Malagasy (Public Electricity and Water Corporation of Madagascar)

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2. Disaster Loss[19]

A. Overview

Component 1 of this initiative built a disaster loss database that registers not only large scale disasters 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[20].

During the project, data were collected on large as well as small-to-medium scale disasters that occurred from 1980 to 2014. 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 accidents, marine accidents, epidemics, shark attacks) were registered in the database but excluded for analysis in this report[21].

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

- Damaged houses;

- Destroyed houses;

- Basic human loss (mortality, injured, affected).

The loss data was assigned monetary value by applying the methodology developed by UNISDR, which allows comparison across countries[22].

The *Cellule de Prevention et Gestion des Urgences* (CPGU) hosted Component 1 with cooperation from the Ministry of Environment.

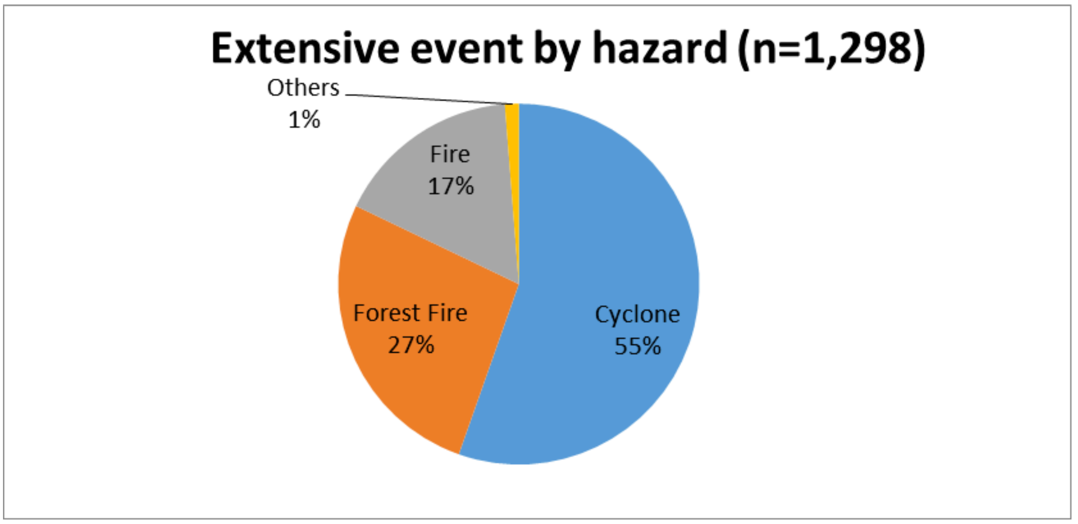
The data is open to public in the following site.
http://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=mdg

[19] This chapter was drafted by Kazuko Ishigaki (UNISDR).
[20] 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).
[21] Fire is included in the analysis, though.
[22] 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 Madagascar[23]

A total of 1,378 data cards were registered regarding natural hazards, of these 1,298 were categorized as extensive disasters while the remaining 80 cards were categorized as intensive disasters. Intensive losses were caused by cyclone (79) and fire (1). Out of 1,298 extensive disasters, cyclone is ranked first in frequency (55%), followed by forest fire (27%) and fire (17%) (Figure 28).

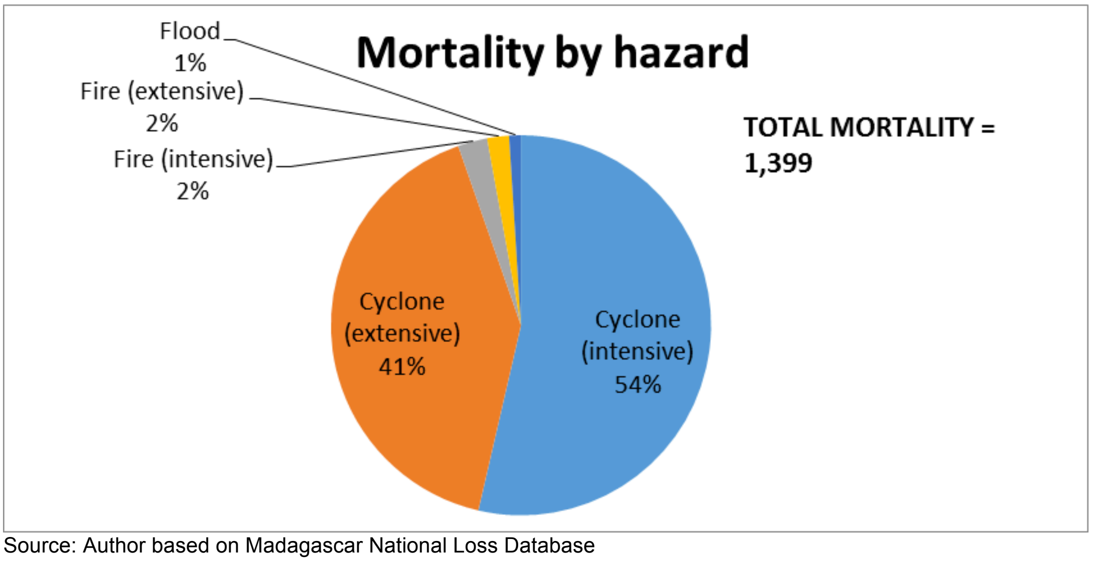
Figure 28: Extensive event frequency by hazard



Note: Others include drought (7) and flood (9), totalling to 16.
Source: Author based on Madagascar National Loss Database

Total mortality is registered at 1,399, more than half of which was caused by intensive cyclones. If extensive and intensive cases are combined, 95% of mortality was due to cyclones (Figure 29).

Figure 29: Mortality by hazard

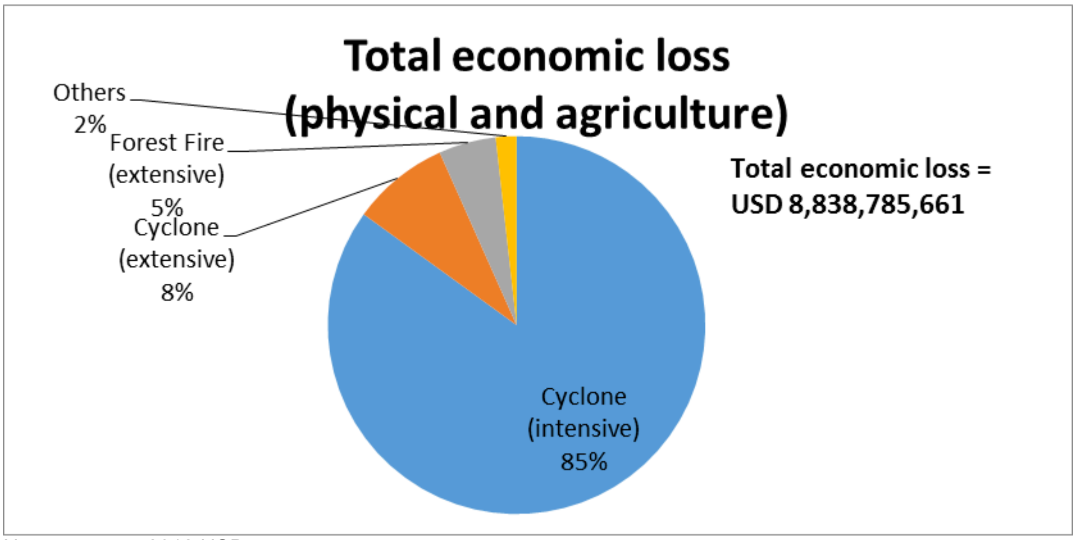


Source: Author based on Madagascar National Loss Database

Economic loss (physical and agriculture) totals USD 8.84 billion at 2012 prices. Intensive cyclones contribute 85% of the total economic loss. If extensive and intensive cases are combined, 93% of economic loss was due to cyclones (Figure 30).

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

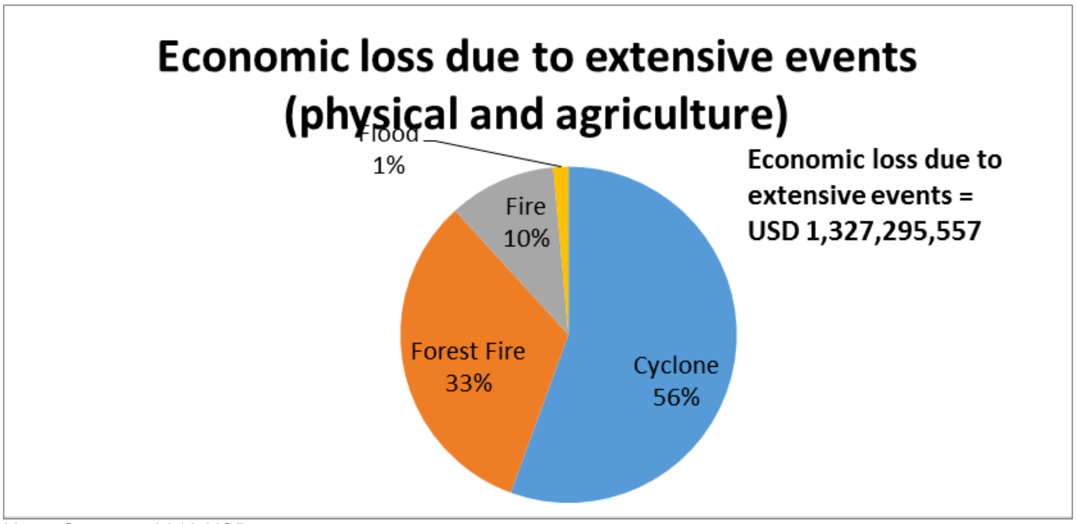
Figure 30: Total economic loss (physical and agriculture)



Note: constant 2012 USD.
Note2: Others include fire (intensive, 351,820), flood (extensive, 19,246,080), fire (extensive, 137,153,132).
Source: Author based on Madagascar National Loss Database [24]

Out of extensive disasters alone (Figure 31), cyclones caused 56% of economic loss, followed by forest fire (33%), fire (10%) and flood (1%).

Figure 31: Economic loss due to extensive events (physical and agriculture)



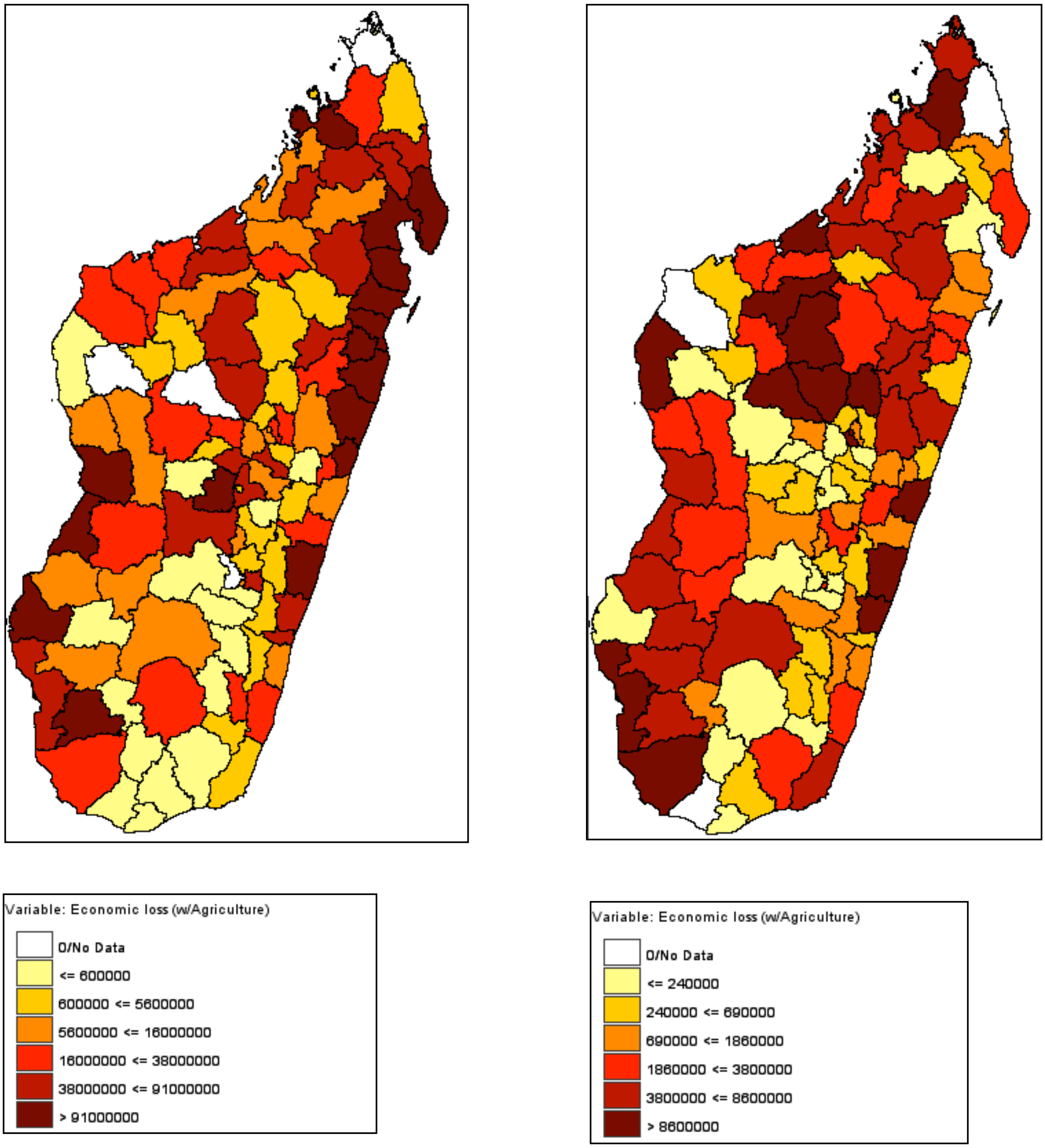
Note: Constant 2012 USD
Source: Author based on Madagascar National Loss Database

Geographically, economic loss is observed in most districts. Cyclone loss was concentrated on the north-eastern coast (which also holds the highest population density) and southwest coast. Some districts were less affected by cyclone loss, but exposed to other hazards (Figure 32). This aligns with what has long been known about the difference between cyclone impacts on the two coasts: while on the eastern side, the wind is most damaging, on the western side the accompanying rains cause the greatest damage.

[s] Forest fire sig significant in Madagacar because in the rural areas, a significant part of farmeres hav always been practicing "tavy" (meaning that they burn forest to gt a plot of landthat they can use for agriculture), in spite of the presence of several institutions which are protecting forest in the country

Figure 32: Geographical distribution of economic loss due to cyclones and other hazards combined (intensive and extensive, physical and agricultural)

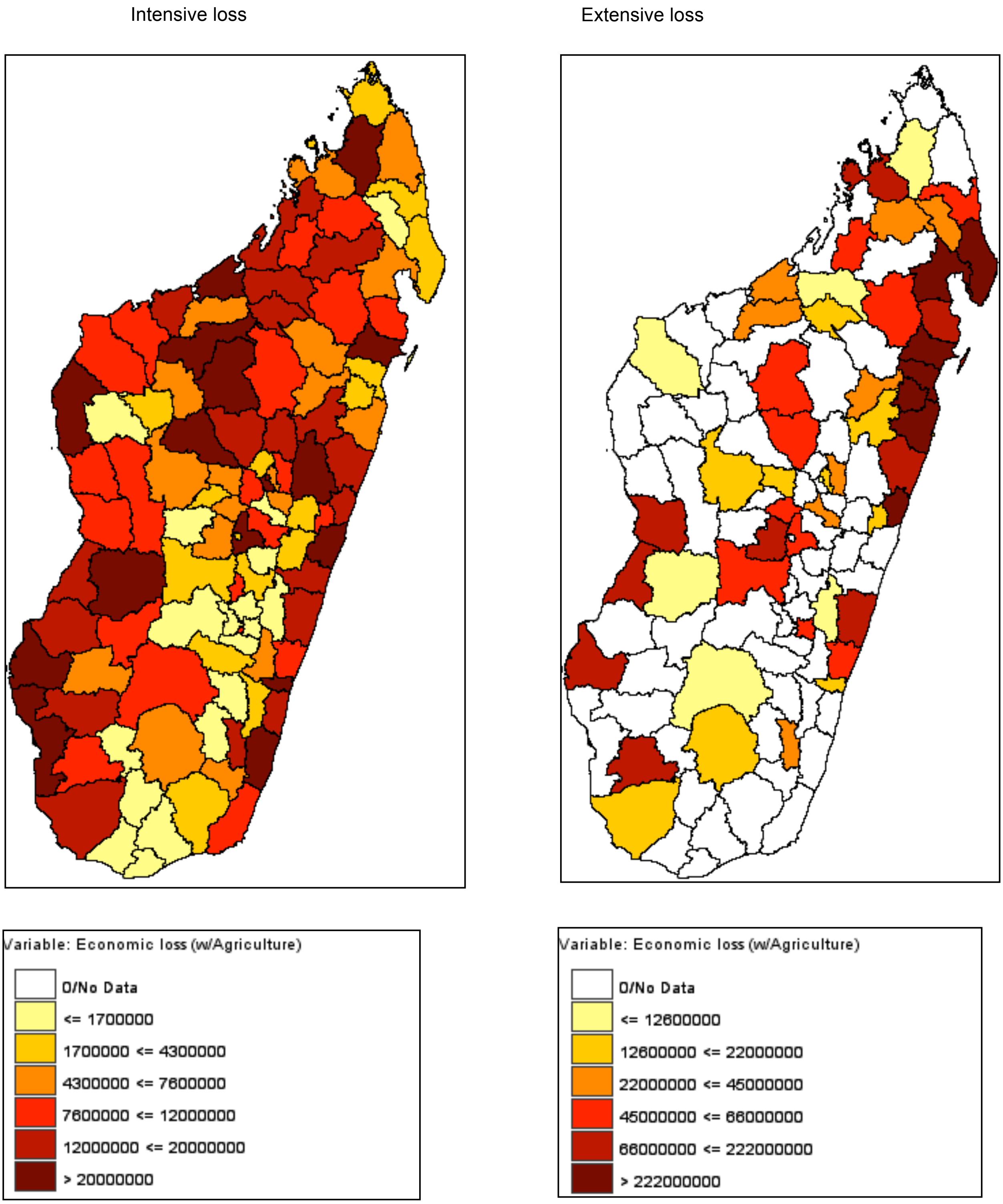
Cyclone | Other hazards combined



Source: Author based on Madagascar National Loss Database

In the same way, the geographical distribution of extensive and intensive loss provides important insights. The country needs to prepare for intensive loss above all in the north-eastern and south-western coasts, while extensive risk affects most of the country.

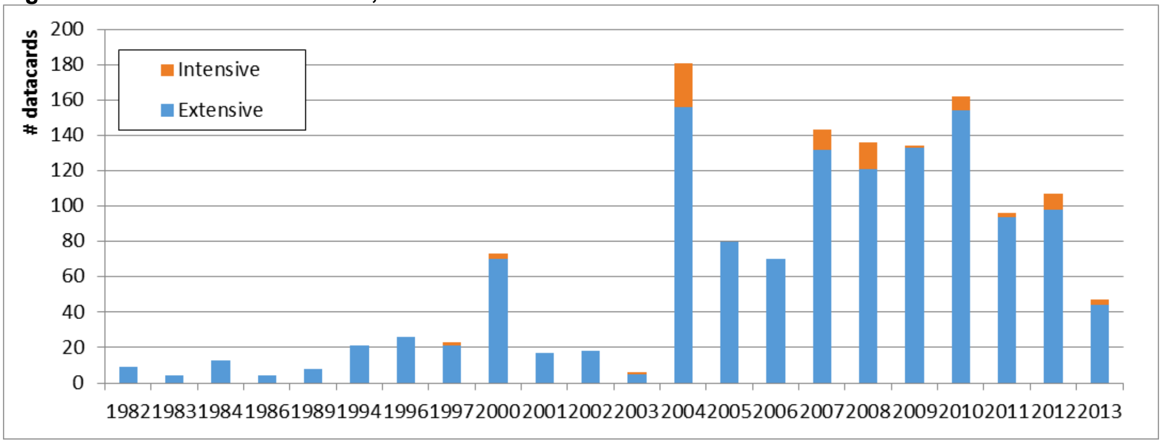
Figure 33: Geographical distribution of intensive and extensive loss (physical and agricultural)



Source: Author based on Madagascar National Loss Database

The number of data cards has increased annually since 2004 (Figure 35). Economic loss is significant in 2004 (USD 2.3 billion) and 2008 (USD 2.7 billion) because Madagascar had experienced three different cyclones that had shown a category 4 according to the Saphio-Simpson scale for both 2004 and 2008. Extensive loss is also significant in 2010 (USD 207.9 million) (Figure 35).

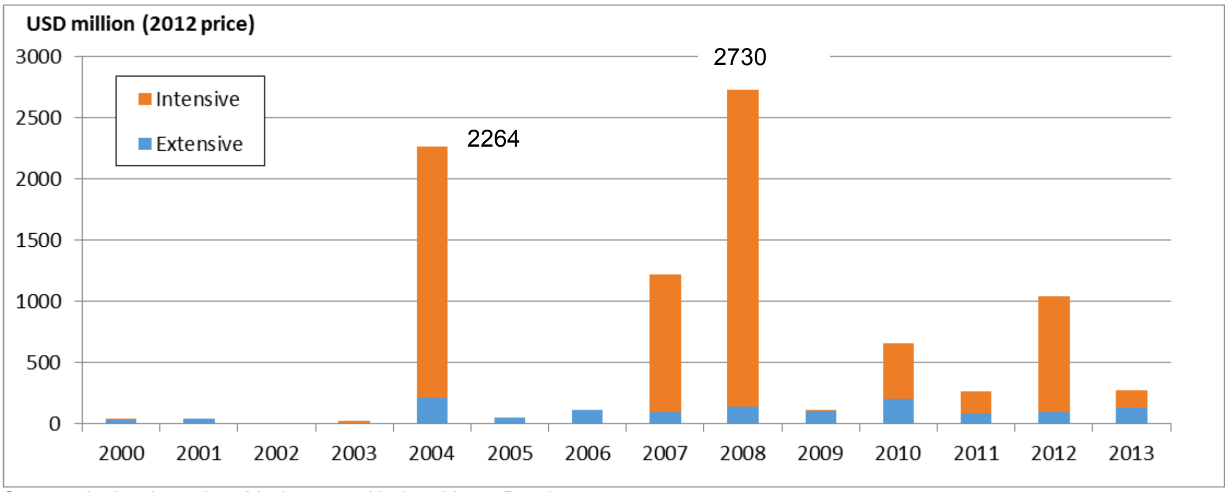
Figure 34: Number of data cards, 1980-2013



Source: Author based on Madagascar National Loss Database

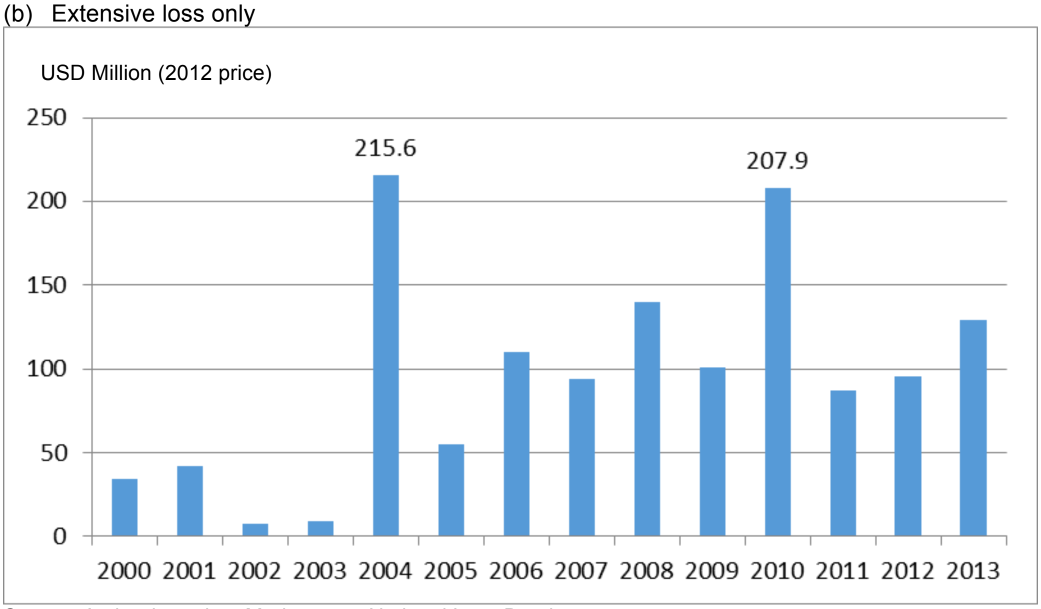
Figure 35: Economic Loss, 1980-2013 (Total and Extensive only)

(a) Total



Source: Author based on Madagascar National Loss Database

(b) Extensive loss only



Source: Author based on Madagascar National Loss Database

According to experience and observation, the most important direct losses that Madagascar experienced from disaster events are those that occur after cyclones. Affected family dwellings (mostly made by local non-solid raw materials, woods, leaves, etc.) remain vulnerable to cyclonic wind. Also, noteworthy is the huge damage to agricultural crops due to both locust and cyclones, destroying many plots of land during their passage. Infrastructure such as schools, and bridges made with local raw materials are also influenced and incur losses.

In regard to indirect losses, households who mainly act in the informal sector and use their dwellings as a business site regularly suffer loss after cyclones in Madagascar, mainly due to the reduction or suppression of their incomes. The same case occurs when infrastructure (bridges, roads) temporarily stop functioning and prevent products (notably the exportable ones, *i.e.* vanilla, cloves, etc.) from reaching markets. Regarding macro-economic impacts, citizens need to recover and repair damage incurred so that the demand of money in the financial system increases and can give rise to interest rates that are very high.

The criteria of intensive and extensive disaster are not always useful in the context of Madagascar. Basically, cyclones and locust disasters are difficult to classify using those concepts, because they can have high-to-mid severity and high frequency. For example, since most housing is made by local raw materials, cyclones can be at the same time severe and of high-to-mid frequency. The same case holds for the impacts of locust events on crops.

Given that Madagascar is the fourth largest island in the world, it has often confronted natural hazards such as cyclones, floods, landslides, drought, earthquakes, tsunamis, locusts and epidemics. We can also note manmade (mainly technological) hazards like transport accidents, industrial pollution, fire, forest fire, deforestation. However, as highlighted by historical disaster events, DRR policies should focus above all on cyclones.

3. Disaster Risk[25]

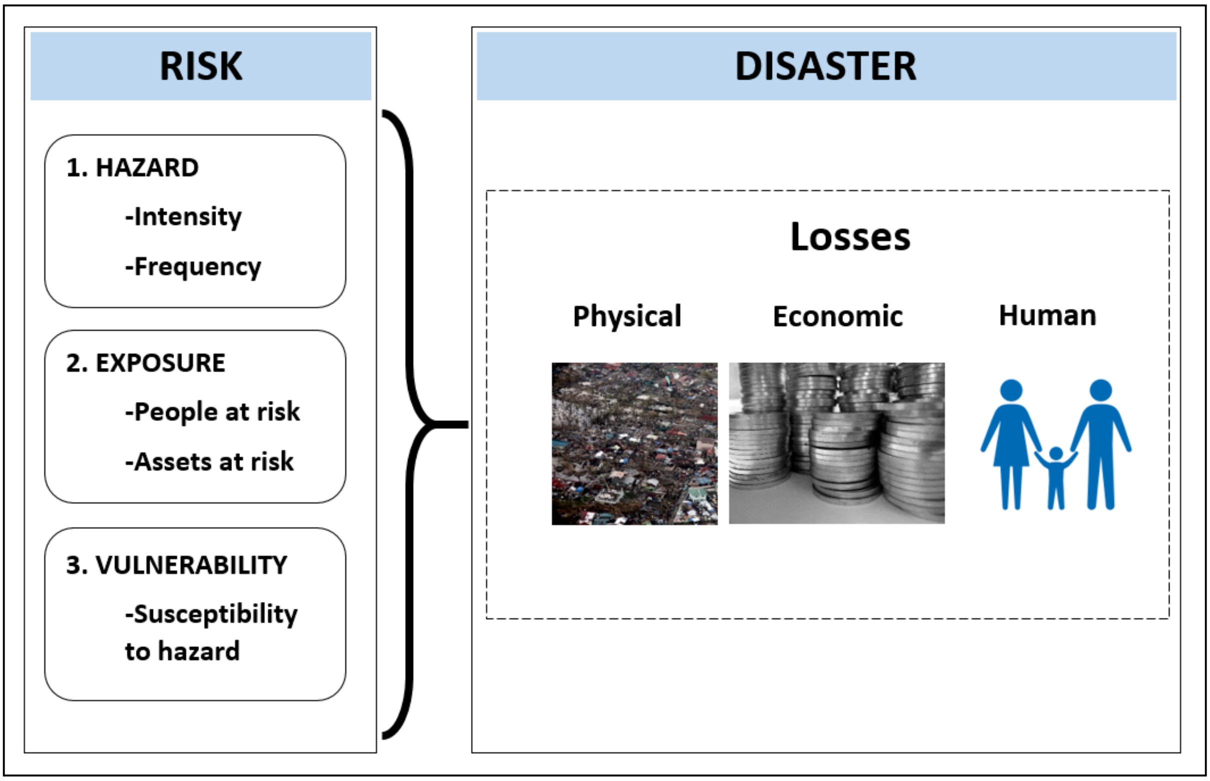
A. Overview

Component 2 of this initiative built 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 36). **Hazard** data are basically calculated from a set of stochastic scenarios and in this initiative the data were extracted from global datasets[26]. **Exposure** data measures the degree to which people and assets will be at risk when a hazard hits, and often consists of inventories of buildings, population and infrastructure. 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 elements 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 36: Key concepts of probabilistic risk assessment

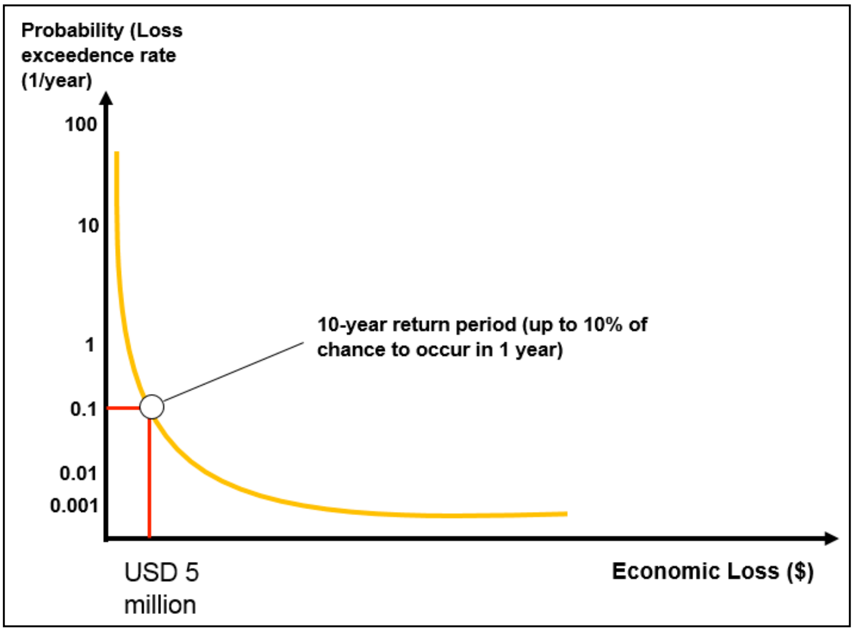


Source: Author

Based on probabilistic risk assessment, a loss exceedance curve for each hazard is produced (Figure 37). The curve shows the relationship between each value of the losses and the likelihood (probability) of having such loss during one year.

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

Figure 37: 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 the combination of all the potential losses that can occur every year due to a particular hazard, weighted according to their likelihood of occurrence. Simply said, the AAL is the loss that can be expected every year, regardless of whether it actually occurs or not. It gives insights into investment planning because the value shows how much risk should be reduced or transferred annually to prepare for all layers of risk. The PML is the loss associated to a specific, usually long return period. PML is a loss that is not frequent, therefore usually high, but still possible. PML is a useful reference value to draft a worst-case scenario and prepare for intensive events.

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

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 confronted cyclones 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 a 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). As probabilistic risk assessment tends to underestimate the extensive risk, historic loss data is used to remedy this problem.

The challenge is that the current historic loss database has a time series that is too short to produce high quality risk assessments. Achieving more detailed risk assessments of higher resolution requires continuity on capacity building processes, improvement of data/information and the 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 Madagascar, the *Cellule de Prevention et Gestion des Urgences* (CPGU), the Research and Development Centre and the University of Madagascar jointly participated in probabilistic disaster risk assessment activities in Component 2.

B. Probabilistic risk assessment in Madagascar[27]

In Madagascar, UNISDR and the national team conducted probabilistic risk assessments for tropical cyclone wind and earthquake risk; both are described below.

B.1. Cyclone wind risk assessment

Table 12 presents the Average Annual Loss (AAL) and Probable Maximum Loss (PML) in absolute terms and relative values to exposed assets, gross fixed capital formation (GFCF) and GDP. AAL is USD 73.39 million and constitutes 4.26% of GFCF.

Table 12: AAL and PML for tropical cyclonic winds in Madagascar

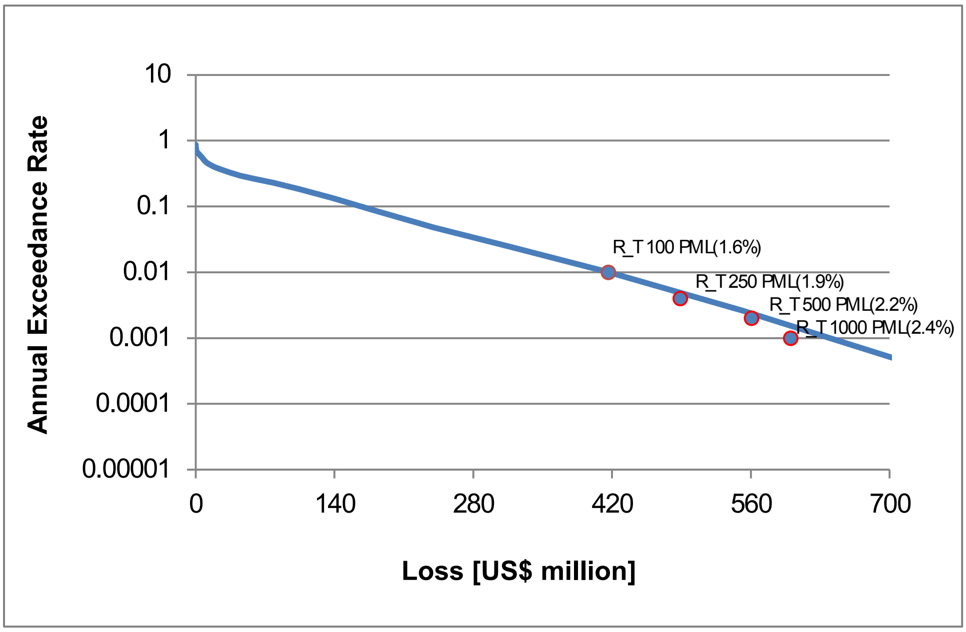
	USD million	Value of Exposed Assets (2014)	**GFCF** (2013)	**GDP** (2013)
		25,341	1719.50	6,080.77
	Absolute	Relative		
Annual Average Loss (AAL)	73.39	2.9‰[28]	4.26%	1.21%
Probable Maximum Loss (PML)				
Return Period (years) 50	367.10	1.45%	21.35%	6.04%
100	438.38	1.72%	25.49%	7.21%
250	545.03	2.13%	31.70%	8.96%
500	583.36	2.28%	33.93%	9.59%
1000	650.34	2.50%	37.82%	10.70%

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

Figure 38 shows the loss exceedance curve while Figure 39 shows the PML curve. In addition, the loss exceedance curves given different exposure periods, specifically 20, 50, 100 and 200 years, are presented in Figure 40. These plots show the probability of exceeding a certain value of loss in a given exposure time frame; for example, the probability of exceeding a loss of USD 583 million (PML for 500 years return period) in the next 20 years is approximately 4%.

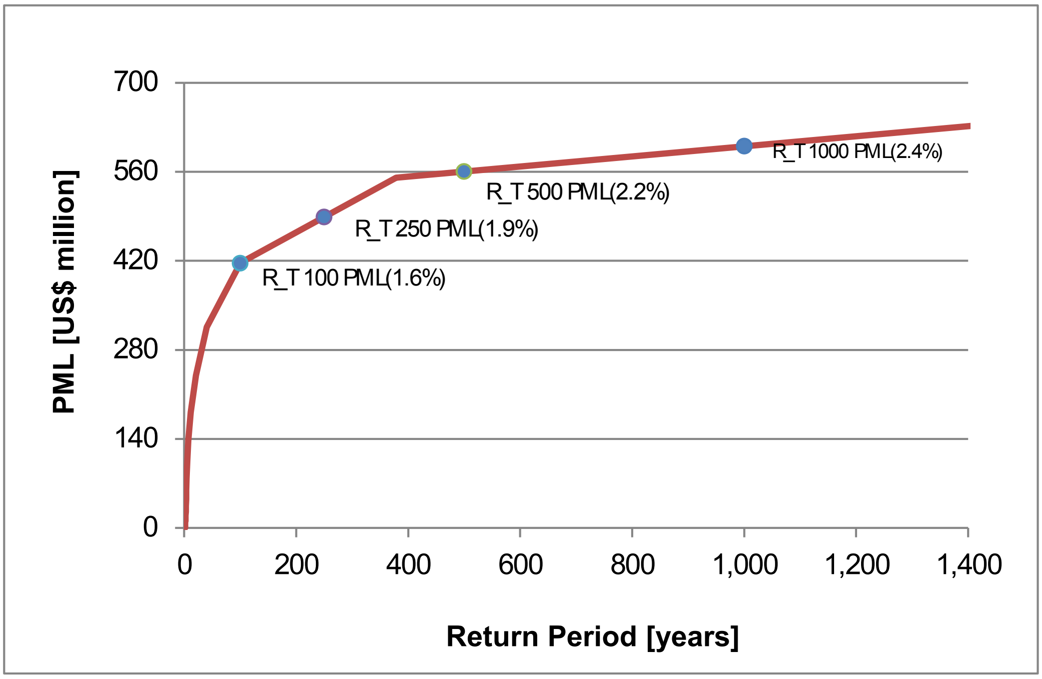
[27] For detailed data source and methodology, see UNISDR/IOC (2014)
[28] Mille is a mathematical term that means per thousand, as its name in French suggests. It is represented by the symbol ‰.

Figure 38: Loss exceedance curve for tropical cyclonic winds



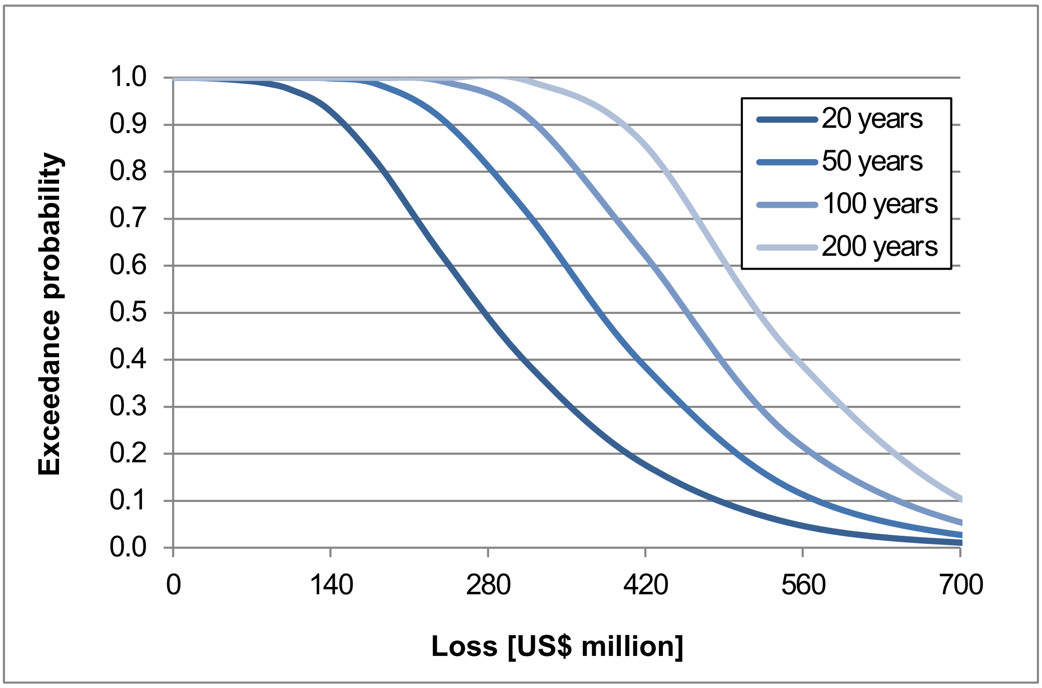
Source: UNISDR/IOC (2014)

Figure 39: PML curve for tropical cyclonic winds



Source: UNISDR/IOC (2014)

Figure 40: Exceedance probability curves given different times



Source: UNISDR/IOC (2014)

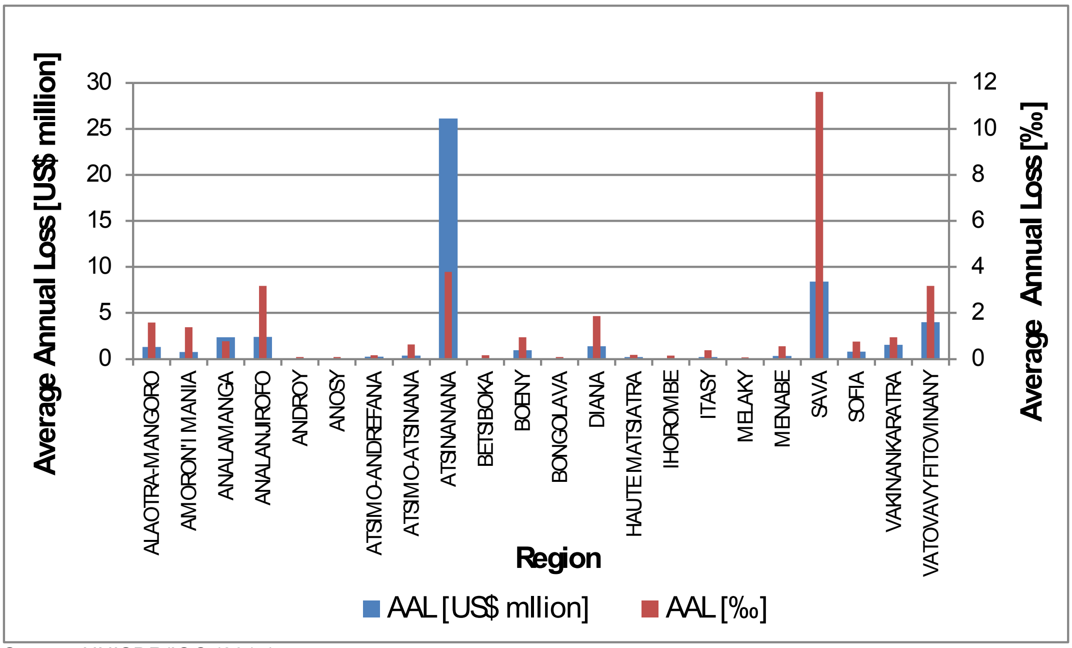
Compared to the earthquakes, tropical cyclonic winds are a more important hazard in Madagascar; the AAL of tropical cyclonic winds is approximately 130 times larger than the AAL of earthquake. This is mainly explained by the geographical location of the country in the South Indian Ocean Basin.

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

Figure 41 and Figure 42 show the AAL (absolute and relative to the exposed value) by region. Despite the fact that the Sava Region (northeast) does not hold the greatest portion of AAL in absolute values (USD 8 million), AAL in relative terms is around 12‰ --which is the highest of all regions and corresponds to a considerable risk level. This means, on average, that the total value of registered assets in the Sava Region can be lost every 100 years. On the other hand, Atsinanana Region has the largest absolute AAL (USD 27 million) but the relative loss is close to 4‰, which is almost three times less than in Sava.

The risk in both absolute and relative terms is concentrated along the eastern coast of Madagascar, which aligns with the loss data outlined in Chapter 2.

Figure 41: AAL (absolute and relative) by region for tropical cyclonic winds



Source: UNISDR/IOC (2014)

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

Absolute AAL

Relative AAL

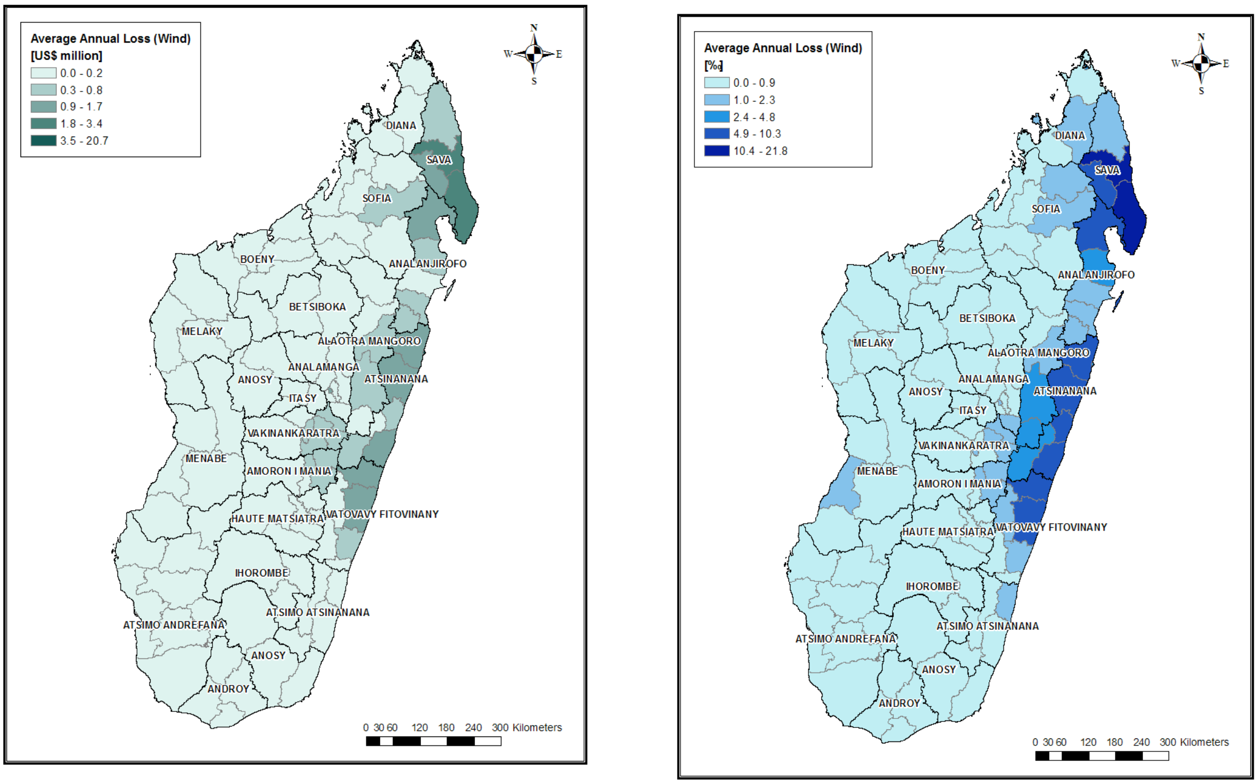
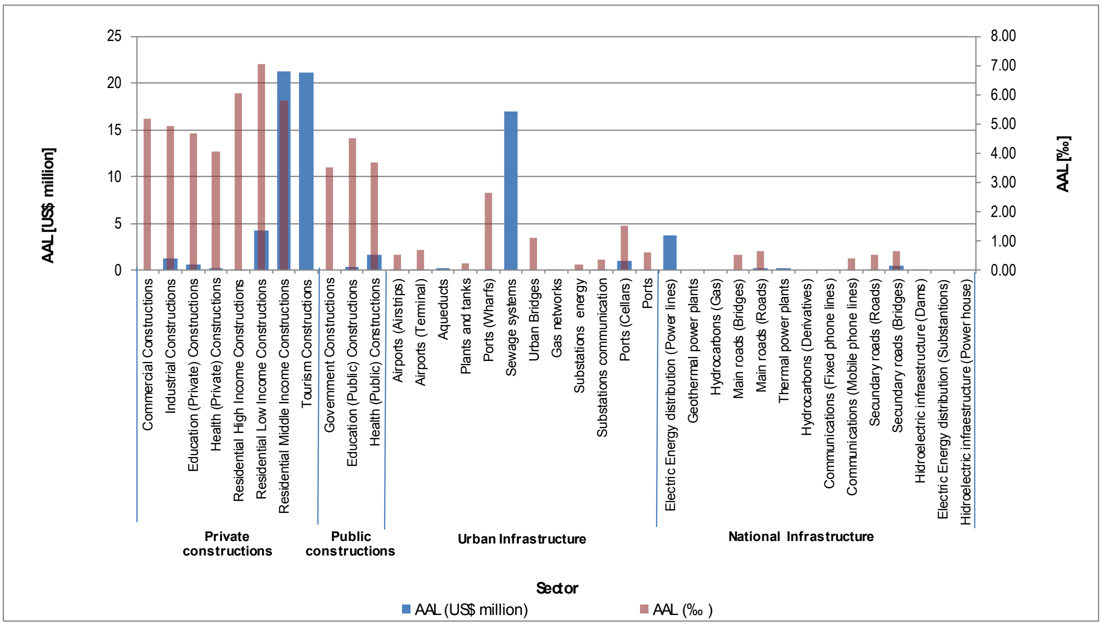


Figure 43 summarizes the AAL (absolute and relative to the exposed assets) for each sector. Both in absolute and relative terms, the “Residential Low Income Constructions” among the built environment assets database has the highest risk level in Madagascar. In fact, the AAL in absolute value has been around 15 million USD and it has reached at 5.3‰ in relative values. In absolute value, the “Residential Middle Income Constructions” has the same level of risk as the “Residential Low Income Constructions” because the AAL is also USD 15 million. However, in terms of relative value, the “Residential High Income Constructions” is in the second position with a relative AAL around 4‰. Generally speaking, the high risk of these constructions can be clarified by the fact that the private constructions present the highest level of the exposed values in the country. It is worth to highlighting that ports register the third level of absolute AAL by reaching USD 12 million and this sector presents a relative AAL to the total exposed values around 5‰.

Figure 43: AAL by sector for tropical cyclonic winds



Source: UNISDR/IOC (2014)

B.2. Earthquake risk assessmentTable 13 presents the AAL and PML in absolute and relative value to exposed assets, GFCF and GDP. AAL is USD 0.56 million and constitutes 0.26‰ of GFCF. PML is USD1.4 million for 50 years of return period and it increases when return periods get longer. The seismic risk results in Madagascar can be considered low; even though a loss of USD 83 million may seem high, it only occurs on average, every 1000 years, and even then it represents only around 0.02% of the total exposed value. However, despite the fact that the risk is low, they should not be considered negligible because an extreme event can generate high disruptions, damages and casualties. Furthermore, since the AAL and PML account for all the events included in the stochastic set, earthquakes can affect different parts of the country.

Table 13: AAL and PML for earthquakes

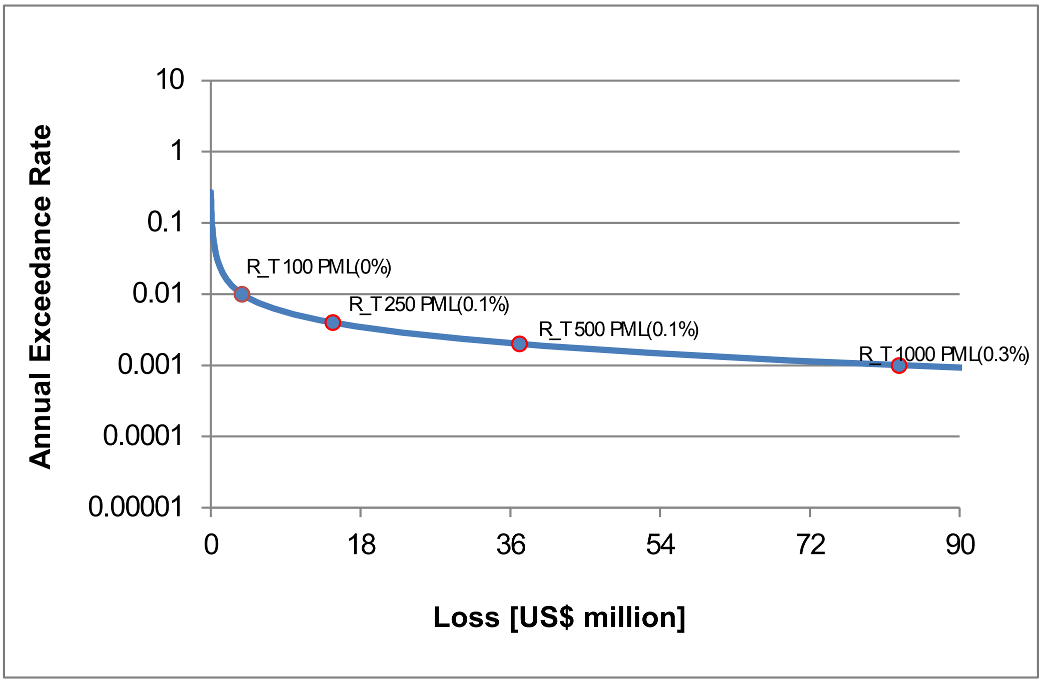
	USD million	**Exposed Assets (2014)**	**GFCF (2013)**	**GDP (2013)**
		25,341	**1719.5**	**6080.8**
	Absolute	Relative		
Annual Average Loss (AAL)	0.56	0.02‰	0.33‰	0.09‰
Probable Maximum Loss (PML)				
Return Period (years) 50	1.40	0.01%	0.08%	0.02%
100	3.74	0.01%	0.22%	0.06%
250	14.68	0.06%	0.85%	0.24%
500	37.20	0.15%	2.16%	0.61%

1000	83.06	0.33%	4.83%	1.37%

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

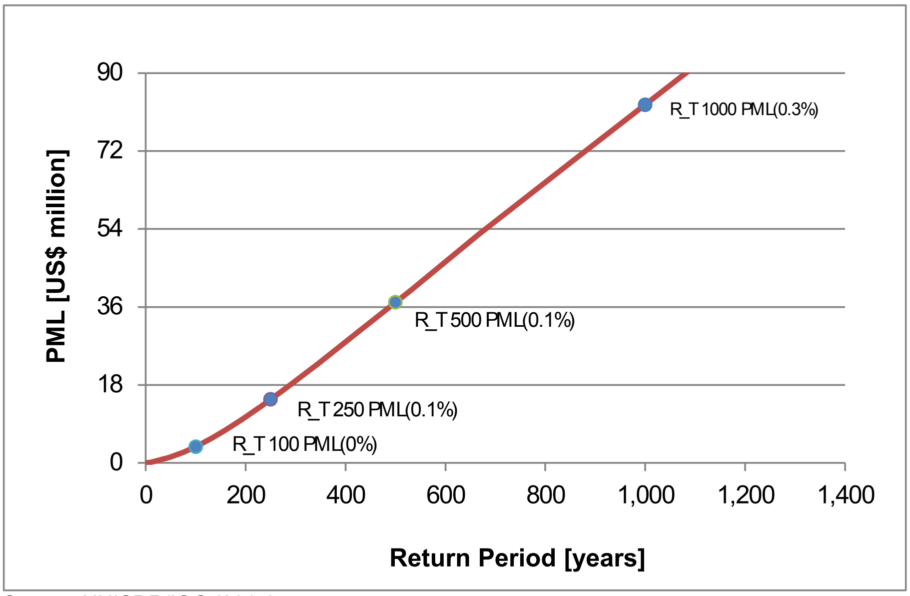
Figure 44 presents the loss exceedance curve and
Figure 45 presents the PML curve. In addition, the loss exceedance curves given different periods, specifically 20, 50, 100 and 200 years, are presented in Figure 46, these plots show the probability of exceeding a certain value of loss in a given exposure time frame; for example, the probability of exceeding a 39 Million USD loss value (PML for 500 years return period) in the next 50 years is approximately 10%.

Figure 44: Loss exceedance curve for earthquakes



Source: UNISDR/IOC (2014)

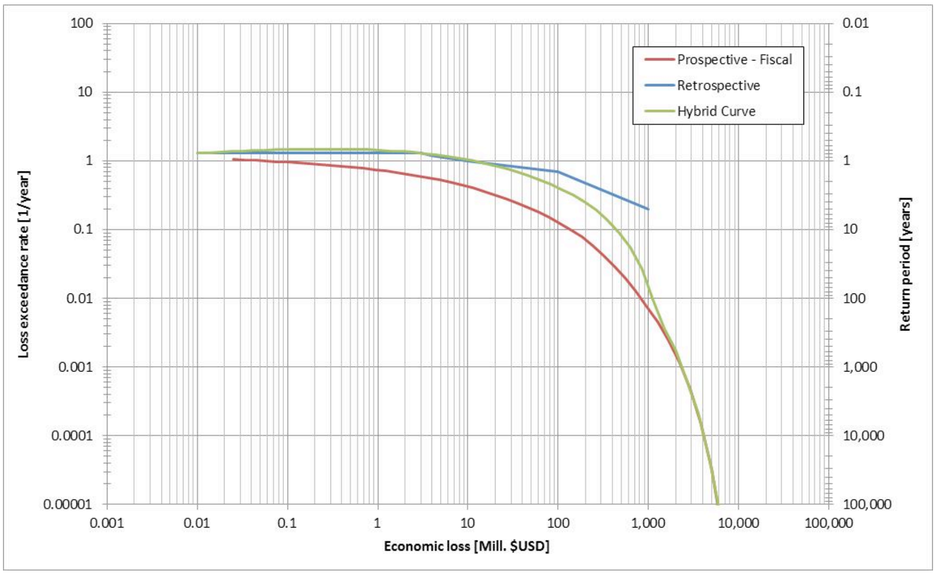
Figure 45: PML curve for earthquakes



Source: UNISDR/IOC (2014)

Figure 46: Exceedance curves given different periods

Source: UNISDR/IOC (2014)

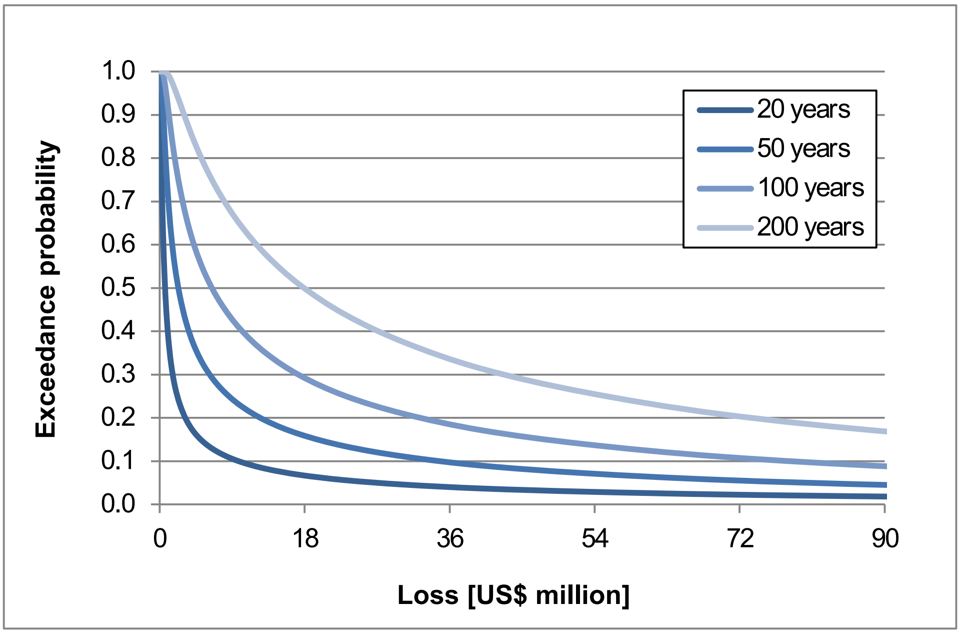


Given the low relative risk of the earthquakes in Madagascar, it is not possible to disaggregate the results by district or by sector.

B.3. Hybrid Loss Exceedance Curve for Tropical Cyclonic Wind

Figure 47 shows the hybrid loss exceedance curve for Madagascar. 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)[29]. Therefore, even though a hybrid curve is obtained, insufficient quality of input data results in a curve that is not statistically significant.

Figure 47: Hybrid loss exceedance curve for tropical cyclonic windSource: UNISDR/IOC (2014)



[29]The disaster database contains records since 1982, but it is only after 2004 that these records display a more uniform number of events per year and can be considered complete. Unfortunately, this period of time (2004 – 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.

References

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.

4. National DRM/DRR/CCA Framework[30]

A. Institutional Structures

Several entities in different sectors, the private sector, organizations of the civil society and donors are involved in Disaster Risk Reduction and the Disaster Risk Management activities in Madagascar.

The Prime Minister Office is the entity that houses the National Council of the Disaster Risk Management (*Conseil National de Gestion des Risques et Catastrophes*: CNGRC) and the Emergency Reduction and Management Agency (*Cellule de Prevention et Gestion des Urgences, CPGU*).

While the *Cellule de Prévention et Gestion des Urgences* (CPGU), is placed under the Prime Minister's office, the National Bureau of the Disaster Risk Management (*Bureau National de Gestion des Risques et des Catastrophes,* BNGRC) remains within the Ministry of Domestic Affairs. These two state agencies deal with preparedness, response, relief and recovery after cyclones and other disaster events. While the CPGU is mandated to intervene both in DRR and DM, the BNGRC focuses mainly on emergency management after a disaster though it is planning now DRR activities. They are not adequately involved to date in the public investment optimization processes.

The 5th section of the Executive Order n° 2005 – 866 of 20th December 2005[31], clarifies that the National Council of the Disaster Risk Management would be the main strategic entity of the planning and the supervision of all activities. The secretary office has been the National Bureau of Disaster Risk Management.

In the University of Madagascar, the Economic Research Center for Development (*Centre d'Etudes et de Recherches économiques pour le Développement)* deals with DRR concerns in many research areas, especially on the topics of vulnerability, damage and loss assessments for cyclone, drought and floods risks.

The National Environment Office (*Office National pour l'Environnement*) is the main agency dealing with climate change adaptation (CCA) concerns in Madagascar.

Currently, a few networks and platforms deal with DRR. It appears that each platform focuses mainly on a specific issue related to DRR. For instance, the national working group for the ISLANDS project deals mainly with setting up financial tools. An informal national DRR platform called the "CRIC", composed by national public agencies (CPGU, BNGRC), NGO and UN partners, holds a periodical meeting in beginning of the cyclone season (in October) each year. It seems that coordination is still lacking even if some structures are in cooperation or partnership, depending on the context and the field of the activities in DRR.

B. Legal Structures

The country is signatory of the Hyogo Multilateral Agreements. At the national level, several public documents, laws and strategies deal with DRR/DRM topics. For instance, the Constitution Act which was revised in 2011 mentioned DRR issues in the section n°136 by highlighting that « both the central and the local authorities ensure the public security service, the civil defence, the administration and the territorial development and the economic development and the improvement of the life conditions of the population».

Until now, the National Strategy on Disaster Risk Management (formulated in 2003)[32] remains the unique tool including several legislative and the political concerns, as mentioned in the National Report on Capacities facing Disaster Risk Reduction in Madagascar. The Strategy has been highlighting the processes on vulnerabilities and risks analysis, weaknesses, needs, priorities and capacities and finally institutional and financial structures. Basically, as seen in the list of legislative documents below, there are legislations related to DRR/DRM in Madagascar.

Madagascar legislative documents on DRR
- The Act n°2003-010 in 5th September 2003 related to the National Strategy on Disaster Risk Management;
- The executive order n°2005-866 in 20th December 2005 related to the enforcement of the Act n°2003-010 of 5th September 2003 determining the National Strategy on Disaster Risk Management;
- The executive order n° 2006-892 in 12th December 2006 highlighting the organization, the liability and the management of the "*Cellule de prévention et de gestion des urgencies: CPGU*;

[30] This chapter was drafted by Pierre Lazamanana.
[31] It determines the terms of enforcement on the Act n° 2003 - 010 of 5th September 2003 related to the National Strategy of Disaster Risk Management.
[32] A workshop was held with DRR/DRM stakeholders to validate the new version of the National Strategy for DRR (Antananarivo, 23th to 24th October 2014).

- The executive order n° 2006-903 in 20th December 2006 changing the executive order n°2005-866 of 20th December 2005 which detailed the terms of implementation of the Act n°2003-010 in 5th September 2003 related to the National Strategy on DRM/DRR.
- The executive order n° 2006-904 in 20th December 2006 highlighting the organization, the liability and the management of the National Bureau of DRM (*Bureau National de Gestion des Risques et des Catastrophes: BNGRC*).

The National Contingency Plan on cyclone and flood that is annually updated by all the stakeholders in DRR/DRM interventions was initially formulated by the BNGRC. It highlights all processes that should be followed during cyclone events and it has been implemented by the BNGRC for many years. Some improvements or updates, however, are required in order to make it relevant to the national context.

The “Decret MECIE”, an organic law for environmental issues including especially Climate Change Adaptation has been released by the Ministry of Environment. By involving the ex-ante environmental impacts analysis in businesses establishment, this document contributes to disaster risk reduction to the extent that it addresses the vulnerability of ecosystem and waterside communities and processes.

Sectorial plans have begun to integrate DRR/ACC aspects since the last decade because in many Ministries (Education, Health, Domestic Affairs, the Prime Minister’s Office, University, Environment, Transport and Public Works, Finance and Budget, etc.) a department (unit or service) was established to be specifically responsible for DRR/CCA issues. To reduce cyclone disaster risk, notably for traditionally built houses, the CPGU has elaborated retrofitting building codes. However, while building standards in specific sectors were improved, these are still not rigorously applied and enforced.

5. DRR/DRM/CCA in Public investment planning[33]

This chapter provides an overview of the current status of public investment planning related to disaster risk reduction/management and climate change adaptation in Madagascar. It moreover contains a summary of the findings of the three types of analysis 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.

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

No special measure for public investment has been set up for the last five years to address DRR/CCA because Madagascar was experiencing political strife. Laws and guidelines do not exist yet to deal with these issues. A disaster risk assessment has not been required for public investment project because there are not yet guidelines to support such efforts. Disaster risk is also not yet integrated into environment impact assessment for public investment because of lack of guidelines.

Some Ministries have implicitly achieved DRR investment (Education, Health, Prime Minister's Office, Finance and Budget, Domestic Affairs, Prime Minister Office, etc.) and CCA investment (Ministry of Environment) but those initiatives are not coordinated and harmonized. Each agency plans DRR/DRM activities independently. Moreover, Madagascar does not have a critical infrastructure protection plan.

Ministry of Finance and Budget leads the budgetary planning processes of each Ministry but does not require cost benefit analysis in the budget request 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 to manage disasters, summarized in Table 14. These mechanisms mainly address recovery and reconstruction costs. Thereafter follows a discussion of the main measures listed.

Table 14: Finance mechanisms for disaster management

EX-ANTE MECHANISMS	
Contingency budget line	-
Contingency funds	A fund was set up in 2008 whose amount has been approved and managed by the Prime Minister office. After totally depleted in cyclone emergencies in the same year, it is not replenished.
Insurance	Both the private and the public infrastructure are not always covered by insurance. Private businesses have their own insurance but the government has no strategy to encourage people to purchase insurance.
Others	-
EX-POST MECHANISMS	
Diverting funds from other budget items	This is the most commonly applied mechanism
Imposing or raising taxes	Mechanism not yet used
Taking a credit from the Central Bank (either prints money or depletes foreign currency reserves)	Possible, and has been used in the past
Borrowing by issuing domestic bonds	Possible, and has been used in the past
Accessing international assistance	The government typically awaits international aid when catastrophic events occur. That is why financial public strategies do not exist to deal with DRR/DRM (or, are not effectively implemented)
Borrowing from multilateral institutions	Mechanism not yet used due to aid
Issuing bonds on the international market	Mechanism not yet used

Source: Author

[33] This chapter was drafted by Pierre Lazamanana.

There is not yet an official framework for risk financing. When a disaster (cyclone, drought, locust, wild fire, and so on) occurs in the country, response and reconstruction are usually managed by assistance and aid from donors, by contracting a domestic credit in the bank sector or by arranging for a budget reallocation.

A National Reserve Fund was set up in 2008 mainly to deal with emergency response. This fund is in a deposit account that should be fed annually through government budgets. The main objective is to have funds available to assist with relief and recovery, to rebuild after an event occurs. However, the fund has not been systematically replenished because of the political difficulties that Madagascar has had to deal with.

Moreover, critical infrastructures (both private and public) are not always covered by insurance. The private sector insurance market is managed by three Malagasy businesses (ARO, Ny Havana, and MAMA) and two foreign direct investment firms (Allianz and SAHAM). However, Malagasy citizens are not accustomed to purchase insurance protection for their houses; it is only compulsory for cars. The government does not promote insurance to prepare for disaster risk, which partly explains why the penetration rate remains low.

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.

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 15 below summarizes the scope of the budget review.

Table 15: Scope of the risk sensitive budget review

Year	2010 to 2014
Coverage	Prime Minister Office and eight sectorial ministries (Domestic Affairs, Finance, Education, Interior Security, Health, Agriculture, Public Works, Transport)
Budget or expenditure	Budget
Current or Capital	Current
Targeted hazards	Cyclone, floods, epidemics and locust

Source: Author based on Ministry of Finance and Budget

Results: The overall estimated investment in DRM/CCA identified in this review is in total USD 131 million, which is around 1.9% of the total budget of USD 7027.1 million during the period 2010 to 2014. A large part of the total budget is identified as "Principal" as shown in Table 16 below.

The Budget Review also classified the marked investment according to the DRM process. By far the most important category is disaster response followed by preparedness as shown in the table below.

Table 16: DRM/CCA investments in 4 components for the total of 5 Year)

Budget allocations per Risk Management phase/category	Significant (USD million)	Principal (USD million)	Total (USD million)	Total Marked (%)
Prevention/mitigation (1)	4.9	13.0	17.9	13.7
Preparedness (2)	5.1	40.6	45.8	34.9
Response (3)	0.3	62.2	62.5	47.7
Reconstruction (4)	-	4.9	4.9	3.7
Total budget allocations	**10.4**	**120.7**	**131.0**	**100**
Share of total budget (USD 7.027 billion)			**1.87%**	

Source: Author based on Ministry of Finance and Budget

The results show that nine state agencies have started to mainstream DRR/DRM activities in their budgets. The list of these institutions is as follows:

- The Prime Minister Office (CPGU)
- Ministry of Finance and Budget
- Ministry of Domestic Affairs (BNGRC)
- Ministry of Public Works
- Ministry of Transport
- Ministry of Agriculture
- Ministry of Health
- Ministry of Interior Security
- Ministry of Education

Institutionally speaking, the Prime Minister's Office has been demonstrating the greatest investment in DRR, with 30.3% in 2010 increasing to 68.3% in 2011. DRR budget in the Ministry of Finance rose from 0% to 42.6% during the period 2010 to 2014. In fact, given that Madagascar was in a crisis situation, it was easier for the transition regime to address DRR/DRM expenditures, especially in disaster response interventions by asking to the Ministry of Finance and Budget to manage it directly.

Component 2 of the project estimated an AAL of USD 73.95 million to tropical cyclonic wind and earthquakes. A simple comparison of estimated AAL to the 5-year average investment in DRR (2010-2014) indicates a **positive balance**: greater investment (USD 26.2 million) than expected loss in the present year (Table 17). However, it is important to keep in mind that AAL is only estimated for tropical cyclonic wind and earthquake risk' it is critical to go back to the actual marked activities to determine their link to cyclonic wind or earthquake risk. If this investment could be reasonably linked to cyclone or earthquake risk reduction, it would seem to offset the AAL by many years.

Table 17: Checking the Gap: DRM Investment, loss and risk

	DRM Investment (budget), 5 year average of 2010-2014	AAL (tropical cyclonic wind and earthquake only)	Loss, 1980-2014 (1378 data cards)
Value	USD 26.2 million	USD 73.95 million	USD 8,839 million (Annual average: USD 259.9 million)
Status		GAP	GAP

As reference, loss data were also compared to the budget. Again, this comparison does not show a positive balance, as even the average registered loss over past 34 years exceeds the annual investment in DRR.

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 Madagascar towards risk-sensitive public investment in light of their most important natural hazards.

The main challenges in conducting the budget review in Madagascar were as follows:

- The awareness and understanding of the executive officers in all ministries and sectors on DRR issues and on the budget processes has been insufficient to make progress readily.
- Officers who have been dealing with the budget planning, evaluation and implementation, especially in the sub national state agencies are changed frequently so the staff is always composed of new persons who are unaware about DRM. We need to invest time in building wide foundation of capacity first through measures such as giving training program before expecting to see visible progress on DRR-related concerns. Continuous sensitization is required.
- Insufficient government's resource means high opportunity cost when implementing review
- Guidelines on budget processes should be formulated in order to facilitate processes on using standards on DRM marker in budgeting and implementing activities.
- No clarification on the respective role of each institution: should ministries deal with DRR or not?
- There are no detailed data within ministries. There is no DRM Marker applied to date when planning budget.
- Institutionalizing DRM marker would be a challenge.

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

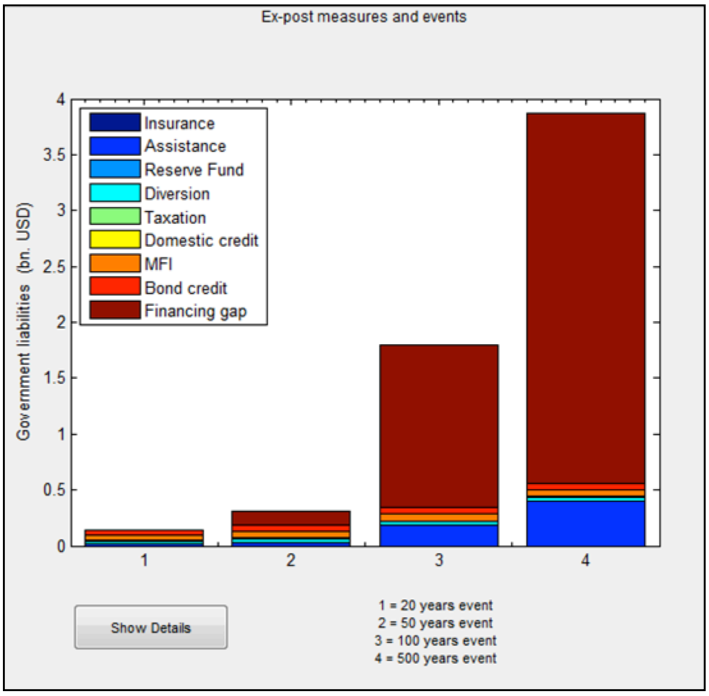
AAL was assumed to be USD 58 million. Total liabilities of Madagascar Government were estimated as USD 25.5 billion based on capital stock data. Then, the options to finance reconstruction and recovery were examined and same assumptions across IOC countries were applied. In a conservative case, USD 158.3 million was estimated to be assured through diversion from budget, 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: Based on the current study, the fiscal resources gap is estimated at 24 years while 2012 study shows 23 years (Figure 48). The relatively close figures estimated for fiscal gaps in 2012 and this study is explained partly by the fact that assets and disaster related information collected in 2012 was used as inputs for risk analysis in Component 2. However, the breakdown of funding sources is markedly different, especially with regards to the access to domestic credit and international lending. This difference is due to the fact that the current estimate of fiscal parameters is made based on standard assumptions applied in the global assessment (Hochrainer-Stigler et al. 2014). Therefore, further validation of fiscal parameters through national workshops and interviews with national stakeholders will be necessary.

Figure 48: Resources gap year analysis for Madagascar

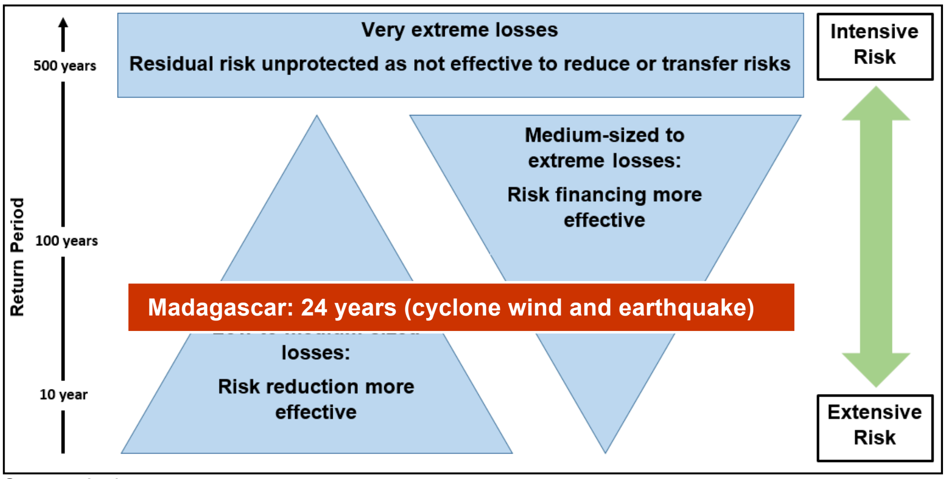
Source: IIASA



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 49). The CATSIM analysis conducted from Steps 1 to 3 has illustrated the need for improved management of disaster risk in Madagascar.

The current fiscal gap for Madagascar is estimated to be 24 years. Given the relatively low fiscal resources gap year estimated, it is advisable that additional resources be first allocated to risk reduction investments and the continued use of a reserve fund.

Figure 49: Risk layering



Source: Author

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

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 Madagascar and other IOC countries (Table 18). 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 Madagascar.

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 Madagascar 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 18: 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 Madagascar where wood and unreinforced masonry housings make up 78% of all residential land area. Assuming that all housings in Madagascar are in the category of low design quality and retrofitting would result in high design quality, it was estimated that retrofitting wood housings is the most cost efficient option yielding the net benefit of approximately USD 1.4 million. While retrofitting all housings do result in substantial annual benefit of approximately USD 24.4 million in risk reduction, this option will only be cost efficient if retrofit costs are below 5% of house values (at a 5% discount rate) (Table 19). While this probabilistic CBA was performed for an illustrative purpose only, data on the specific materials and resources available in Madagascar would aid in determining a more accurate retrofit cost and contribute to better results.

Table 19: Benefit-Cost ratio of Different retrofit options (at 5% discount rate)

Type/cost	3%	5%	10%
wood	3.37	2.02	**1.01**
UM	1.73	1.04	0.52
both	2.10	1.26	0.63

Source: IIASA

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

Based on the analysis so far, the stakeholders in Madagascar for the process of risk-sensitive public investment mainly include three types of institutions:

- State agencies: the Prime Minister's Office (CPGU) and a list of Ministries which are implementing DRR (prevention and preparedness) or DM (response, recovery and reconstruction) activities: The Ministry of Finance and Budget, the Ministry of Domestic Affairs (BNGRC), the Ministry of Public Works, the Ministry of Transport, the Ministry of Agriculture, Ministry of Health, the Ministry of Interior Security and the Ministry of Education.
- NGO and Civil Society: both national and international entities mainly represented by CARE International, the Red Cross and Catholic Relief Services.
- Multilateral donors: UNDP, OCHA, FAO, UNICEF, GFDRR/WB, UNISDR.

6. Policy Recommendations[34]

The main conclusions from the overall initiative are as follows:

- Economic loss (physical and agriculture) totals USD 8.84 billion at 2012 prices.
- Geographically, the economic loss was observed in most districts. Cyclone loss was concentrated in the north-eastern (which holds the highest population density) and southwest coasts.
- Madagascar has often confronted both natural hazards such as cyclones, floods, landslides, drought, earthquakes, tsunamis, locusts and epidemics and manmade (mainly technological) hazards like transport accidents, industrial pollution, fire, forest fire, deforestation. However, the most important direct losses that Madagascar experienced from natural hazards are those that occur after cyclones. Affected family dwellings (mostly made by local non-solid raw materials, woods, leaves, etc.) remain vulnerable to cyclonic wind. Also, noteworthy is the huge damage to agricultural crops due to both locust and cyclones, destroying many plots of land during their passage. Infrastructure such as schools, and bridges made with local raw materials are also influenced and incur losses.
- The country needs to prepare for intensive risk above all in the north-eastern and south-western coasts, while extensive risk affecting most of the country.

The greatest challenge to go forward in addressing and mainstreaming DRR/CCA in public investment and risk financing strategy is the lack of pertinent policies in the fields of agriculture, road and public infrastructure, health, environment. Officers who have been dealing with the budget planning, evaluation and implementation, especially in the sub national state agencies are changed frequently according to political situation. Therefore, the staff is always composed of new persons who are unaware of DRM. Sensitization of key decision makers is crucial; short training courses on DRR concepts and its importance in poverty reduction and development are critical.

Another challenge to mainstream DRR is budget constraints. Indeed, though some decision makers are sometimes aware of the importance of DRR, the lack of resources during the five years crisis has resulted in a focus first on other priorities and emergencies. The opportunity costs of implementing DRR measures were considered too high, even if it was not necessarily true.

One good practice is what was done previous to the 2009 crisis. Indeed, financial partners and stakeholders[35] made regular courtesy visits to ministers and high decision makers to inform and sensitize. It seems that the sensitization campaign that was carried out at this time drove the political actors to explore setting up a reserve fund. However, it has to be agreed that strong financial commitment has been shown by financial partners.

Given those conclusions, the national risk profile and the lack of financial resources in the country, mainstreaming DRR in the budget planning process needs to be made more effective by implementing the following noteworthy recommendations:

- We need to invest in building a wide foundation of capacity (*i.e*. workshop trainings) before expecting to see visible progress on DRR-related concerns. For example, a capacity building program on DRR/DRM concepts will be compulsory to state agency staff.
- Technical staff of government and policy makers should be further sensitized on the importance of the DRR aspects on development so that they will apply it in the budget planning processes. Several meetings with staff of key ministries dealing with DRR should be organized to advocate DRR mainstreaming in ministerial activities.
- The awareness of the executive officers in all ministries and sectors on DRR issues and on the budget processes should be raised to make visible progress.
- A more thorough database (with more field investigation) will be necessary in Madagascar. Indeed, the time series of information related to historic losses is still inadequate to be able to conduct a probabilistic risk assessment and economic analysis.

[34] This chapter was drafted by Pierre Lazamanana.

[35] United Nations and the World Bank were supporting Damage Loss and Needs Assessment after the 2008 cyclone season in Madagascar.

- Guidelines on budget processes should be formulated in order to facilitate processes on using standards, such as the DRM marker and CBA in budgeting and implementing activities.

- A risk sensitive budget review using DRR/ DRM Marker should be established as an annual exercise in budget formulation to clarify the extent of DRR/DRM activities in ministries and to monitor trends.

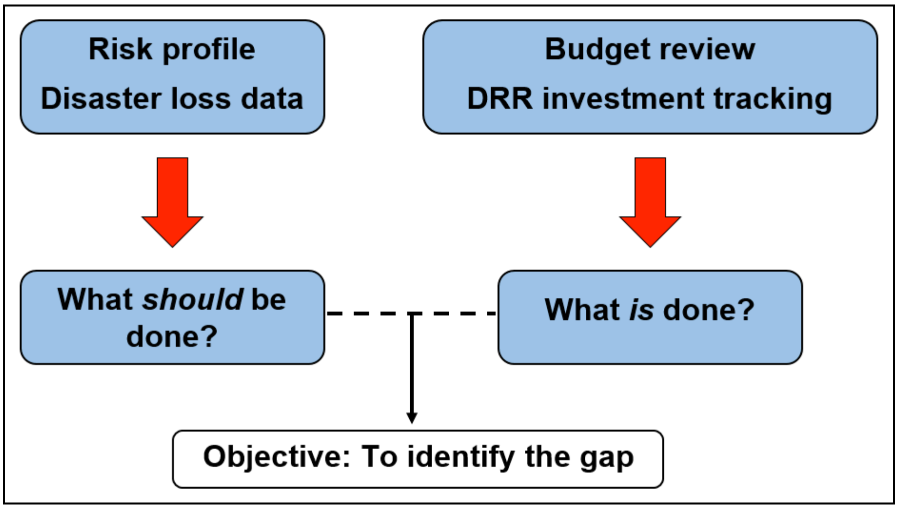
- Guidelines for retrofitting wood homes will be useful to improve the quality design of housing and to reduce vulnerability to cyclone wind around the country. Individuals should be encouraged to buy insurance to cover disaster loss. These will contribute to reduce implicit fiscal liability of government.

Annex A: Risk-Sensitive Budget Review (RSBR) [36]

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 50). 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 50: 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 20: DRR Budget in selected countries (% of total budget)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 20: DRR Budget in selected countries (% of total budget)

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

Source: Author based on HFA Progress Report for each country

[36] Section A-C of this chapter were drafted by Kazuko Ishigaki (UNISDR) and Section D was drafted by Pierre Lazamanana.

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[37]. 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 Madagascar.

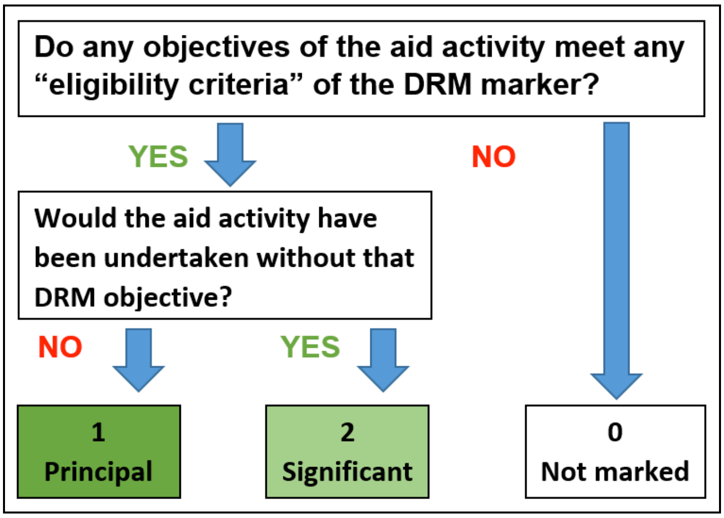
B. DRM Marker

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 51). 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[38]). 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"[39].

Figure 51: 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

[37] The Rio Marker monitors CCA aid activity since 2011. DRM Marker is proposed using the similar methodology.
[38] 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
[39] 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.

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 52, 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 52: 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[40].

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).

[40] 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 Madagascar

D.1 Scope

The scope of the budget review is defined as follows (Table 19).

Table 19: Scope of the risk sensitive budget review

Year	2010 to 2014
Coverage	Prime Minister Office and eight sectorial ministries (Domestic Affairs, Finance, Education, Interior Security, Health, Agriculture, Public Works, Transport)
Budget or expenditure	Budget
Current or Capital	Current
Targeted hazards	Cyclone, floods, epidemics and locust

Year/Period: The budget in period of 2010 to 2014 (five years) was examined.

Coverage: The Budget Review currently covers both the Prime Minister Office budget and eight sectorial budgets that take into account DRM/DRR activities. The sectors include:

- Domestic Affairs
- Finance
- Education
- Interior Security
- Health
- Agriculture
- Public Works
- Transport

Budget or Expenditure: Data used to clarify the amounts in DRR/DRM category are drawn from national budgets, not expenditures.

Capital (investment) or Current budget: The amounts that have been taken into consideration are mainly current budgets.

Targeted disasters: The targeted disasters include geological (*e.g.* earthquake, tsunami, landslide), meteorological (*e.g.* cyclone, heat wave) and hydrological disasters (*e.g.* flood, landslide, drought). It is noteworthy that hazards with an important effect such as epidemics, locust, fire, and bush fire have a high probability of occurrence in Madagascar but they are not included in targeted hazards in the present study.

Documents available and used: The main documents that have been used are the Finance Act for the years from 2010 to 2014 which are available in the website of the Ministry of Finance and Budget of Madagascar (www.mfb.gov.mg) and the detailed line by line database of Ministry which is also available in electronic format in the Ministry of Finance and Budget.

Process: Several meetings with staff of Ministry of Finance to advocate and to prepare data collection;
One informative session with the Technical Work National Group on ISLANDS Project whose members are from the main stakeholders mentioned before; Data compilation (Ministry of Finance and Budget and state agencies); preliminary quantitative analysis; main analysis using DRM Marker methodology.

D.2 RSBR Results

The initial analysis has produced a foundation of knowledge about current investment in DRM at various levels and in many sectors. Nonetheless, many efforts are still required to cover the central government, state corporations and the sub-national state agencies.

The overall estimated investment in DRM/CCA identified in this review is in total about USD 131 million, which is approximately 1.9% of the total budget of USD 7027.1 million between 2010 and 2014. Most of the budget is identified under the category “Principal” as shown in Table 17 below.

The Review also tried to divide the marked budget in categories according to the allocation within the DRM process. By far the most important category is for disaster response and preparedness as shown in the Table 20.

Table 20: DRM/CCA investments in 4 DRM sub-components for the 5 Year-Total

Budget allocations per Risk Management phase/category	Significant (USD million)	Principal (USD million)	Total (USD million)	Percentage of Total Marked (%)
Prevention/mitigation (1)	4.9	13.0	17.9	13.7
Preparedness (2)	5.1	40.6	45.8	34.9
Response (3)	0.3	62.2	62.5	47,7
Reconstruction (4)	-	4.9	4.9	3.7
Total budget allocations	**10.4**	**120.7**	**131.0**	**100**
Share of total budget (USD 7.027 billion)			**1.87%**	

Source: Author based on Ministry of Finance and Budget

While the proportion invested in risk reduction (56% over the five years) is roughly equivalent to disaster management (44%), scrutiny in Table 21 reveals the highest investment is still attributed to response (five year average of 36.3% compared to 20.2% for prevention/mitigation or 7.7% for reconstruction). Especially noteworthy is response spending in 2014 by reaching 74.7% of the total Marked. This suggests the focus of DRM project in Madagascar is response and preparedness and the country is dominated by the paradigm of disaster management.

In comparison with the figure in 2013, an increase of 35.2% has been registered in 2014. This was explained by the huge investment in the locust response. Another noteworthy hike is under preparedness for 2011 when the amount had represented 78.6% of the Total Marked. Investment in preparedness was the highest of the four components in 2010 and 2011, with 57.3% of the total marked in 2010. No reconstruction activity was budgeted during the same year. Otherwise, the latter attracted 1.6% of the DRR total budget and the response activities monopolized 74.7% of the DRR budget in 2014.

Table 21: DRM-Tagging per DRM Sub-component

Period	Risk Reduction		Disaster Management		Total (million USD)
	Prevention/ Mitigation	Preparedness	Response	Reconstruction	
2010	20.3%	57.3%	22.4%	0.0%	14.8
2 011	10.0%	78.6%	11.4%	0.0%	28.6
2 012	28.0%	11.4%	33.5%	27.0%	7.4
2 013	37.6%	12.8%	39.5%	10.1%	18.5
2 014	4.9%	18.7%	74.7%	1.6%	61.7
5-Year Average	20.2%	35.8%	36.3%	7.7%	
	0.91%		0.96%		

Source: Author based on Ministry of Finance and Budget

We can notice in **Table 22** below that an increase of 43.2 million has been registered in 2014 on the total marked public investment (43.2 USD million) because of the rise of the budget invested in the locust.

Table 22: DRM/CCA investments by DRM/DRR Marker for the period 2010-2014

	Significant (USD million)	Principal (USD million)	Total Marked Budget (USD million)
2010	3.4	11.4	14.8
2011	2.3	26.4	28.6
2012	2.4	5.0	7.4
2013	1.6	16.9	18.5
2014	0.7	61.0	61.7
Total 5-Year (2010-2014)	**10.4**	**120.7**	**131.0**

Source: Author based on Ministry of Finance and Budget

Regarding marked budget by sector, share of budget is the largest in Prime Minister's Office (average is 0.45%), followed by Ministry of Agriculture (0.41%), and Ministry of Finance (0.39%) (**Error! Reference source not found.**). In fact, those three state agencies have had the greatest responsibility with DRM/DRR concerns during the political crisis until present. The Prime Minister Office has been the public institution that invested most in DRR with 30.3% in 2010. And this proportion has increased to 68.3% in 2011. The contribution of the Ministry of Finance has risen from 0% to 42.6% during the period 2010 to 2014.Ministry of Agriculture always contributes more than 10%.

Table 23: "Marked" Budget per sector (Above: % of Total Budget, below: % of total DRM budget))

Level/sector	2010	2011	2012	2013	2014	AVERAGE
Prime Minister Office	0.30 (30.3%)	1.31 (68.3%)	0.01 (1.2%)	0.01 (0.7%)	0.64 (14.1%)	0.45
Agriculture	0.20 (19.8%)	0.20 (10.5%)	0.11 (19.2%)	0.21 (16.2%)	1.31 (28.9%)	0.41
Finance	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.03 (2.5%)	1.94 (42.6%)	0.39
Domestic Affairs	0.11 (10.6%)	0.10 (5.3%)	0.07 (11.3%)	0.38 (29.2%)	0.26 (5.7%)	0.18
Public Works	0.13 (12.7%)	0.11 (5.5%)	0.01 (1.4%)	0.40 (30.8%)	0.19 (4.2%)	0.17
Transport	0.00 (0%)	0.13 (0%)	0.16 (27.0%)	0.13 (10.1%)	0.07 (1.6%)	0.10
Health	0.16 (15.6%)	0.13 (6.6%)	0.08 (13.6%)	0.05 (3.8%)	0.03 (0.6%)	0.09
Interior Security	0.08 (7.5%)	0.06 (2.9%)	0.13 (22.5%)	0.07 (5.2%)	0.03 (0.6%)	0.07
Education	0.03 (3.5%)	0.02 (0.9%)	0.02 (3.8%)	0.02 (1.4%)	0.08 (1.7%)	0.03
Total	1.00 (100%)	1.92 (100%)	0.58 (100%)	1.31 (100%)	4.55 (100%)	1.87

Source: Author based on Ministry of Finance and Budget

D.3. Gap between loss, risk and DRM budget

Component 2 of the project determined an AAL of USD 73.9 million to cyclonic winds and earthquakes; combined they represent 2.9‰ the value of exposed assets, 4.3% of Gross Fixed Capital Formation, and 1.2% of GDP. The overall estimated investment in DRM/CCA identified in Madagascar through the above budget review, over the studied years 2010-14 is USD 131 million with annual average of USD 26.2 million (ranging from 7.4 to 61.7 million).

A simple comparison of AAL to the 5-year average annual investment in DRM indicates a **negative balance: there is greater expected loss to the two hazards than investment.** Furthermore, the marked investments in DRM significantly fall short of registered average annual loss between 1980 and 2014. In general, more investment in DRM is needed to offset expected loss.

It is also crucial to point out that AAL is only estimated for tropical cyclonic wind and earthquake risks only and go back to the actual marked activities to determine their link to these two hazards. If the studied investments had no discernable link to cyclones or earthquakes, of course, the DRM budget impacts of offsetting AAL would have much less value.

Table 23: Checking the Gap: DRR budget, loss and risk

	DRM budget 5-year average in 2010-2014	AAL (tropical cyclonic wind and earthquake only)	Loss, 1980-2014 (1378 data cards)
Value	USD 26.2 million	USD 73.95 million	USD 8,839 million (Annual average: USD 259.9 million)
Status		GAP	GAP

As reference, loss data was also compared to the budget. Again, this comparison does not show a positive balance, as even the average registered loss over past 34 years exceeds the annual investment in DRR.
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 and the budget review as a combined tool to move Madagascar towards risk-sensitive public investment in light of their most important natural hazards.

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 Madagascar towards risk-sensitive public investment in light of their most important natural hazards.

D.4. Challenges experienced in conducting Risk Sensitive Budget Review

The main challenges in conducting the budget review in Madagascar were as follows:

- The awareness and understanding of the executive officers in all ministries and sectors on DRR issues and on the budget processes has been insufficient to make progress readily.
- Officers who have been dealing with the budget planning, evaluation and implementation, especially in the sub national state agencies are changed frequently so the staff is always composed of new persons who are unaware about DRM. We need to invest time in building wide foundation of capacity first through measures such as giving training program before expecting to see visible progress on DRR-related concerns. Continuous sensitization is required.
- Insufficient government's resource means high opportunity cost when implementing review
- Guidelines on budget processes should be formulated in order to facilitate processes on using standards on DRM marker in budgeting and implementing activities.
- No clarification on the respective role of each institution: should ministries deal with DRR or not?
- There are no detailed data within ministries. There is no DRM Marker applied to date when planning budget.
- Institutionalizing DRM marker would be a challenge.

D.5. Next steps to be considered: Other Levels and Categories

In terms of public investment and budgetary formulation, local level authorities have just to highlight their priorities and plan their activities. Then, the central ministry is accountable for the budget project formulation, which should be suggested to ministries councils. In fact, the decentralization application is not yet effective in the country.

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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 CATSIM Assessment for Madagascar[41]

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 24): 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.

Table 24: 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

[41]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 Madagascar team and UNISDR.

B. CATSIM analysis in Madagascar

In this analysis, we also implemented the comparison between CATSIM results in 2012 and results based on this initiative.

Step 1: Direct Risk Assessment

This study evaluates the ability of the Government of Madagascar to manage potential fiscal and economic risk arising from cyclone (wind) and earthquake combined. Probabilistic risk assessment using the CAPRA GIS software shows that the estimate provided in this study is lower than the previous estimate using backward looking assessments based on EM-DAT and Manages (see Hochrainer-Stigler 2012 for further details) (Table 25). The differences in assessments illustrate that the uncertainty regarding direct risk is high and further validation of risk assessment would be useful.

Table 25: Estimated PML at varying return periods (in USD million) [42]

Return period	CAPRA estimate (implemented in this initiative)	Hochrainer-Stigler 2012 based on EM-DAT*	Hochrainer-Stigler 2012 based on Manages*
5	50.5	-	-
10	138	-	-
20	275	229	5,311
50	545	820	7,982
100	826	2,094	13,044
500	1,783	17,908	17,304
1000	2,293	-	-
AAL	58	-	-

Note: * expressed in terms of 2000 USD

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

Total contingent liabilities of Madagascar Government were estimated as outlined in Table 26.

Table 26: Estimated Government Direct and Contingent Liability

Item	Value (in USD billion) in this study	Value (in USD billion) in 2012 study	References
Total Capital Stock	51	54.8	Penn World Table (2014)
Public Capital (a)	15.3	16.4	Assumed as 30% of total capital stock based on Hochrainer-Stigler (2012)
Private Capital	35.7	38.4	Assumed as 70% of total capital stock based on Hochrainer-Stigler (2012)
Relief Spending (b)	10.2	10.9	Assumed as 20% of total capital stock based on Hochrainer-Stigler (2012)
Governments Total Liability (a+b)	25.5	27.3	N/A

Source: Author

[42] 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 note reiterate the CATSIM assessment based on new data. The inconsistency with Chapter 2 stems from this issue.

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 27 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 Madagascar. We also did not consider ex-ante options because of data availability issues.

Table 27: Estimated ex-post fiscal resources availability in Madagascar

Sources	Assumptions	Value in current study	Value in 2012 study
International Donor Assistance	10.4% of public liability based on international average[43]	10.4% of damage	10.4% of damage
Diversion from budget	5%>deficit, then 0 5%<deficit, then 5% of total revenue	USD 30.2 million	USD 68 million (0.1% of the budget)
Domestic Bonds and Credit*	1% of gross domestic credit from private bank	USD 7.9 million	USD 50 million
MFI/ International bond market borrowing	SDR allocation	USD 120.2 million	USD 40 million
Total excluding international assistance		USD158.3 million	USD 158 million

Source: Author

Assumptions for fiscal resource availability

International assistance

[43] 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.

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 Madagascar 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

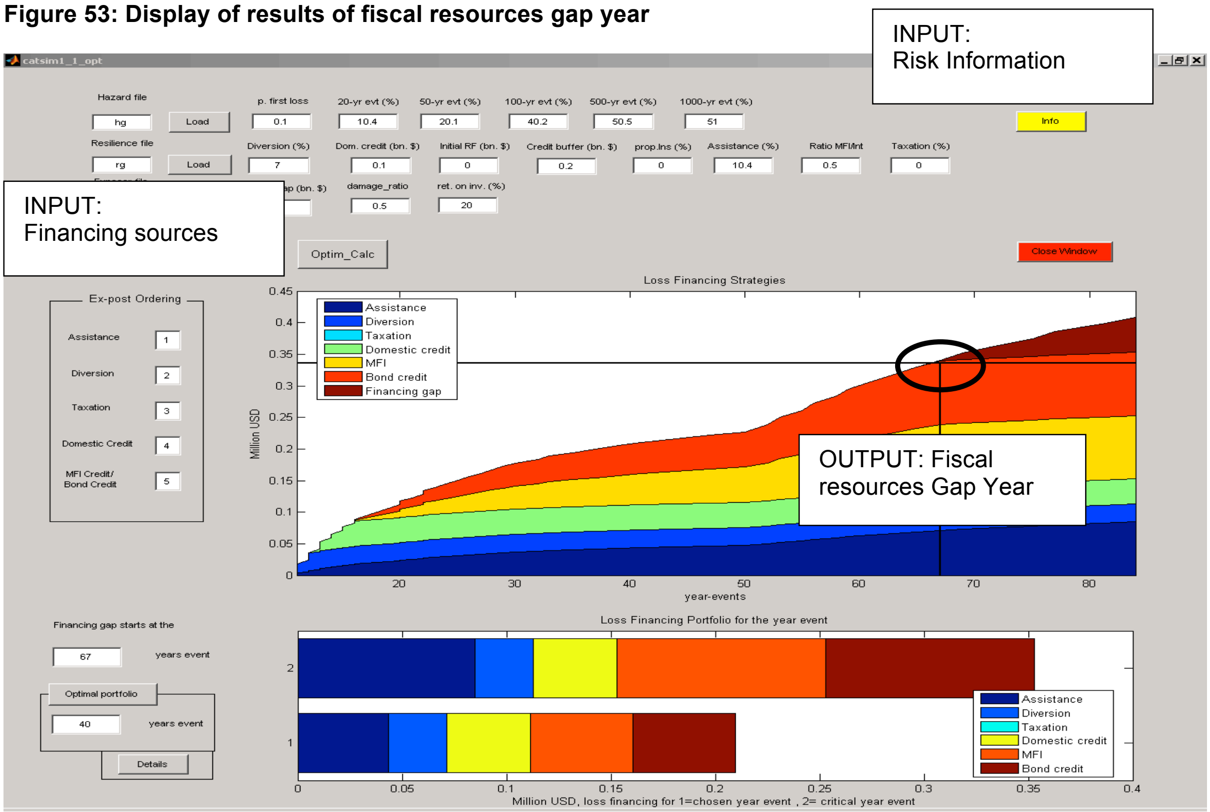
A further option for financing reconstruction and recovery comes from borrowing on international markets and from multi-lateral financing institutions. The International Monetary Fund's Special Drawing Rights (SDRs), which represent an international reserve asset, is used as a baseline estimate for how 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).

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 55). 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 53: Display of results of fiscal resources gap year

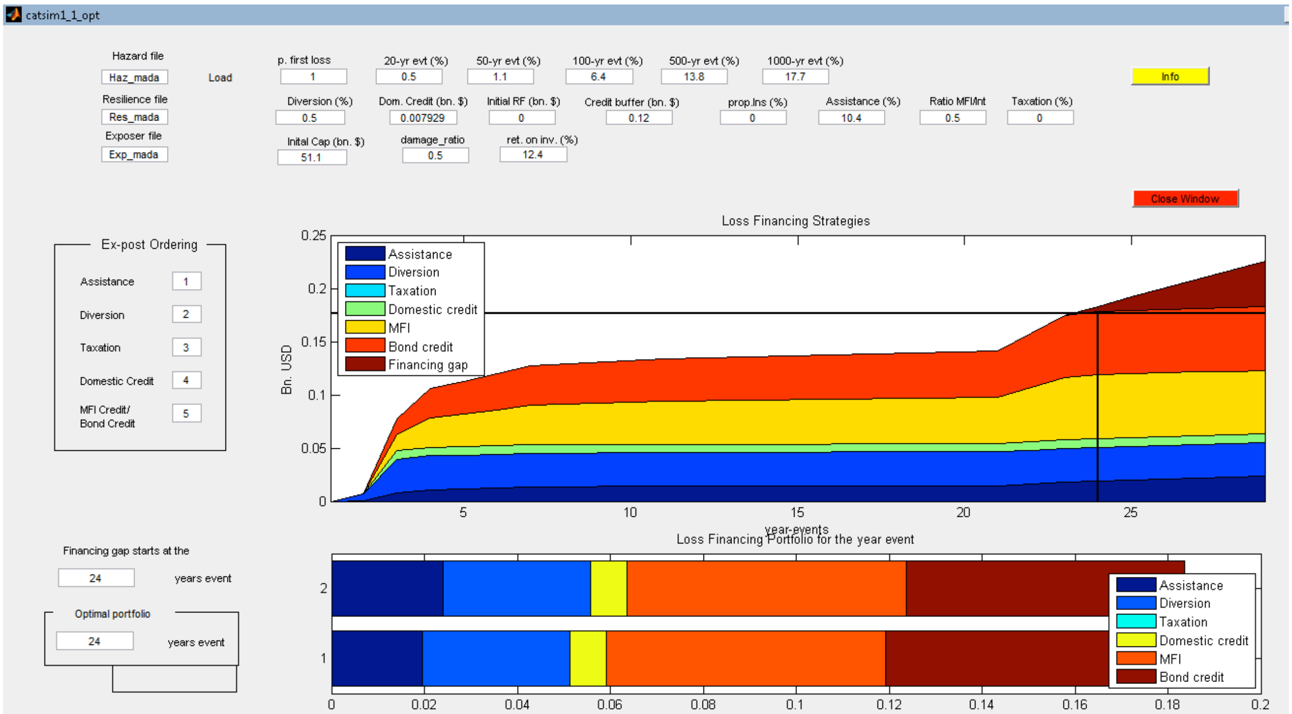


Source: Author

Figure 54 shows the current estimate while Figure 55 shows the estimate based on fiscal parameters obtained in the 2012 study and risk parameters estimated in Hochrainer-Stigler (2012). Based on the current study, the fiscal resources gap is estimated at 24 years while 2012 study shows 23 years.

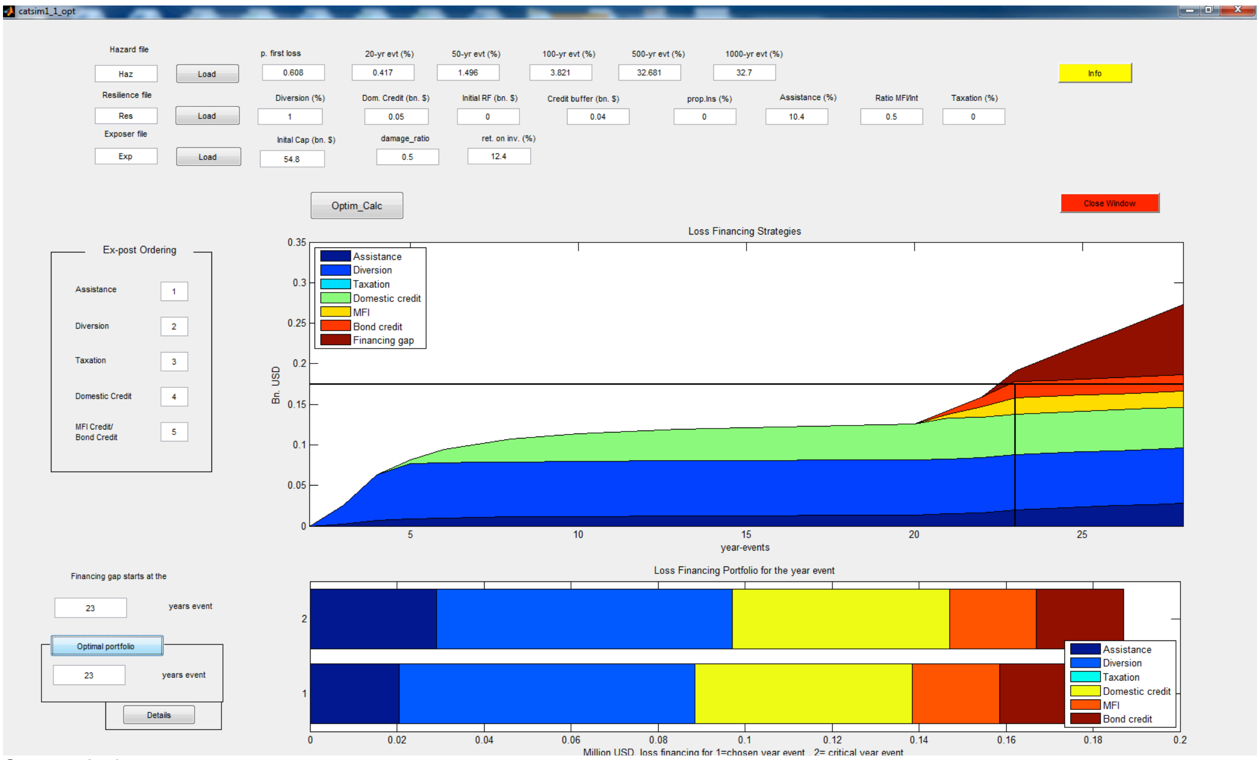
The relatively close figures estimated for fiscal gaps in 2012 and this study is explained partly by the fact that assets and disaster related information collected in 2012 was used as inputs for risk analysis in Component 2. However, the breakdown of funding sources is markedly different, especially with regards to the access to domestic credit and international lending (Figure 56). This difference is due to the fact that the current estimate of fiscal parameters is made based on standard assumptions applied in the global assessment (Hochrainer-Stigler et al. 2014). Therefore, further validation of fiscal parameters through national workshops and interviews with national stakeholders will be necessary.

Figure 54: Fiscal resources gap year estimated in the current study



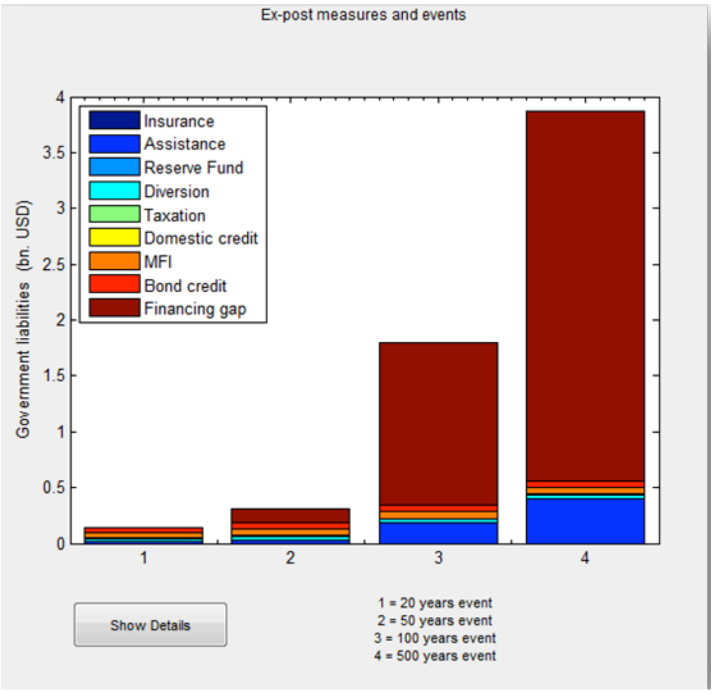
Source: Author

Figure 55: Fiscal resources gap year estimate based on Hochrainer-Stigler (2012)



Source: Author

Figure 56: Fiscal resource gap in this initiative and in 2012 study

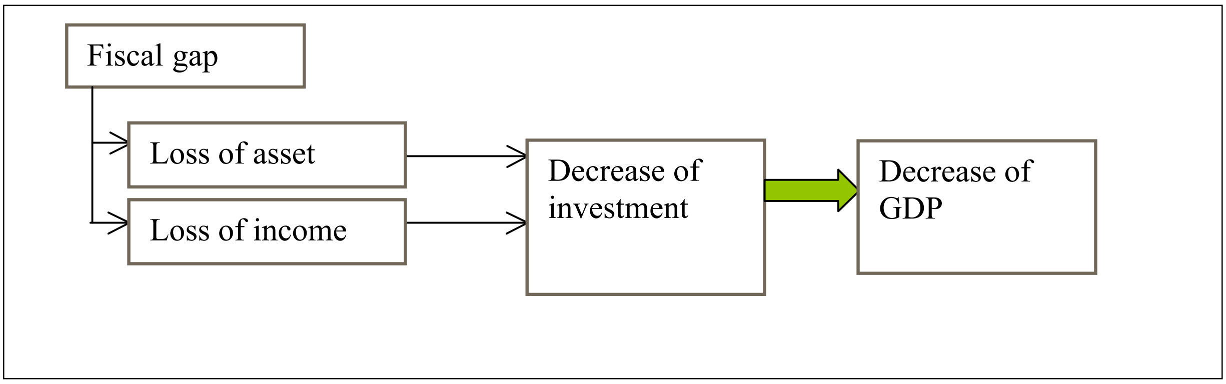


Source: Author

Step 4: estimating indirect economic impact of disasters

Fiscal gap that cannot recover damaged public infrastructure and other productive assets due to disasters could adversely affect the country's future economic growth trajectory (Figure 57).

Figure 57: Impact of fiscal gap on GDP



Source: UNISDR input to this study

To estimate the magnitude of risk to future growth prospects, this study uses a simple exogenous growth model as described in Hochrainer-Stigler (2012) and projects stochastic growth trajectories of macro-economy. The country's GDP is assumed to depend on the state of technology as well as labour and capital inputs, where dynamic changes in the capital asset occur as a result of investment, depreciation, and stochastic natural disaster capital destruction. Specifically, the country's aggregate economic output on the supply side (Y) is described using a Cobb-Douglas function as:

$Y = A K^a L^b$

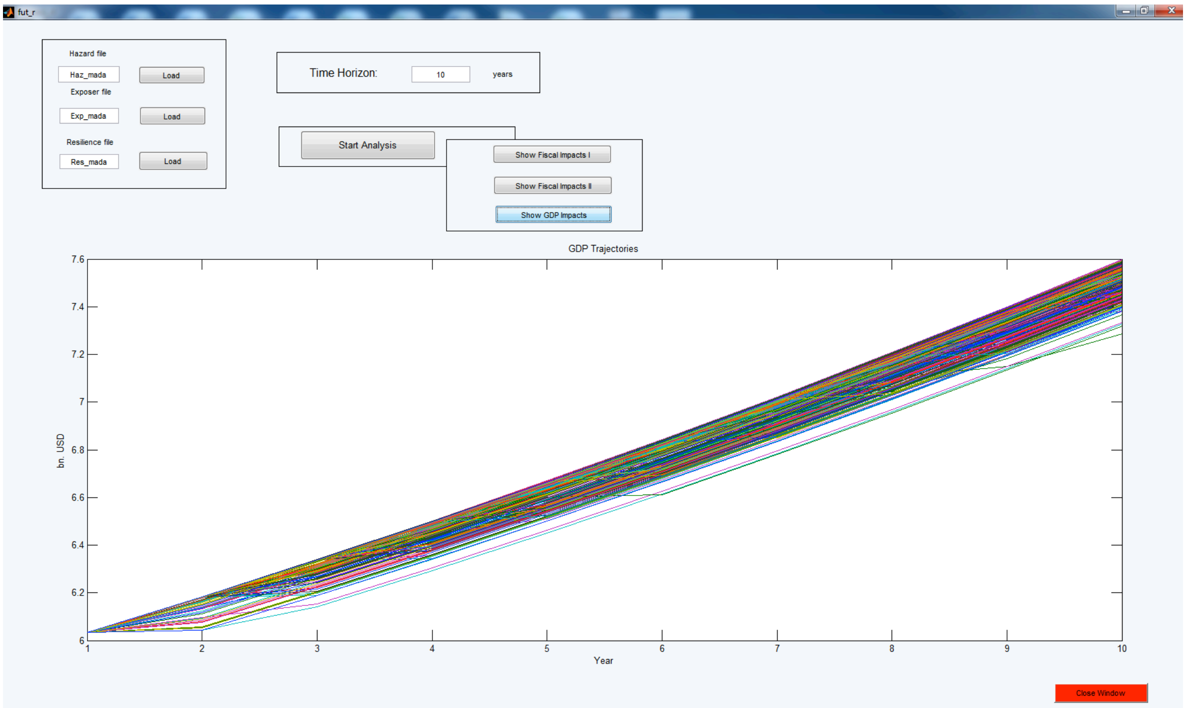
Where K denotes total capital stock and L labour.

An annual change in capital (DK) is expressed as:

$DK = I - DK_{dep} - DK_{cat} + I_{recon}$

Where I is aggregate public and private investment, DK_{dep} depreciation, DK_{cat} destruction of capital due to disasters, I_{recon} replacement of capital due to reconstruction. In the baseline case without any disaster event, Madagascar's GDP is expected to grow from the current level of approximately USD 6 billion to USD 7.6 billion in ten years. In case of catastrophic disaster events, the country's growth trajectory may move downward as shown in Figure 58.

Figure 58: Potential GDP growth trajectory under disaster risk in Madagascar



Source: Author

Step 5: Evaluating risk management options

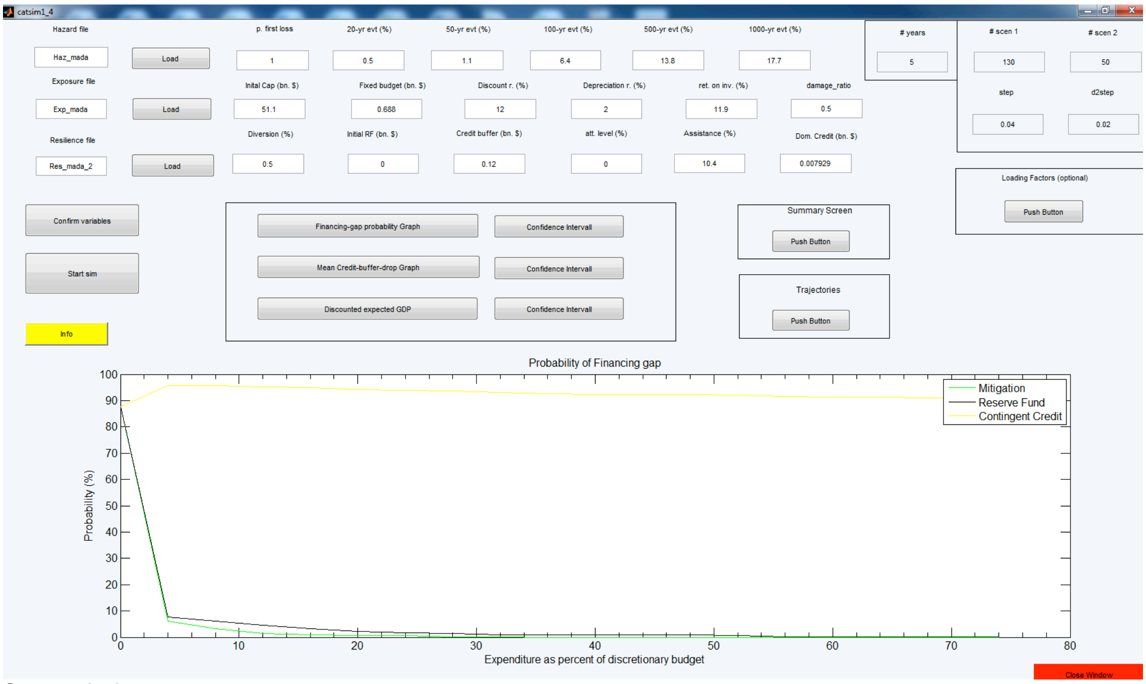
As the final step of CATSIM analysis, this section evaluates the effectiveness of the following ex-ante risk management options:

- Risk reduction investment
- Reserve fund arrangement
- Contingent credit arrangement

The input parameters used in this section are based on Hochrainer-Stigler (2012). The efficiency of DRR investment is assumed as 4.5 (*i.e.* for every dollar spend on DRR investment, there is USD 4.5 benefit in risk reduction over-time). A reserve fund is assumed to accumulate interest at the rate of 6% annually. Contingent credit arrangement has an annual fee of approximately 0.5% of loan with an interest rate of 6%.

The results of risk management evaluation (Figure 59) show that by investing approximately 4% of discretionary budget in DRR, the government may reduce the probability of facing a fiscal resources gap from the current level of above 85% to less than 10% over the next five years. The same amount of resources allocated for a reserve fund will also reduce the probability of a fiscal resources gap below 10% over the next 10 years. On the other hand, contingent credit arrangement is found not to reduce the probability of a fiscal resources gap over the long-run. This is because the additional resources used to repay the loans made under the contingent credit arrangement will reduce resources available to manage disaster risk over-time.

Figure 59: Risk Management Policy Evaluation for Madagascar



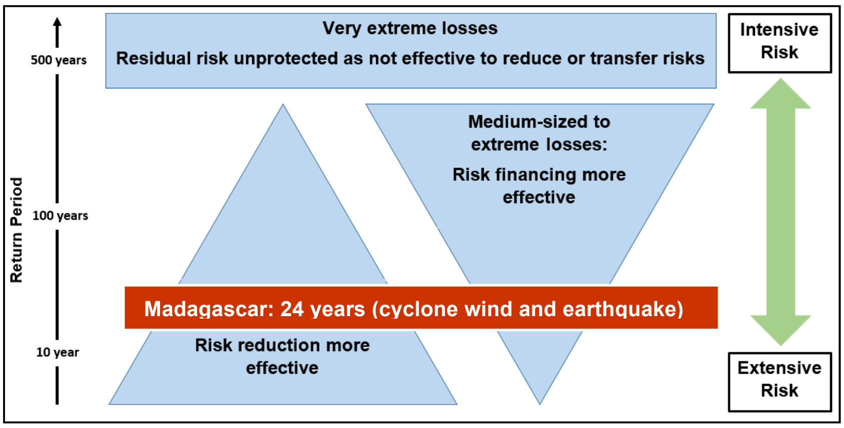
Source: Author

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 60). The CATSIM analysis conducted from Steps 1 to 3 has illustrated the need for improved management of disaster risk in Madagascar.

The current fiscal gap for Madagascar is estimated to be 24 years. Given the relatively low fiscal resources gap year estimated, it is advisable that additional resources be first allocated to risk reduction investments and the continued use of a reserve fund.

Figure 60: Risk layering



Source: Author

The use of a reserve fund has been discontinued in recent years, where the government faces a practical issue regarding how the account created in the name of a former administration can be transferred to the current one. As the use of reserve fund comes at high opportunities for developing country governments with competing development needs, it is more advisable that the Madagascar government considers allowing a portion of the reserve to be used for DRR investment.

In particular, the government may identify priority areas for DRR investment with high potential co-benefits to other development needs (such as education, public health, and rural development). Identification of locally appropriate and affordable DRR options will be a key to promoting DRR investment.

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

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 Madagascar 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 Madagascar and other IOC countries (Table 28). 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 Madagascar.

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 Madagascar 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 28: 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: Author

Reference

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ANNEX C: Micro / Cost-Benefit Analysis (CBA)[44]

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 29). 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 29: 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.

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

[44] 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).

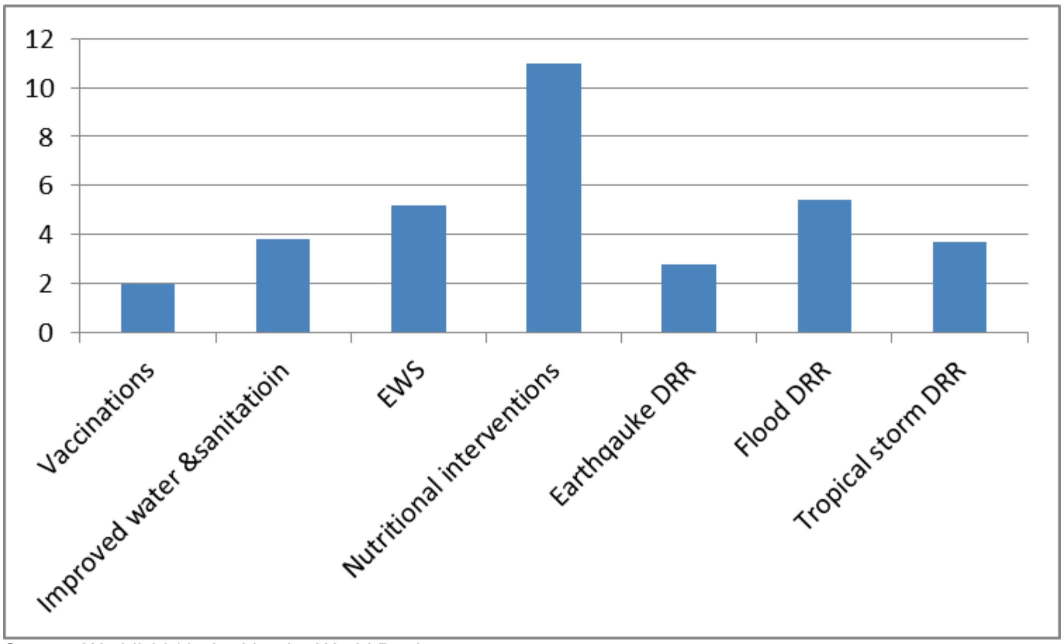
items?). Furthermore, there are concerns regarding who conducts the CBA in order to retain objectiveness and accountability. Administrative costs for implementing CBA are also a concern for government.

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 61 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 61: 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 30). Now that more countries have risk profiles, more accurate forward-looking benefit estimation is increasingly possible.

Table 30: 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 62). 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 62: 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)

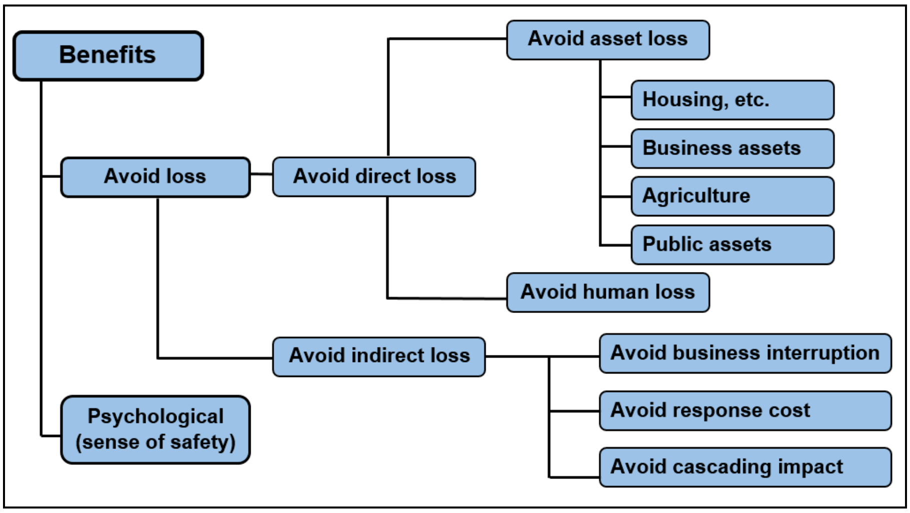
STEP 4: Sensitivity Analysis

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 63).

Figure 63: Expected benefits from DRR investment

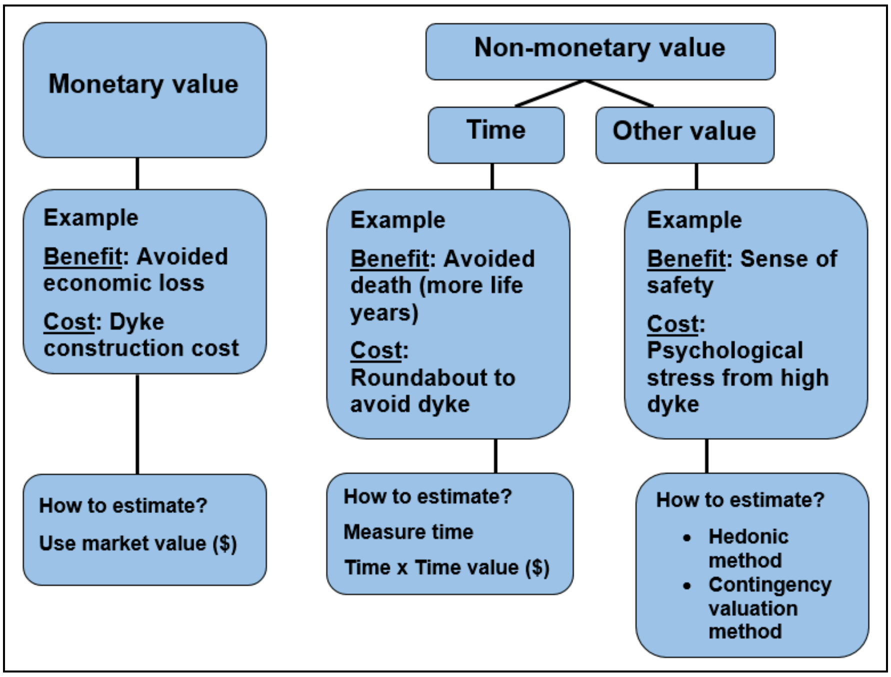


Source: Author

In estimating benefit, a main challenge is to assign monetary values to each expected benefit (Figure 64). If the benefits and costs have monetary values, the government can use them[45]. If the benefit is expressed by time (*e.g.* reduction of commuting time due to road infrastructure), the government needs to estimate the time gained and multiply it by the value of time (*e.g.* the average wage or minimum wage per hour).

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

Figure 64: Expected benefit classification



Source: Author

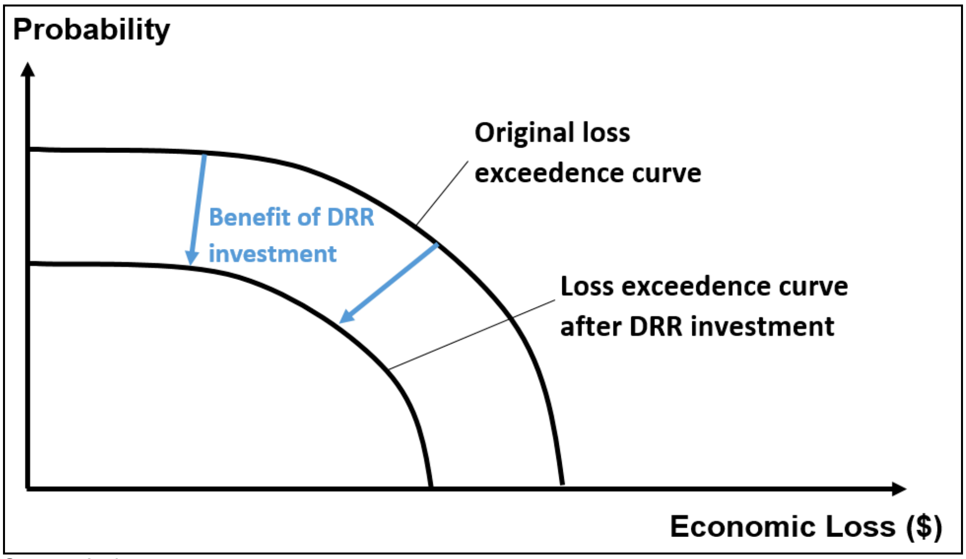
It is important to keep it in mind that this CBA often reflects only partial benefits. In probabilistic CBA, estimation of avoided loss is based on probabilistic risk assessment (forward-looking CBA) or historic loss database (backward-looking CBA). In that sense, the scope of CBA analysis is defined by the scope of risk and loss data.

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

For the case study described below, the risk assessment was limited to direct loss. Therefore, the CBA study also focuses only on the direct loss (written in bold in Figure 57). However, this is nonetheless a meaningful first step, because physical loss often needs to be recovered by reconstruction, which is very costly.

The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment (Figure 65). 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[46]).

Figure 65: 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[47]. 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 31). 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.

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

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

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

[47] 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.

Table 31: Discount rates in several countries

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

Source: 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 wood and unreinforced masonry housings against cyclone wind damage and compare the Benefit-Cost (B/C) ratio 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 the cyclone (wind) and based on discussion with Madagascar team, we selected its impact on housings.

Wood and Unreinforced masonry housings make up 78% of all residential land area in Madagascar (INGENIAR, 2014).

II. Key Assumptions

1. Housing Quality

We adopt the following assumptions for wind retrofitting.

- All housings in Madagascar are in the category “low design quality” according to the Global Assessment Report (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 32was provided by the Madagascar consultant to show the damage to housing types due to the 2012 cyclone. Linking these figures to the GAR vulnerability curves we confirmed the associated damages were in line with those of “low design quality”. Based on the vulnerability curves we also assume that “semi solid and solid housing” represents the “unreinforced masonry housings” in Madagascar.

Table 32: Average damage to housing units (low design quality) per type and per category of the cyclone in 2012 (percentage)

	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)
Traditional (wood) housing	34	36	55	75
Semi solid and solid housing (Regarded as "unreinforced masonry housings)	28	37	42	50

Source: CERED (Centre d'Etudes et de Recherches Economiques pour le Developpment)/ University of Antananarivo, 2012.

Table 33 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 33: Mean damage percentage to housing units with "high design quality" according to 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)
Traditional (wood) housing	0	0	5	25
Semi solid and solid housing(Regarded as "unreinforced masonry housings)	0	0	2	10

Source: GAR 2013

2. Retrofitting Costs

There is no readily available cost estimate of wind retrofitting options in Madagascar, 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[48]. This variation of cost is represented below for the sensitivity analysis. Table 34 below shows the estimated total cost of retrofitting wood and semi solid and solid housing (unreinforced masonry housings) based on different costs assumptions.

Table 34: Total cost of retrofitting wood and unreinforced masonry housings (USD)

cost	wood	Semi solid and solid (unreinforced masonry)	total
3%	39,513,767	133,655,375	173,169,143
5%	65,856,279	222,758,959	288,615,239
10%	131,712,559	445,517,919	577,230,478
15%	197,568,839	668,276,879	865,845,718

Source: Author

3 Time factors

3.1 Discount rate

There has been no official social discount rate in Madagascar. 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 Madagascar, 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

[48] Gujarat 2001; Li, Stewart 2011, Stewart, Rosowsky, Huang, 2003; Pinelli, Torkian, Gurley, Subramanian, Hamid, 2009

be assumed that the benefits will remain at the values specified in Table 33 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 associated. We assume the lifetime of the retrofit to be 30 years.

III. Results

1. Benefits

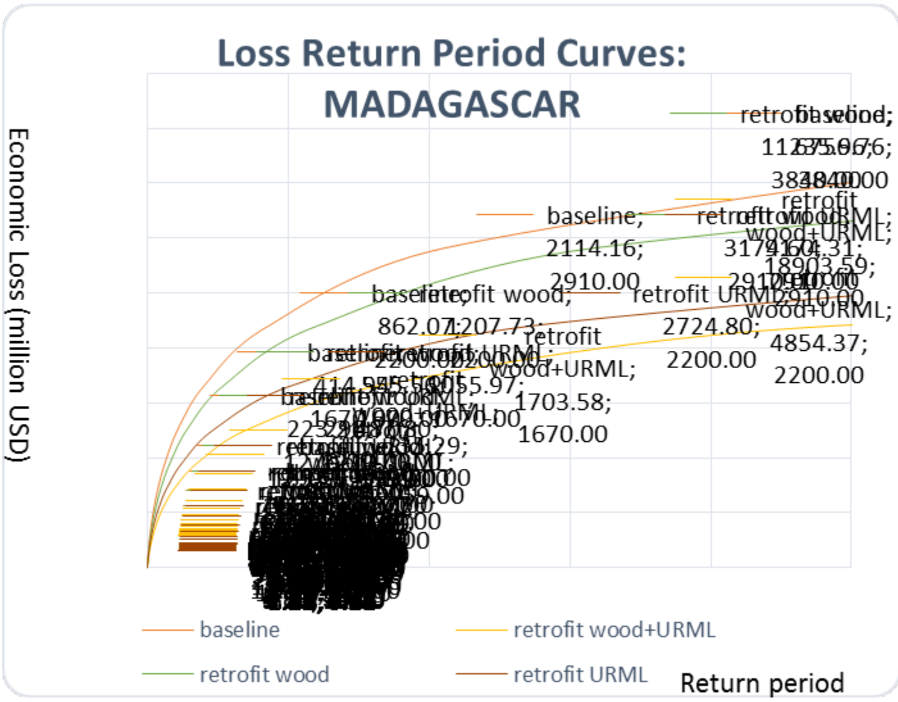
Benefits of retrofitting have been assessed using the CAPRA GIS risk software (CAPRA-GIS V2.0). Hazard, exposed asset, and vulnerability files were eventually obtained and run in CAPRA to determine the Annual Average Loss (AAL). The vulnerability inputs were then adjusted for residential building made of wood and unreinforced masonry 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 35 shows this benefit in terms of reduced AAL for retrofitting wood housing only, unreinforced masonry housings only and both housing types. Figure 66 shows the shift in the loss return period curves[49], illustrating the reduction in vulnerability as a result of the retrofitting.

Table 35: Annual benefit of retrofitting (in USD million)

AAL before retrofitting (AAL1)	Option for retrofitting	AAL after retrofitting (AAL2)	Benefit of retrofitting (AAL1-AAL2)
57.4	Wood only	48.5	8.9
	Unreinforced Masonry (UM) only	42.0	15.5
	Both wood and UM	33.0	24.4

Source: Author

Figure 66: Loss Return Period Curves for different retrofit options



Source: Author

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

2. Net Present Value

Table 36 below shows the results of the CBA with a cost of retrofitting wood housings at 10% of the housing value and a 5% discount rate. As can be seen, the Net present Value (NPV) is positive, suggesting a cost efficient project.

Table 36: CBA of wood housings with 10% retrofit cost and 5% discount rate (amounts in USD)

Project year	Calendar year	benefits(no exposure increase)	costs (10% of housing value)	net benefits	discounted net benefits (5%)
1	2013	0	131,712,559	-131,712,559	-131,712,559
2	2014	8,920,000	0	8,920,000	8,474,000
3	2015	8,920,000	0	8,920,000	8,050,300
4	2016	8,920,000	0	8,920,000	7,647,785
5	2017	8,920,000	0	8,920,000	7,265,396
6	2018	8,920,000	0	8,920,000	6,902,126
7	2019	8,920,000	0	8,920,000	6,557,020
8	2020	8,920,000	0	8,920,000	6,229,169
9	2021	8,920,000	0	8,920,000	5,917,710
10	2022	8,920,000	0	8,920,000	5,621,825
11	2023	8,920,000	0	8,920,000	5,340,733
12	2024	8,920,000	0	8,920,000	5,073,697
13	2025	8,920,000	0	8,920,000	4,820,012
14	2026	8,920,000	0	8,920,000	4,579,011
15	2027	8,920,000	0	8,920,000	4,350,061
16	2028	8,920,000	0	8,920,000	4,132,558
17	2029	8,920,000	0	8,920,000	3,925,930
18	2030	8,920,000	0	8,920,000	3,729,633
19	2031	8,920,000	0	8,920,000	3,543,152
20	2032	8,920,000	0	8,920,000	3,365,994
21	2033	8,920,000	0	8,920,000	3,197,694
22	2034	8,920,000	0	8,920,000	3,037,810
23	2035	8,920,000	0	8,920,000	2,885,919
24	2036	8,920,000	0	8,920,000	2,741,623
25	2037	8,920,000	0	8,920,000	2,604,542
26	2038	8,920,000	0	8,920,000	2,474,315
27	2039	8,920,000	0	8,920,000	2,350,599
28	2040	8,920,000	0	8,920,000	2,233,069
29	2041	8,920,000	0	8,920,000	2,121,416
30	2042	8,920,000	0	8,920,000	2,015,345
31	2043	8,920,000	0	8,920,000	1,914,578
	total	267,600,000	131,712,559	135,887,441	**1,390,463**

Table 37, Table 38 and Table 39 show the results of sensitivity analysis with regards to the project cost, the discount rate and project lifespan, which can be seen in Tables 35, 36 and 37below.

Table 37: Sensitivity analysis with regards to project cost for wood housings (at 5% discount rate)

cost	3% of housing value	5% of housing value	10% of housing value
NPV	93,589,255	67,246,743	**1,390,463**
B/C	3.37	2.02	**1.01**

Table 38: Sensitivity analysis with regards to discount rate (at 10% cost)

discount rate	15%	10%	7%	5%	2%	0%
NPV	-81,551,602	-54,835,721	-26,639,005	**1,390,463**	66,947,154	135,887,441
B/C	0.38	0.58	0.80	**1.01**	1.51	2.03

Table 39: Sensitivity analysis with regards to project lifespan (at 5% discount rate and 10% cost)

project lifespan	10 years	20 years	30 years
NPV	-63,706,496	-22,988,753	**1,390,463**
B/C	0.52	0.83	**1.01**

3. Other Options

Table 40below shows the benefit-cost ratios of retrofitting in three cases: i) wood housing only, ii) unreinforced masonry housing (UM) only, and iii) both housing types. From this analysis, it appears that retrofitting wood housings only is the most cost efficient option.

Table 40: Benefit-Cost ratio of Different retrofit options (at 5% discount rate)

Type/cost	3%	5%	10%
wood	3.37	2.02	**1.01**
UM	1.73	1.04	0.52
both	2.10	1.26	0.63

4. Conclusions

While the lack of locally specific cost estimates prohibits detailed analysis of wind-retrofitting interventions, a tentative conclusion suggests that retrofitting wood housings is the most cost efficient option due to the high wind vulnerability of these housings. While retrofitting all housings do result in substantial annual benefit of approximately USD 24.4 million, this option will only be cost efficient if retrofit costs are below 5% of housing values (at a 5% discount rate). Data on the specific materials and labour costs available in Madagascar would aid in determining a more accurate retrofit cost.

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Annex D: Workshops and Meetings in IOC region

<u>**Inception meeting**</u>

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

<u>**Component 1: capacity building for national disaster loss database**</u>
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

<u>**Component2: Capacity building for Probabilistic Risk Assessment:**</u>

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

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