Review of Seychelles

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Review of Seychelles

February 2015

UNISDR Working Papers on
Public Investment Planning and Financing Strategy for 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
DRDM	Division for Risk and Disaster Management
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

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Executive Summary

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

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

As a first step (Component 1), a total of 636 data cards on disaster events and losses between 1980 and 2013 were registered in the national disaster loss databases. All of the records are classified as extensive loss (high frequency but small-middle scale events). Economic loss totalled approximately USD 16 million (2012 constant price). The main hazard, contributing half of economic loss, was flooding.

In the following probabilistic risk analysis (Component 2), Average Annual Loss (AAL) and Probable Maximum Loss (PML) for tropical cyclonic wind and earthquake were estimated to be zero given the location of the country. It is pointed out that, even though there is no catastrophe risk in terms of either hazard, the country should continue the risk assessment efforts to be able to consider other hazards (especially flood) and manage the anticipated risk.

The loss and risk information highlighted the need to reduce risk to natural hazards. However, it, in itself, did not suggest policy guidance. Grounded in loss and risk analysis, 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 102 to 329 years. This corresponds to the middle to intensive risk layers, which means that Seychelles must target risk-financing mechanisms. However, judging from loss data analysis, if countries apply this analysis into flood, it is likely that the financial gap year might correspond to extensive to middle risk layers where DRR investment is the most efficient.

The subsequent probabilistic cost benefit analysis (CBA) presents how CBA can support concrete and specific decision-making. As an example, the CBA of the flood alleviation project in Point La Rue found that the project is cost efficient, resulting in a benefit to cost ratio of 1.2. In the analysis it was pointed out that additional information regarding past damage and losses could also significantly change the results of present analysis. For a backward looking CBA as was done here, the data on previous disaster losses in combination with data on the severity of the weather events is critical to making accurate estimates for the AAL. Some of the previous loss data was rather limited, which suggests that there is potentially more unreported damage. This further emphasizes the importance of complete and accurate loss data when conducting backward-looking CBA.

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

[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.

To explore the financial aspects of DRM policy, Seychelles 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 2 to 5 % of the current budget (from 2012-14) and about 10% of the capital budget (in 2013 and 14) was estimated to be invested in DRM. This corresponds to approximately USD 18.1 million and USD 9.1 million, respectively. On average between 2013 and 2014 62.4% of combined current and capital DRM budgets are marked “significant”, which is embedded in development projects and mainly dedicated for prevention/mitigation. This indicates the level of mainstreaming of DRR investment in Seychelles. Compared to AAL, this was a positive balance, but Seychelles identified that budgets need to be linked to a specific hazard (in this case tropical cyclones and earthquakes) to be meaningful.

During several meetings with the Ministries of Finance in the IOC region, it was established that a scattered approach to DRM is inefficient and there is need for stronger collaboration between the DRM agency, Ministry of Finance and other key sectoral ministries. Continuous capacity building on risk terminology and concepts, loss and risk information management and economic analysis was recommended by Ministries of Finance in the region.

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

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

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

Introduction: Conceptual Framework [2]

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

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

The initiative has three components:

- Component 1: disaster loss
- Component 2: probabilistic disaster risk assessment
- Component 3: public investment planning

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

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

This report summarizes all activities implemented for 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.

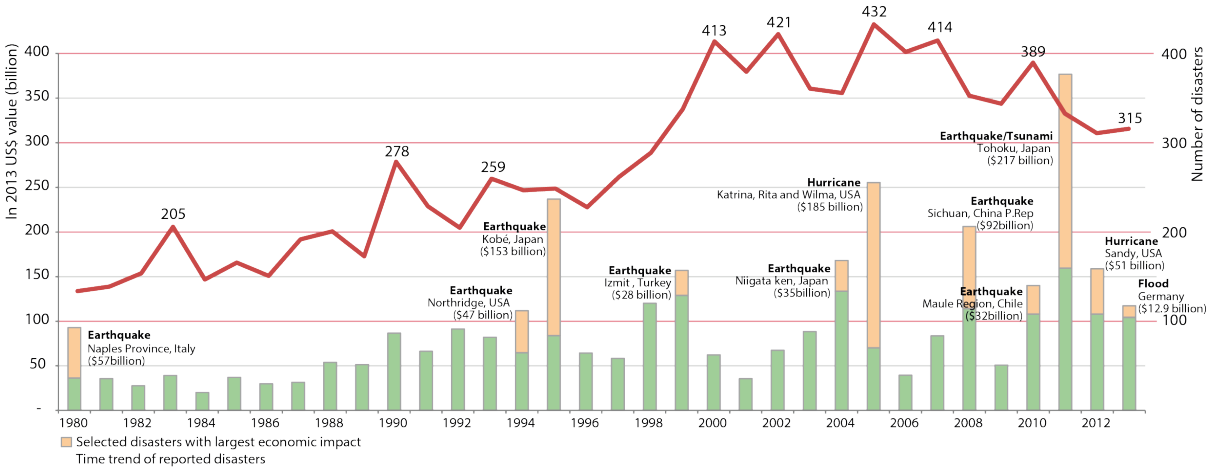
In this introductory chapter, the background, especially why we need risk-sensitive public investment, is explained. Then, the overall streamlined process from loss data analysis through probabilistic risk assessment into economic analysis is explained. Lastly basic concepts of economic loss are defined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

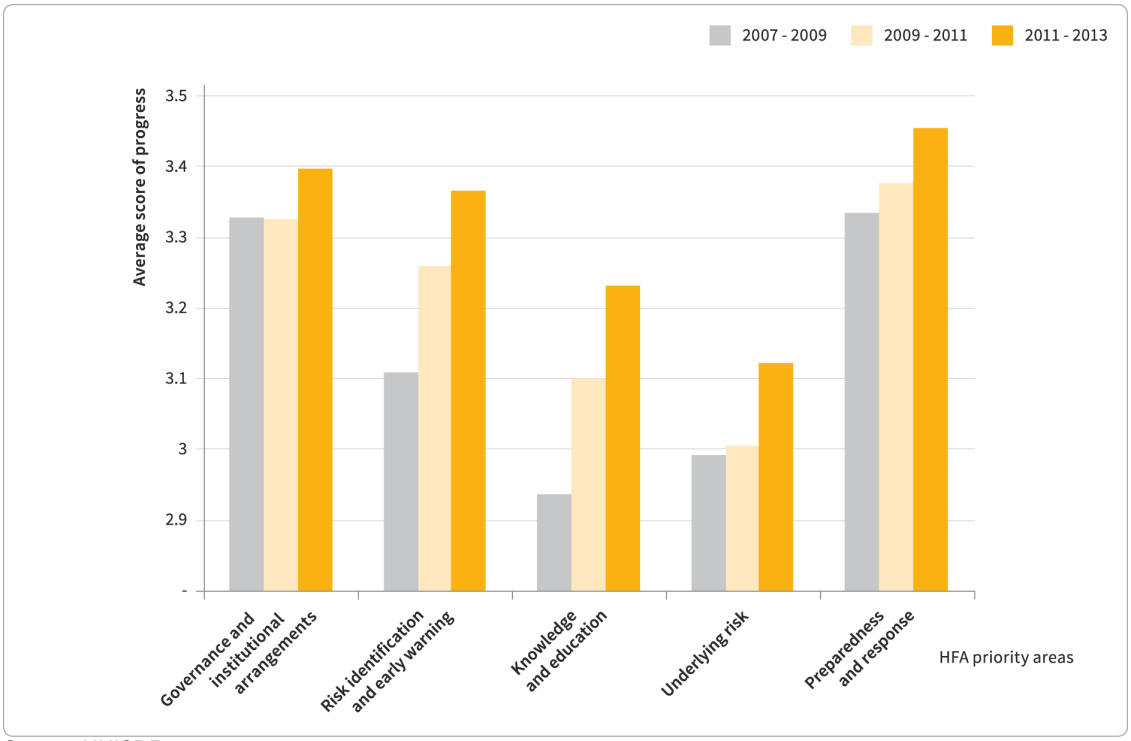
Why do we need to promote risk-sensitive public investment? First of all, economic loss due to disasters has been increasing in spite of substantial progress in DRR policies promoted by Hyogo Framework of Action (HFA) (**Figure *1*** and **Figure 2**). HFA priorities have been progressing in all areas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

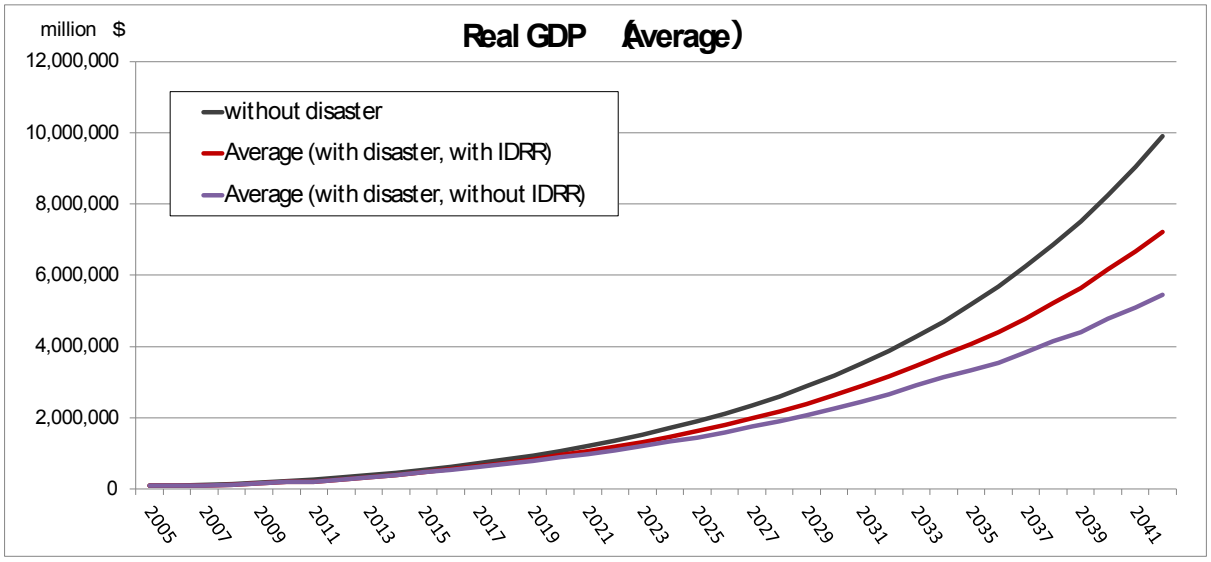
Figure 2: HFA Progress



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.

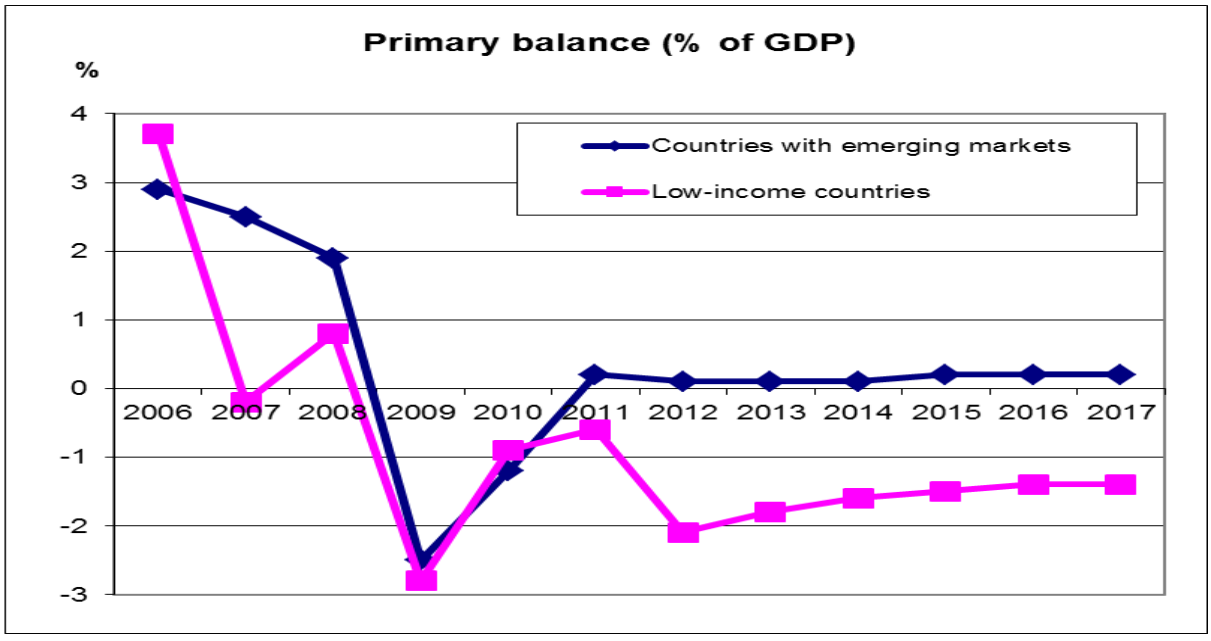
Figure 3: Pakistan GDP estimate, 2005-2041



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]

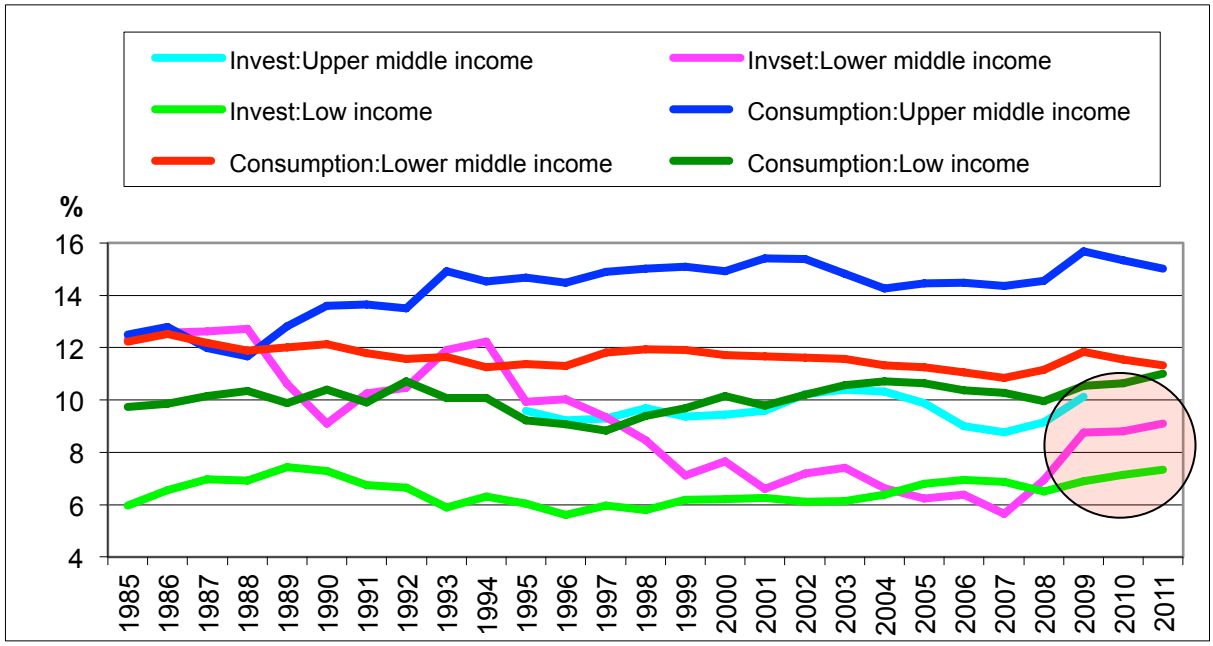


[4] The primary balance is the difference between a government's revenues and its non-interest expenditures; it is the most accurate reflection of government fiscal policy decisions. A country with a primary deficit, for example, spends more on roads, schools, defense, than it takes in from taxes and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

Source: Author based on IMF

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

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



Source: Author based on the World Bank Development Indicators

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

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

In economics, **public goods** are characterized both as non-excludable and non-rivalrous in that individuals cannot be effectively excluded from use and use by one individual does not reduce availability to others. Classic examples of public goods include street lighting, police service, and fresh air and water. Paul A. Samuelson, in his seminal paper of 1954 entitled *The Pure Theory of Public Expenditure*, defined a public good (what he called "collective consumption good") as follows: "[goods] which all enjoy in common in the sense that each individual's consumption of such a good leads to no subtractions from any other individual's consumption of that good."

Disaster risk reduction mechanisms are also public goods satisfying conditions of non-excludability and no-rivalry. Sea walls and early warning system protect many people and assets at once and do not exclude anyone. The

problem of public goods is that no one wants to pay for the service and the goods are likely to be under-produced (*i.e.* free-rider problem[5]).

The argument of public goods is closely related to **market failure** in economic theory. Market failure is a situation in which the allocation of goods and services by free market is not efficient. Market failures are scenarios in which the individual pursuit of pure self-interest leads to results that are not efficient – that can be improved upon from the societal point of view[6]. The typical causes that lead to market failures include lack of information, externalities, or public goods.

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

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

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

In spite of **decentralization** trends, the role of national government does not diminish. Disaster risk management infrastructure, such as sea walls, are often very costly and beyond the financial ability of local governments. Given the positive externality of such infrastructure, national governments are justified to financially commit in the investment. Catastrophes such as Indian Ocean tsunami in 2004 (just before HFA adoption) and Great East Japan Earthquake in 2011 (whose experience will influence post-2015 Framework for DRR informally called HFA-2) refocused the role of national government on their capability to prepare for and respond to intensive disaster risk. In the context of developing countries, accumulated impacts of low-to-mid scale disasters damage local level capacity and need support from national governments.

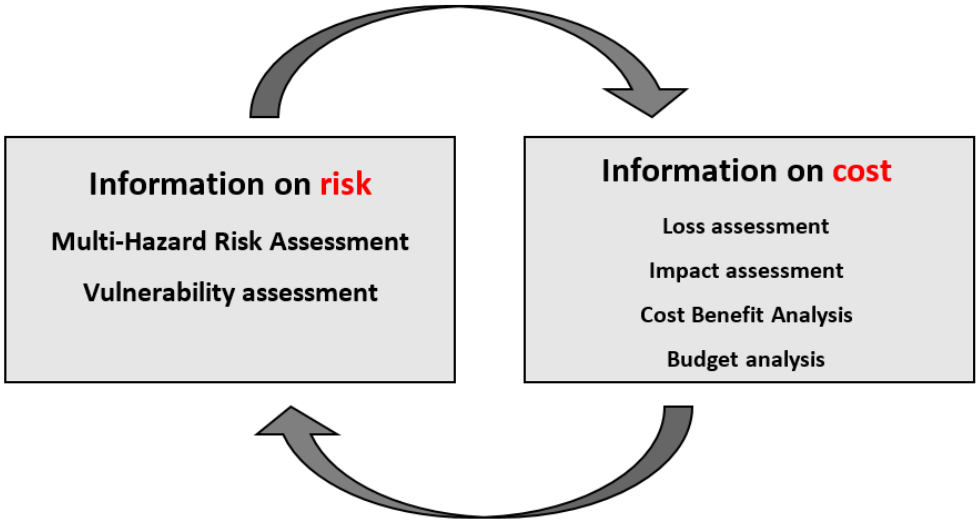
In case of catastrophe, horizontal risk transfer mechanisms such as insurance may often not be sufficient. DRR investment is, unlike risk transfer mechanism, considered inter-generational risk sharing. Following the definition of sustainable development by the Bruntland Committee, only development that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

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

What are the gaps to be filled? It is important to focus on the lack of linkages between natural science and social science, especially in economics. Risk information produced by natural science is not well connected to cost information examined by social science. Even when risk information exists, if it is not linked to cost information, it is difficult to promote DRR Investment (Figure 6). For example, Solomon Islands states "*If policies based on risk information would lead to increased project costs, budget constraints may limit utilization of the risk information. Promoting cost benefit analysis is necessary in order to counteract this "*[7].

[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.
[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).

[8] HFA Report of Nepal, 20xx

Table 1: DRM structure

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

B. Streamlined process for evidence based decision making

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

Figure 7: Overall design to support evidence based decision making

STEP 1: Identify loss trend and produce risk profile

(Loss analysis, risk assessment)

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

(Policy review, budget review)

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

(Macro-economic analysis)

STEP 4: Measure the impact of investment on DRR

(Probabilistic Cost Benefit Analysis)

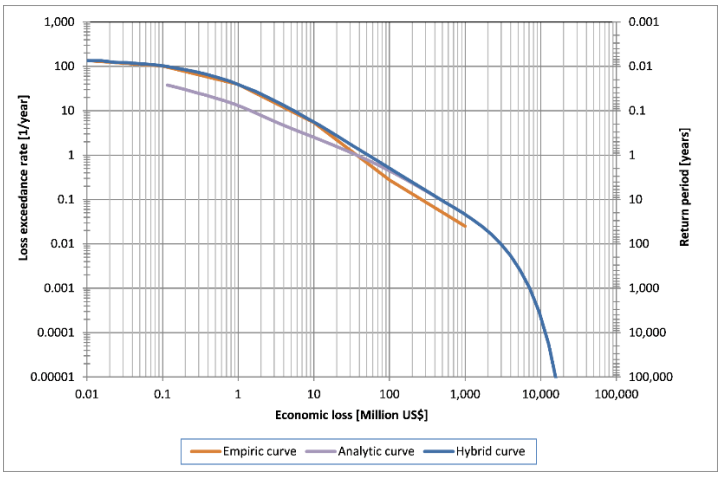
STEP 5: Political discussion based on evidence

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

Source: Author

Understanding loss and risk in a country is the **first step** to evidence-based decision making. Loss and risk data present what has historically been lost and what is likely to be lost in future. Both loss and risk information contribute to produce hybrid curves portraying all possible combinations of probability of an event happening and the expected loss (Figure 8) in all risk layers including intensive (low frequency and high loss) and extensive (high frequency and small loss) (See Chapters 2 and 3). However, as outlined above, this information alone cannot determine how much should be invested in DRR.

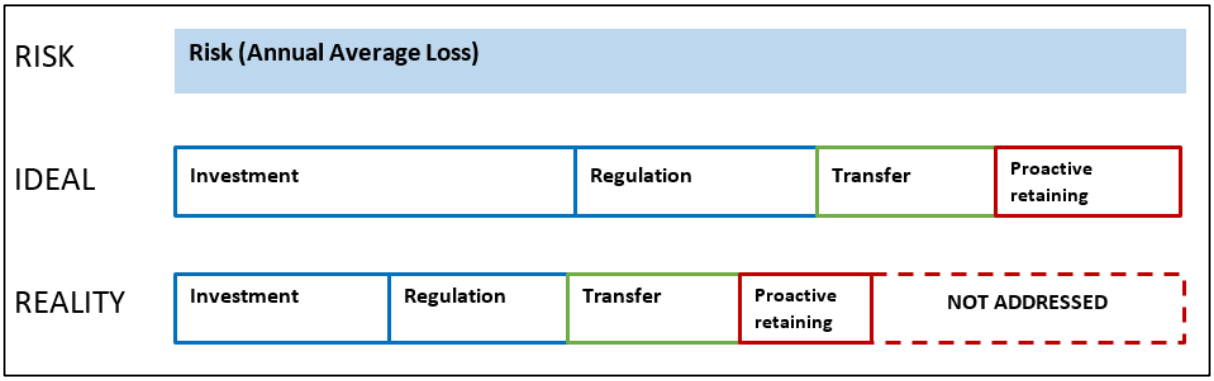
Figure 8: Hybrid loss exceedance curve



Source: UNISDR

Step 2 aims to determine the gap between risk and current levels of DRR policy. An examination of current DRR and investment policies and a comparison between risk levels and DRR investment will provide insights on how much investment in DRR is needed to fill the gap (Figure 9). (See Chapters 4, 5 and Annex A).

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



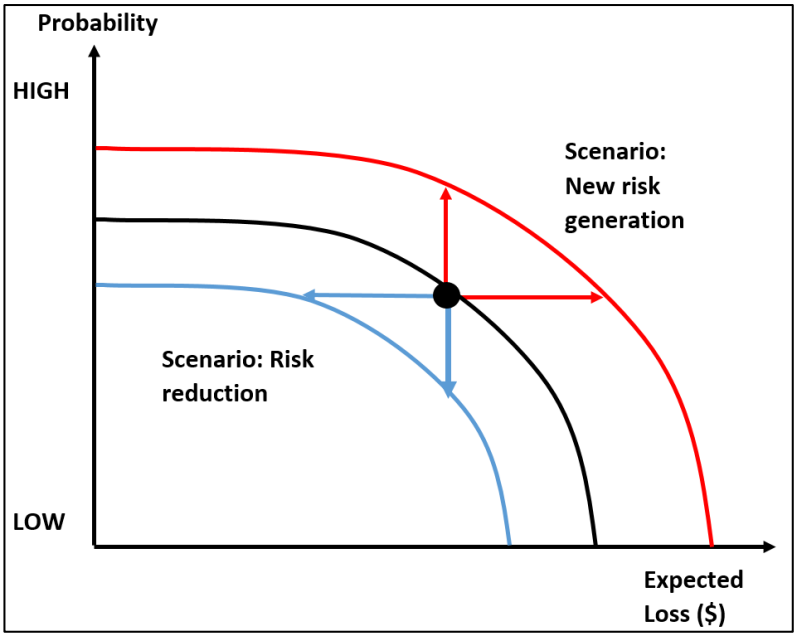
Note: Impact of investment usually lasts for certain project periods and therefore reduces AAL the following year.

Source: Author

Step 3 measures the impact of disaster on economy and public finance, to further verify the expected impact of disasters on a country. The focus is not necessarily limited to direct loss and indirect loss, and macro-economic impacts are considered to a certain extent depending on the model. In the Indian Ocean Commission (IOC) region, the CATSIM model developed by IIASA and taking indirect loss to a certain degree was used to measure the impact of disasters on public finance (See Chapters 5 and Annex B).

Step 4 aims to measure the impact of policy on DRR. Some policies are more cost efficient than others, meaning that such policies reduce risk more with less investment. Cost benefit analysis is implemented in this step. (See Chapter 5 and Annex C). DRR policy can shift the risk curve inward (*i.e.* lower frequency of event happening and/or decrease of expected loss) (Figure 10).

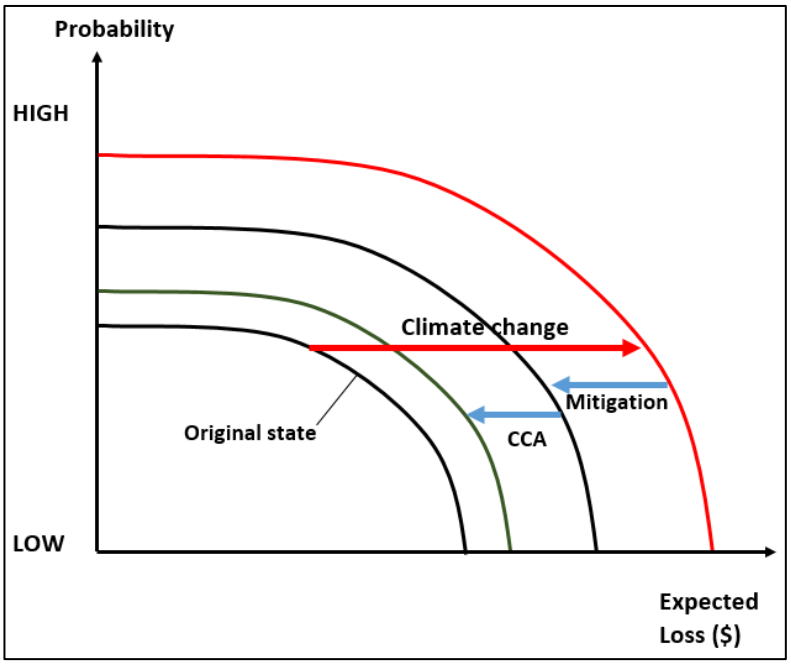
Figure 10: Shift of loss exceedance curve by DRR investment (blue) and new risk generation (red)



Source: Author

Climate change will also influence loss exceedance curve. However, investment in mitigation and adaptation can reduce the total cost. This is graphically expressed in Figure 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

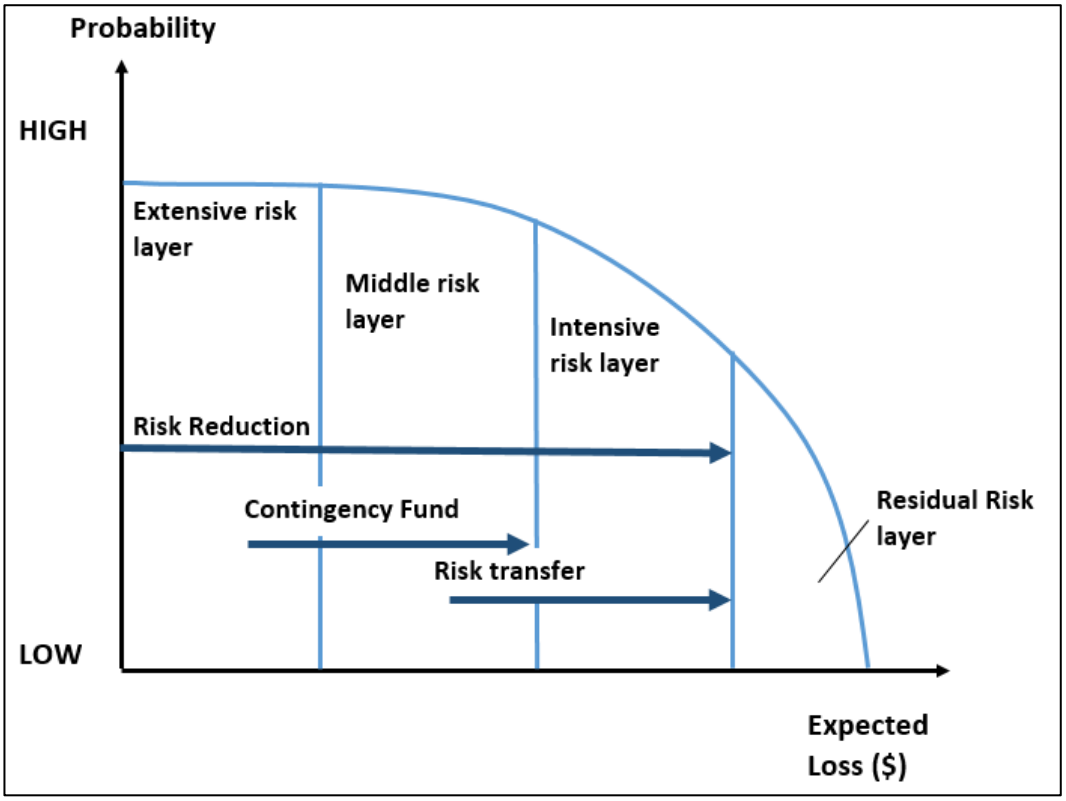


Source: Author

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

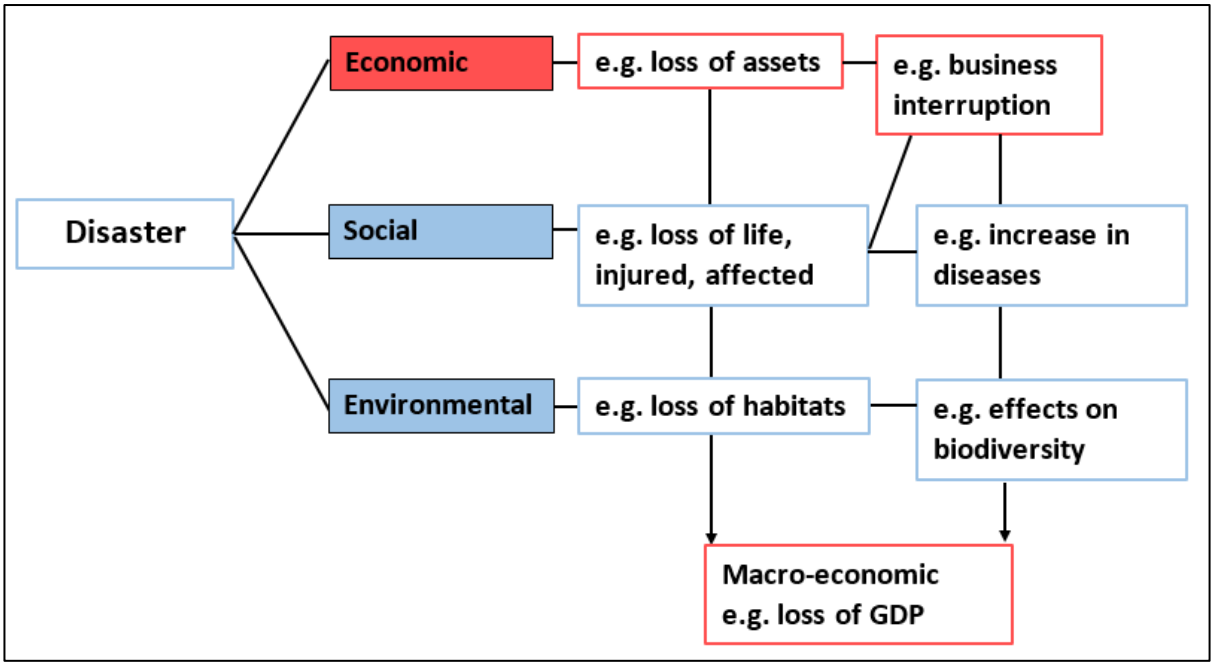


Source: Author

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

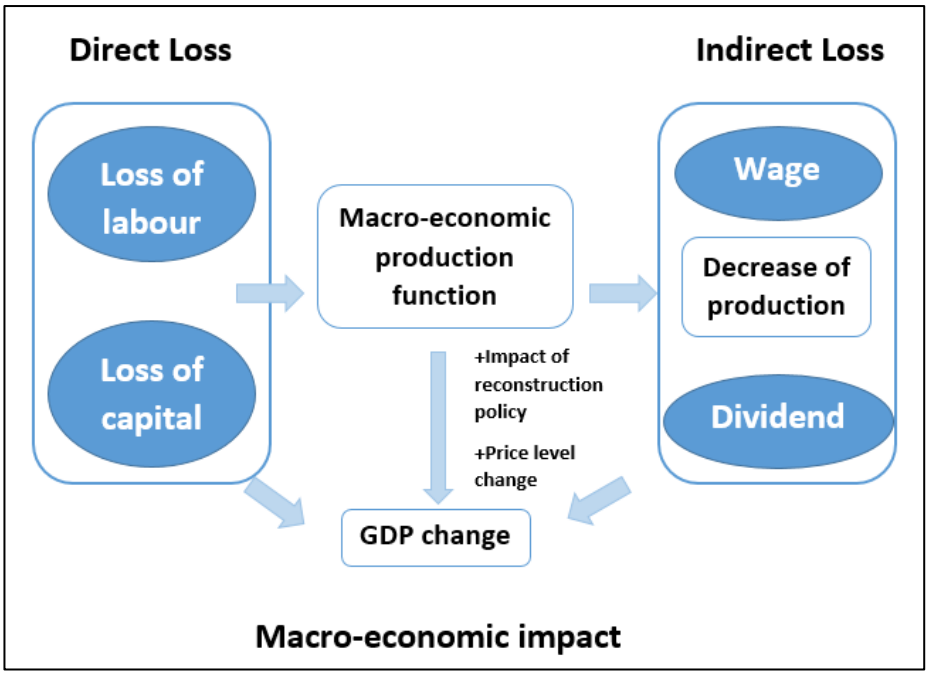


Source: Author

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]?

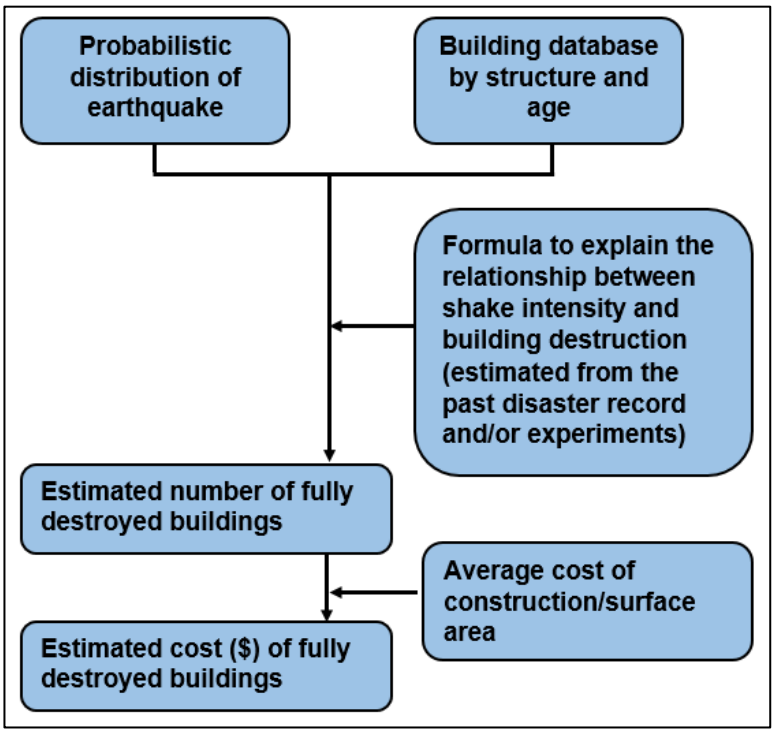
There is another important issue in measuring direct loss; "How to evaluate human loss?" There are some methodologies, for example, that evaluate human loss as lost income. However, this remains an on-going debate

[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.

among economists because assigning monetary value to human life is an ethical issue, considered morally wrong. If we use the lost income approach, the life of a rich person is more valuable than a poor person. But sometimes, monetary value is assigned to human loss. For example, after 911, NY City estimated the monetary value of human loss in the World Trade Center, Many were high income, young to middle-aged people who pay high taxes and consume and invest heavily in the NY economy. The economic planner of city government practically would have needed the economic and financial impact of loss of such people, but this is a very rare case. It is not common to monetize human loss[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



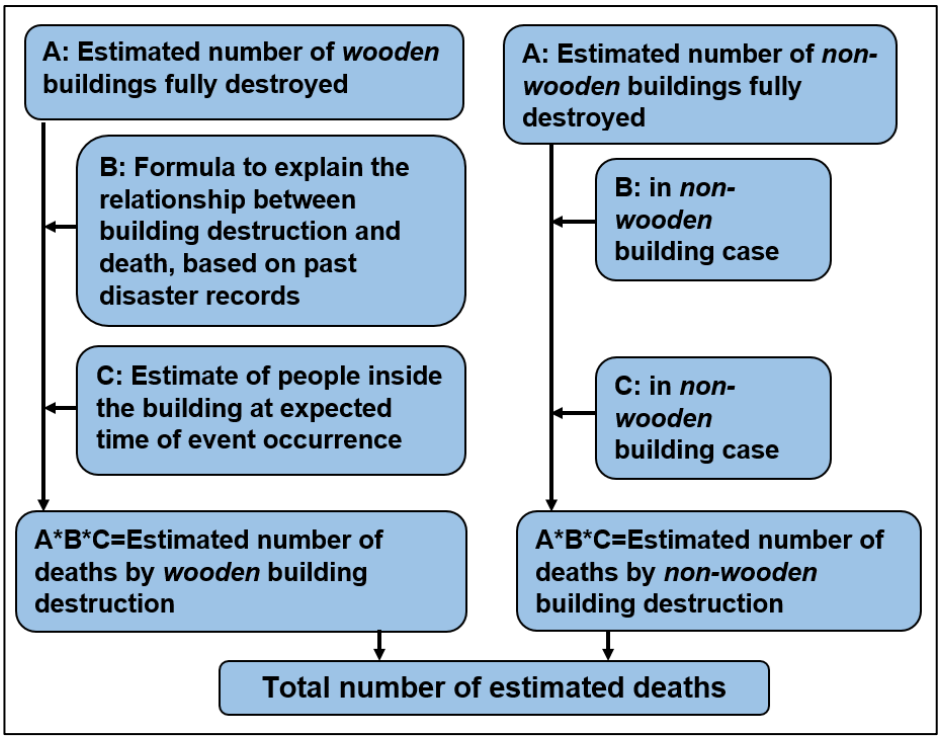
Source: Author

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

[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.

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 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

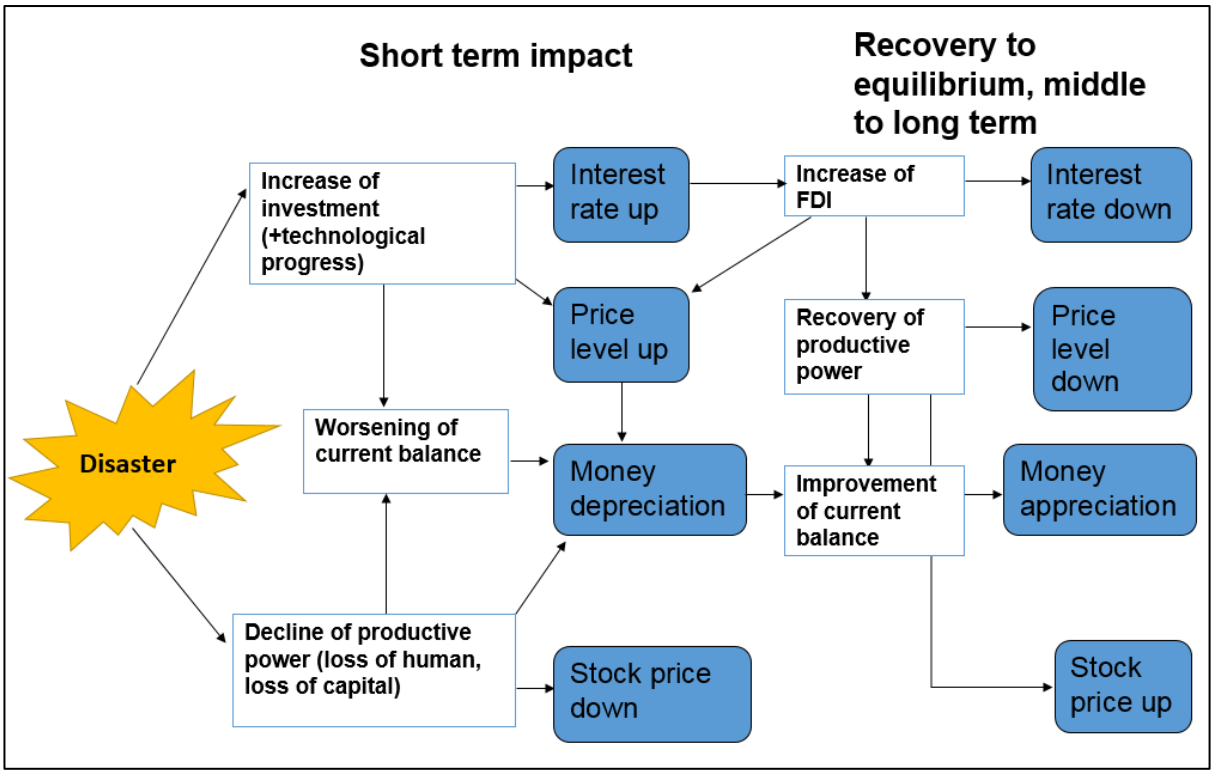
In analysing macro-economic impact, it is very important to analyse the impact from supply and demand sides and short and long-term perspective (Table 3). From supply side, decrease of production due to capital loss can be observed as a negative impact in the short term. However, in the long term, replaced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

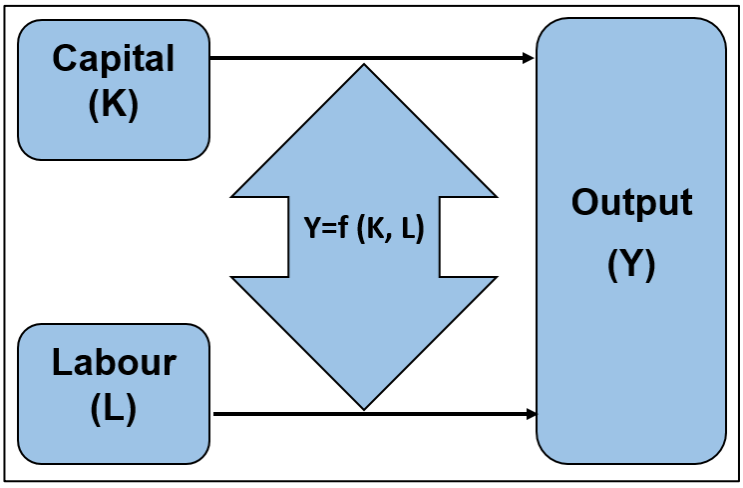
Figure 17: Example of economic modelling



Source: Author

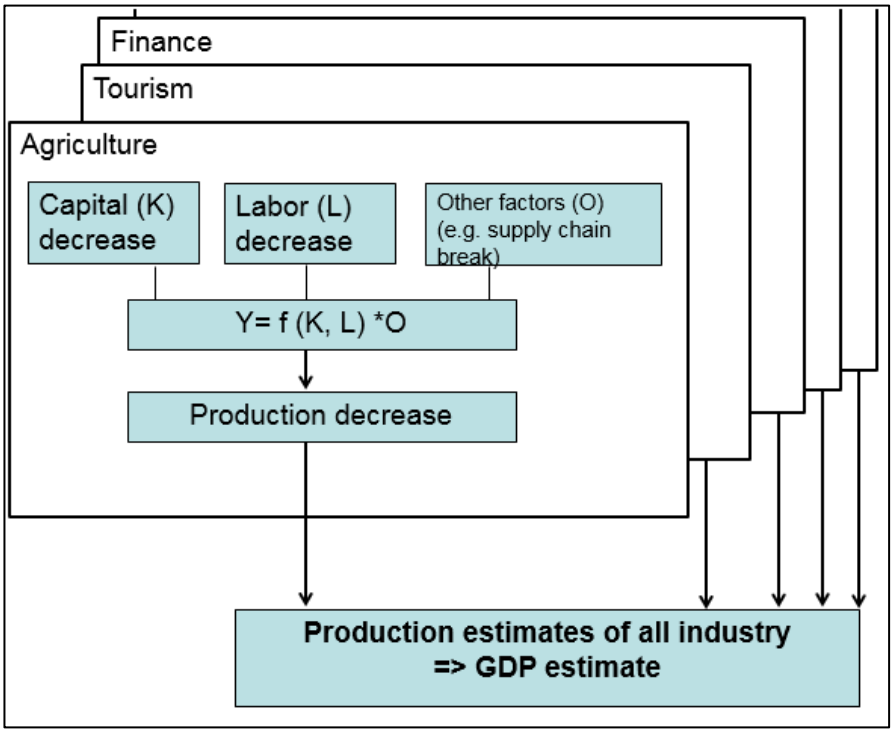
When macro-economic modelling is not available or a more micro-level approach is more practical, a sectoral-based approach might be preferable. The essence of estimating economic impact is in how disasters impact labour and capital --the two most important factors for economic growth (Figure 18). If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

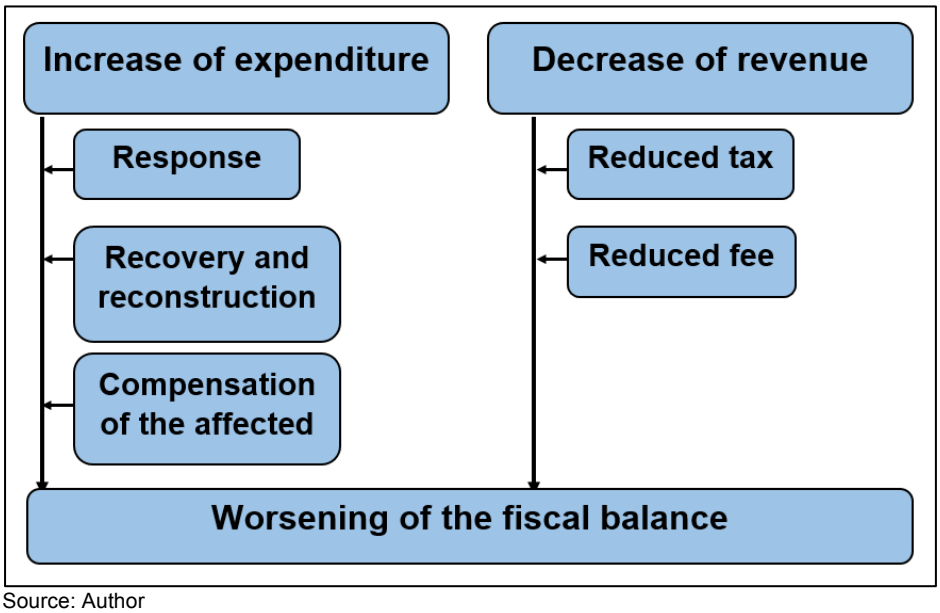


Source: Author

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).

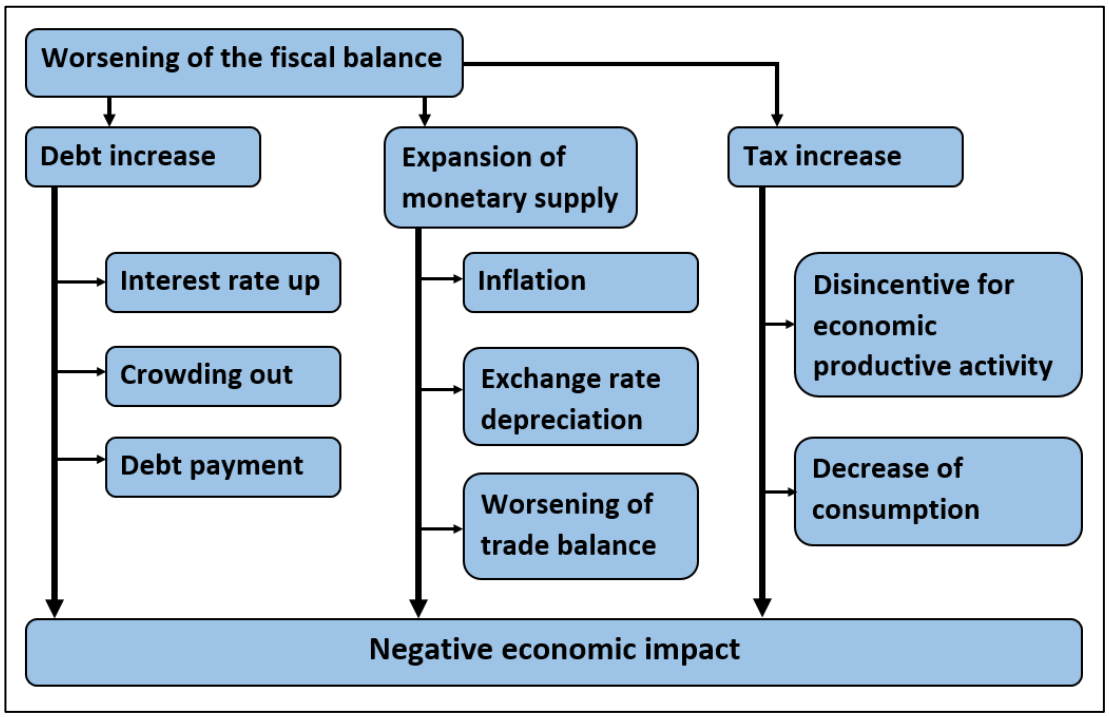
Figure 20: Fiscal impact of disasters



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]

By definition Seychelles can be classed as a young country with a comparatively small population, and it is a remote, small island-state with middle-income country characteristics and a population growth of about 0.4% per year. Seychelles comprises 115 tropical islands spread over 1.374 million square kilometres in the western Indian Ocean, covering 455.3 square kilometres in land area (Figure 22). Habitation is limited to 10 of the islands, and approximately 90% of the population of Seychelles lives in the largest island, Mahé (60% urbanized), where the capital, Victoria, and the main fishing port are located.

Figure 22: Islands of Seychelles

Source: World Bank

A. Population

Over the years there have been major changes to the population structure influenced by a growing number of aging citizens, and a male/female gender ratio of almost 1:1. These changes have been brought about by the gradual improvement in the quality of life and a host of other factors, notably socio-economic factors.

The resident population of Seychelles estimated at 88,300 in 2012, was characterized by a slow growth rate of 0.8% (2007-2012) and was affected by external migration, typical of small island states (Table 4). The dependency ratio was 433 in 2012. Literacy rate is over 97% and life expectancy was estimated in 2010 to be 73.2 years (67.7 years for males and 78.9 years for females) from the date of birth (WB Indicators, 2012). Baie Saint Anne and Anse Etoile are the two most populated districts with population of 4,739 and 4,651, respectively.

[18] This chapter was drafted by William Danis Zarine.

Table 4: Key population indicators

Resident Population	88,300 (2012)
Growth rate (annual average of the past 5 years)	0.8% (2007 -2012)
Spatial distribution	Mahe (Main Island) : 76, 300 Praslin: 8, 300 La Digue: 3, 600
Age dependency ratio	433

Source: NSB 2013

B. Political Structures

Since it was discovered in the early 16th century, Seychelles has undergone different types of governance. Seychelles received its independence from Britain in 1976 and became a republic. Seychelles was then governed by a coalition Government until 1977 when a one-party system was established. The one-party system was formally abolished in 1993 following a referendum after which a new Constitution was adopted. This marked a new era in the political history of the Seychelles as it re-established a multi-party system; hence the birth of the third republic.

The Seychelles Constitution is the supreme law of the country and it guarantees the Nation its fundamental rights through executive, legislative and judiciary power. It prescribes that presidential and parliamentary elections take place every five years. It ensures equal opportunity and protection for men and women, as well as several other policies and legislations to promote gender equality and women empowerment. The constitution also makes specific reference to the rights of women, whereby it guarantees amongst others, the right to own property, the right to equal protection by law, the right to education without discrimination and equal opportunity to employment.

Unlike in many other countries, the political transition in the Seychelles had been very smooth and peaceful. Today the country is enjoying a high level of political stability where national unity, pride and aspirations override ideological and economic differences. This is reflected in the ranking of Mo Ibrahim[19] which placed Seychelles 2nd among all the African countries for Good Governance in 2010, and 5th in 2014.

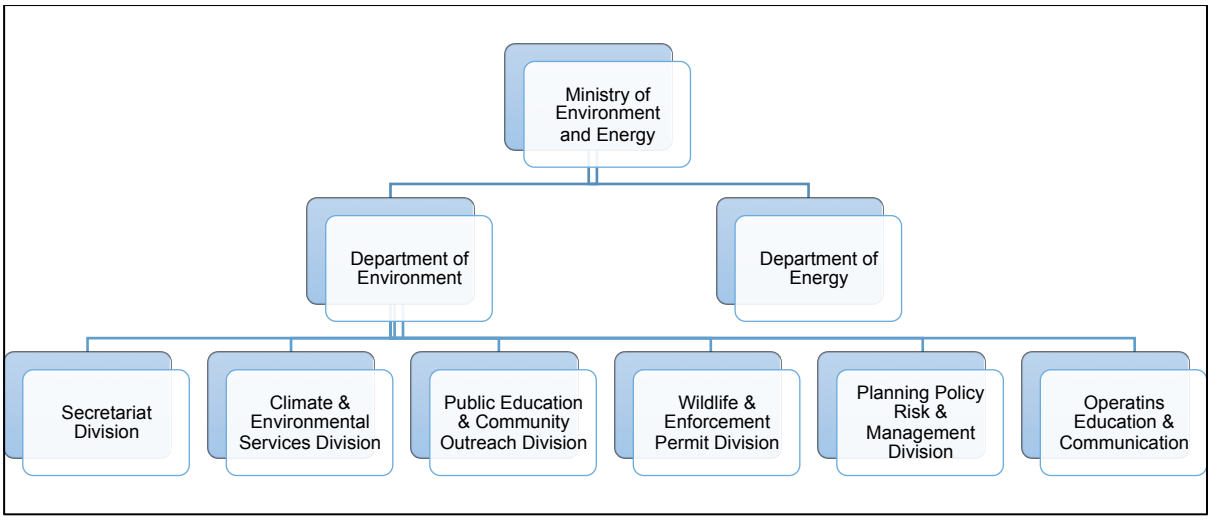
The government organizations of the Seychelles consist of the Office of the President, the Office of the Vice President, eleven Ministries, and Constitutional Bodies. The Ministries are:

- Ministry of Community Development, Social Affairs and Sports;
- Ministry of Home Affairs and Transport;
- Ministry of Education;
- Ministry of Foreign Affairs;
- Ministry of Natural Resources and Industry;
- Ministry of Finance, Trade and Investment;
- Ministry of Environment and Energy;
- Ministry of Tourism and Culture;
- Ministry of Land Use and Habitat;
- Ministry of Health;
- Ministry of Employment and Human Resource Development

The main ministries working with DRR and CCA are Ministry of Environment and Energy, Ministry of Land Use and Habitat, and Ministry of Community Development, Social Affairs and Sports. The Ministry of Environment and Energy holds responsibilities as illustrated in Figure 23.

[19] An award given to African heads of state or Government who deliver security, health, education and economic development to their constituents, and who democratically transfer power to their successor.

Figure 23: Organogram of Ministry of Environment



Source: JICA Report 2012, Project for the Study of Coastal Erosion and Flood Control Management in Seychelles

Much of the administrative work of the government and Ministries are centralized but are supported by structures at local districts which include the District Administration Offices and some task forces. Civic society and NGOs (notably, LUNGOS, BIRDLIFE and Red Cross Society) are increasingly playing important roles in the affairs of the country.

Seychelles is a member of the United Nations, Commonwealth, African Union, La Francophonie, Common Market for Eastern and Southern Africa (COMESA), Southern African Development Cooperation (SADC) and the Indian Ocean Commission. It is presently in the process of finalising the necessary protocol to become a member of the World Trade Organization (WTO).

C. Economic Structures

Seychelles is a small, service-based island-state economy with a GDP per capita of USD 15,644 in 2013, and hence, classified as a high-middle-income country. The Seychelles has traditionally enjoyed good public sector governance. Seychelles has already achieved most of the Millennium Development Goals, especially for education, health, poverty eradication, and the environment. Poverty in Seychelles is relatively low, with less than 2% of the population living on less than USD 2 per day. Today Seychelles stands among the best in Africa in term of socio-economic development and governance.

During the past 25 years (1987 – 2012), the Seychelles economy has gone through major transition. The pre-1994 era was characterized by a closed, tightly controlled and Government-led economy with limited private sector participation, limited Foreign Direct Investment (FDI) and no formal monetary policy rules. The post 1994 era saw a gradual opening up and a more outward looking economy with an increasing role for the private sector, inflow of FDI and a changing role of Government to be facilitator and service provider. The economy remains highly dependent on tourism but diversification to non-traditional tourism markets continues.

The overall performance of the Seychelles' economy since independence has been remarkable, especially regarding the per capita income. Over the thirty-five years that followed independence, Seychelles has achieved a nine-fold increase in GDP per capita from some USD 1, 000 in 1976 to USD 15, 644 in 2009, the highest in Sub-Saharan Africa. Since the mid-1990s, Seychelles has been ranked as an upper-middle-income country by UNDP.

After a slowing down in the rate of growth of 0.9% in 2001 and 1.3% in 2002, the economy experienced a massive setback in 2003, when it recorded a negative rate of growth of -6.3%. This persisted in 2004 and 2005 when rates of growth of -2.0% and -1.5% were registered respectively. Consequently, this had an adverse effect on the economic development of the country.

To restore the country's competitiveness, the Government had come up with reforms, such as Macro-Economic Reform Programme (MERP) in 2003, which brought about very little success, and the IMF backed reform programme in 2008, which the Government instituted comprehensive macroeconomic reforms to address these fiscal and structural challenges. As part of the macroeconomic reform in November 2008, a series of measures leading to fiscal discipline and a more effective monetary policy resulted in:

- streamlining expenditure (recurrent and capital) in public sector reforms (accountability, transparency, workforce)
- developing more efficient revenue collection (tax) procedures
- removal of subvention from parastatals
- rescheduling of public debt
- adopting a new monetary regime from a fixed exchange rate to a floating exchange rate
- introducing a market driven interest rate
- building-up foreign exchange reserves

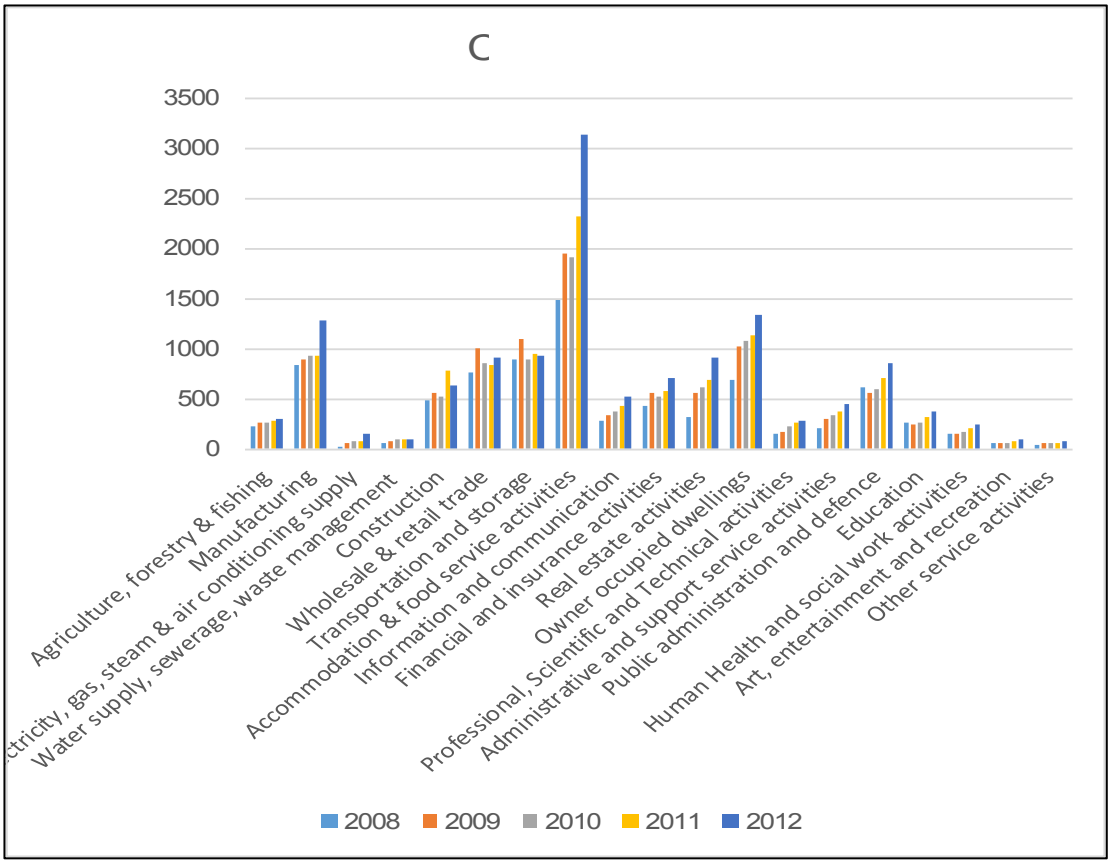
Despite the precipitated initial impact, those measures have had relative success in "addressing large fiscal and external deficits and economic inefficiencies"(MEFP Dec. 2011).

Economic growth in Seychelles is projected to accelerate to 3.7% in 2014. This will be dependent on increasing number of tourists during the second half of the year based on an uptick in arrivals and new flight connections to Europe. Unemployment, although growing, remains low at around 5.2%.

The current account deficit improved in 2013, mainly due to increased tourism and tuna exports, and was comfortably financed by foreign direct investment (FDI). A recent rise in imports and fall in tourism growth has put some emergent pressures in the foreign exchange market. The authorities have accelerated monetary tightening to curb strong credit growth. A comfortable level of international reserves at USD 456 million (3.9 months of imports) and a flexible exchange rate will support this process although it will require careful monitoring given the shallow foreign exchange market. The government's external reserves, a flexible exchange rate, high government deposits, and a fiscal surplus provide some bulwark against external shocks.

The Seychelles economy depends to a significant extent on a clean environment and its renewable resources, with tourism, agriculture, forestry and fisheries accounting for over 50% of GDP and approximately over 37% of employment (Figure 24). As a Small Island Developing State, its dependence on the external world has made Seychelles highly susceptible to external shocks. Furthermore, the reliance on tourism and fisheries as the main foreign exchange generator means that the country is extremely vulnerable to the vicissitudes of the outside world.

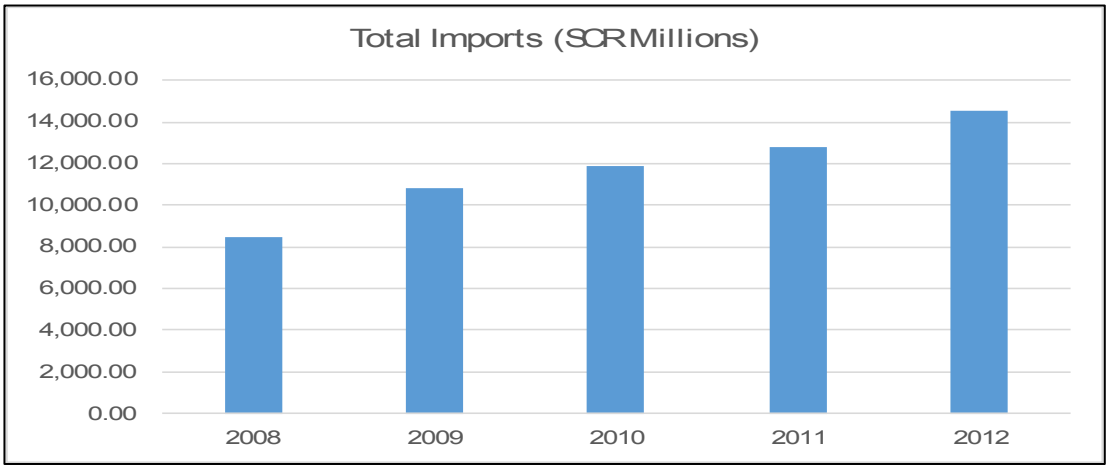
Figure 24: GDP by sector/Industry



Source: World Bank, 2014

The level of imports have remained high over the years (Figure 25) and they are mainly gas oil, food and live animals and transport and machinery equipment. The reliance of Seychelles on imports, especially fossil fuel have continued to remain high over the years, and the situation has raised cause for concern as they consumed the higher proportion of the foreign exchange resources.

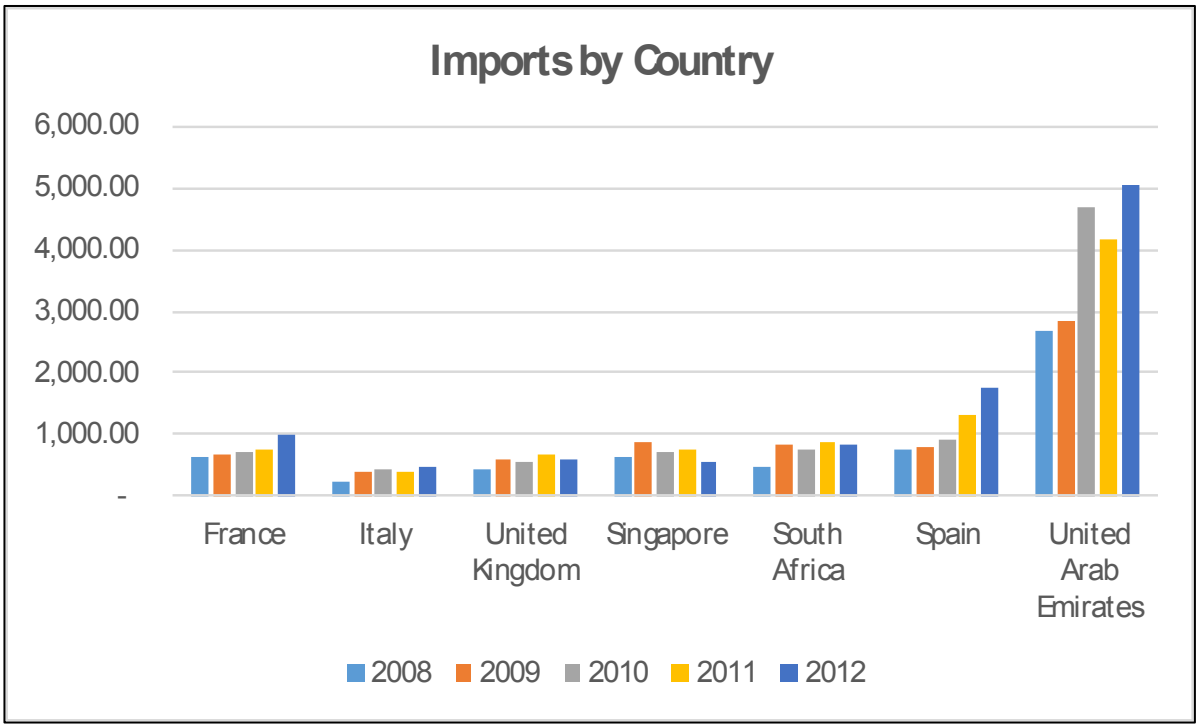
Figure 25: Total imports



Source: World Bank, 2014

Most of Seychelles imports have been traditionally from Europe and Asia but a growing volume of imports has come from the Middle East in the last five years. This is mainly attributed to favourable air and sea links with the region (Figure 26)

Figure 26: Country of imports



Source: CBS Report 2013

D. Public Finance

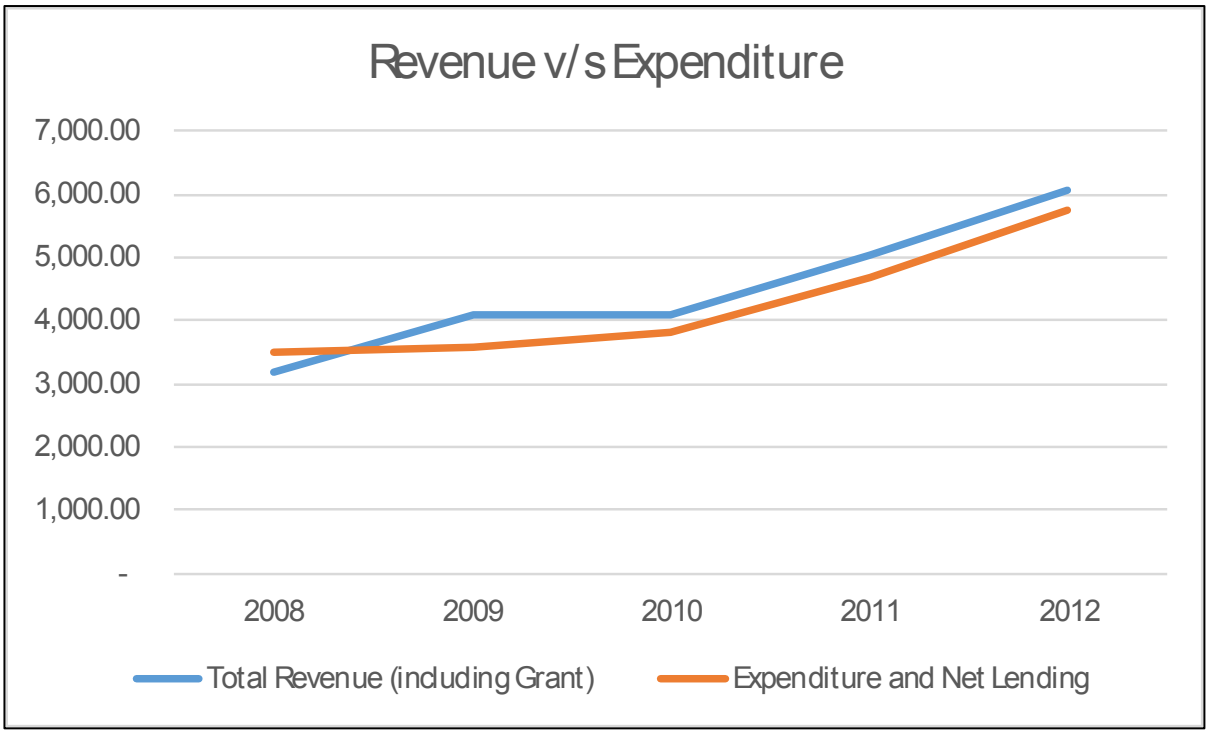
The 2008 financial reforms require that the government maintain strong fiscal discipline which remains a critical element of the strategy to ultimately achieve debt sustainability in the medium term. The primary balance for the year 2013 was a surplus of 4.7% of GDP, which was in line with the 2013 budget. In terms of policy, further tax reforms were pursued with the aim of strengthening the efficiency of the tax system and sustaining economic growth. Value Added Tax (VAT) system was introduced whilst some changes were also made.

The trends in revenue and expenditure in the last five years are illustrated in Figure 27[20]. Total revenue for the year 2012 including grants, stood at R 6,163 million (USD 510.6 million) [21], which was 2.6% below expectation. Receipts of grants amounted to R 691 million (USD 57.3 million), 10% less than the budgeted amount of R 770 million (USD 63.8 million). Tax receipts, which remained the main source of government revenue stood at R 4, 676 million (USD 387.4 million). The largest component of tax receipts for the year was VAT, which accounted for 31% of total tax revenue, followed by Business Tax at 17%.

20 Most information in this section is from CSB (2013).

21 Exchange rate at 2012 constant prices at USD1=RS12.0706 was applied in this report.

Figure 27: Trends in Revenue and Expenditure



Source: CBS (2013)

In total, government expenditure and net lending in 2013 amounted to R 6, 004 million (USD 497.4 million), of which 74% was allocated to current spending. Actual total spending was 3.6% less than planned on account of savings materialised under both current and capital expenditures.

Current expenditures stood at R 4,429 million (USD 366.9 million) or 3.5% below the budgeted amount. Savings were made under most categories, of which the most significant was 6.4% recorded (CBS, 2013).

At R 1,508 million (USD 124.9 million), total capital expenditure was 1.6% less than its allocation. The bulk of capital expenses went towards the funding of projects amounting to R 1,310 million (USD 108.5 million).

The Seychelles fiscal year is from January to December, and the budget exercise usually gathers momentum from August when all public institutions operating on recurrent budget have the task of establishing their financial requirements for both current and capital budgets. The provisional budget allocation is completed by November, in time for the consolidated budget proposals to be presented to the National Assembly for approval.

The ultimate budget for current budget is normally based on the programmes and operational needs of the different institutions, following the annual negotiations between the public institutions and the Ministry of Finance. However, the capital budget is based on the importance and priority of the capital projects and they can span over years depending on funds availability and priority status.

E. Other socio-economic elements

Seychelles' relative standing regarding its social development may be assessed by its performance on the Human Development Index (HDI) and progress towards achieving the Millennium Development Goals (MDGs). Measured by the Human Development Index (HDI), the UNDP report (2011) considers Seychelles as a medium level developing country, ranking 52nd out of 187 countries. This measured advantageously compared to regional states like Mauritius, Maldives, Madagascar and which ranked 72, 107, and 135, respectively (Table 5).

In terms of political stability, Seychelles is ranked 142 on the political instability index out 165, indicating a stable political environment. According to Transparency International, Seychelles' rank in transparency and good governance using the corruption perception index (CPI) was 54th out of 182 countries in 2009 and 50th out of 182

countries in 2011. Although Seychelles has moved from 54th to 50th over the last three years, it should be noted that its CPI score has remained at 4.8 out of 10 throughout that period (Transparency International, 2011).

Additionally, the 2012-2013 Global Competitiveness Index (GCI) ranks Seychelles 76th out of 144 countries, whereas Mauritius and Madagascar rank 54th, 130th respectively (WEF, 2011). The GCI report characterizes Seychelles as a country in the *efficiency-driven* stage of development which means that although Seychelles has all the forms of capital and some elements of the pillars of competitiveness, in most cases they are not efficiently or effectively supporting Seychelles' transition to the third stage of development: that is, an *innovation-driven* economy.

The choice for Seychelles to become a prosperous society is to intentionally address those deficiencies that undermine our productivity and international competitiveness. These include the inadequacies in the fundamental operations of our institutions, soundness of the infrastructure, degree of macroeconomic stability and quality of public goods and services such as health care and primary education.

With respect to the environment, Seychelles ranks 52th out of 187 countries in the 2011 Environmental Performance Index (EPI). On the EPI, Seychelles outperformed many developed countries, and along with Mauritius and Madagascar, are the leaders in the Indian Ocean islands with respect to environmental protection and sustainability. However, the Environmental Vulnerability Index (EVI) ranks Seychelles as highly vulnerable with an EVI score of 355. Despite the many improvements in environmental management, many challenges remain and need to be addressed.

Table 5: Comparative Performance Measures

	Human Development Index	Political Instability Index	Corruption Perception Index (CDI)	Global Competitive Index (GCI)	Environment Vulnerability Index (EVI)[22]
	Ranking				Value
Out of	187	165	180	144	
Seychelles	52	142	50	76	355 (HV)
Mauritius	72	158	46	54	358 (HV)
Maldives	107	-	134	-	383 (EV)
Madagascar	135	33	100	130	279 (V)
Comoros	140	-		-	-

Source: HDI: UNDP report 2011, GCI:WEF 2011, CPI: Transparency International 2011, EVI:The Official Global EVI

[22] V: Vulnerable, HV: Highly Vulnerable, EV: Extremely Vulnerable

References

Central Bank of Seychelles (CBS) Annual Report, 2013

Memorandum of Economic and Financial Policies for Seychelles (MEFP), 2011

National Statistics Bureau (NSB), 2013

NSB Statistical Abstract 2009-2010

The Official Global EVI Website

Transparency International Report, 2011

United Nation Development Programme (UNDP) Report (2011)

World Economic Forum (WEF) Report, 2011

World Bank Development Indicators, 2013

2. Disaster Loss[23]

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[24].

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[25].

During the project, data on large scale as well as small-to-medium scale disasters that occurred from 1980 to 2014 were collected. The data were registered by sub-national region, which allows more detailed examination of loss distribution in the country. The current loss database basically registers direct physical loss data only. Indirect and socio-economic loss data are not registered in principle. Even if registered, it needs to be analysed with caution due to ambiguity of definitions. The disaster data not directly associated with natural hazards (*e.g.* traffic accident, marine accident, epidemic, shark attack) were registered in the database but excluded for analysis in this report[26].

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

- Damaged houses;

- Destroyed houses;

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

The loss data were assigned monetary value by applying the methodology developed by UNISDR, which allows comparison across countries[27].

Division of Risk and Disaster Management hosted Component 1 with cooperation from Ministry of Environment and Energy.

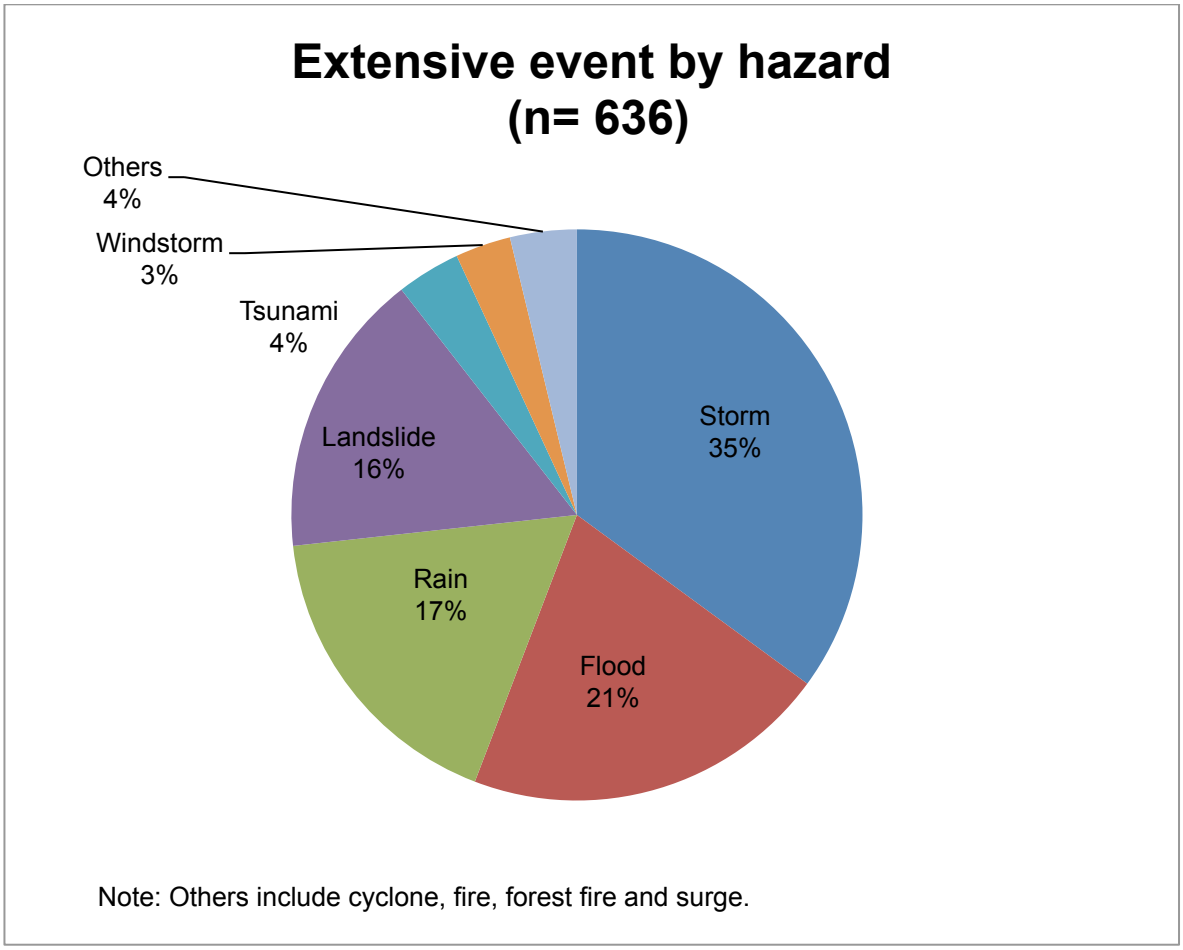
[23] This chapter was drafted by Kazuko Ishigaki (UNISDR) with the support of William Danis Zarine.
[24] As an example of loss data use for cost benefit analysis, please see case study of Annex C.
[25] The most well-known international disaster loss database called EM-DAT registers disasters for a minimum of 10 deaths (see http://www.emdat.be/criteria-and-definition).
[26] Fire is included in the analysis, though.
[27] For methodology of assigning monetary value to loss, please see http://www.preventionweb.net/english/hyogo/gar/2013/en/gar-pdf/Annex_2.pdf

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

B. Disaster loss in Seychelles[28]

A total of 636 data cards was registered regarding natural hazards. All events were categorized as extensive disasters. Storm is ranked the first (35%), followed by flood (21%), rain (17%), landslide (16%) and tsunami (4%) (Figure 28).

Figure 28: Extensive event by hazard

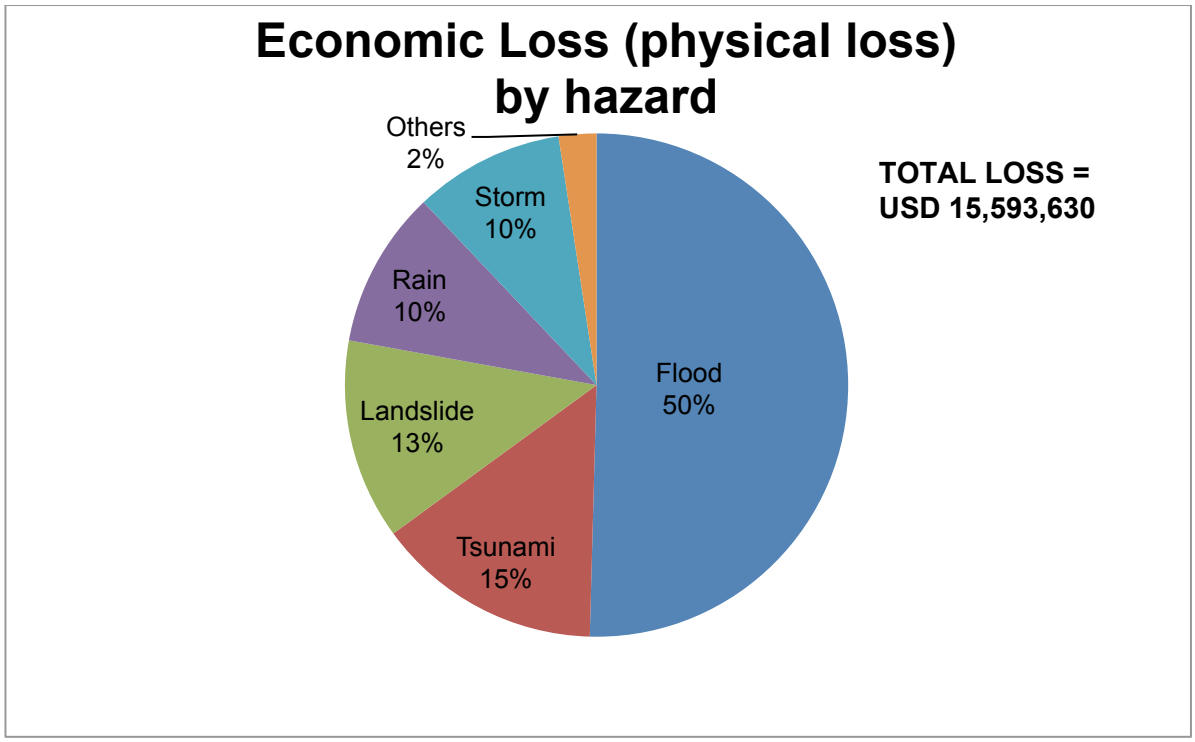


Source: Author based on Seychelles National Loss Database

Seven deaths were registered, the cause of which was landslide (5) and tsunami (2). Economic loss (physical loss) is USD 15.6 million at 2012 price. The largest share is flood (50%), followed by tsunami (15%), landslide (13%), rain (10%) and storm (10%) (Figure 29).

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

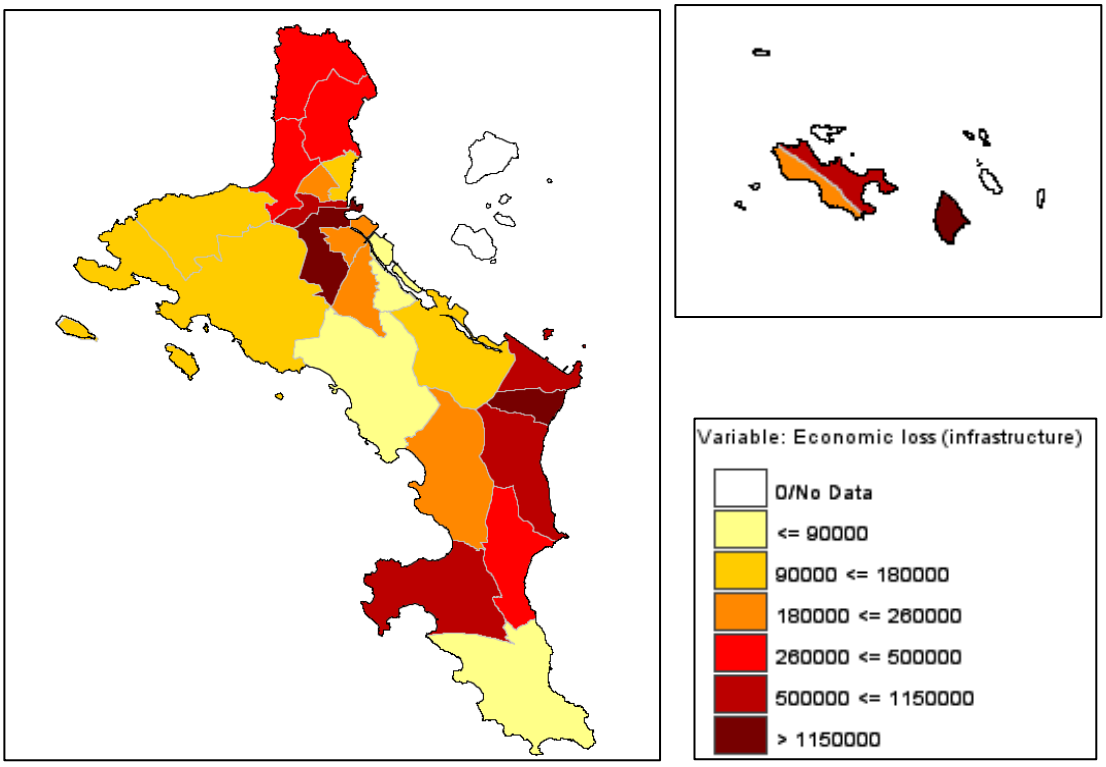
Figure 29: Economic loss (physical loss) by hazard



Source: Author based on Seychelles National Loss Database

Geographically, the loss is concentrated La Digue, Anse aux Pins et Bel Air) (Figure 30)

Figure 30: Economic Losses in Seychelles

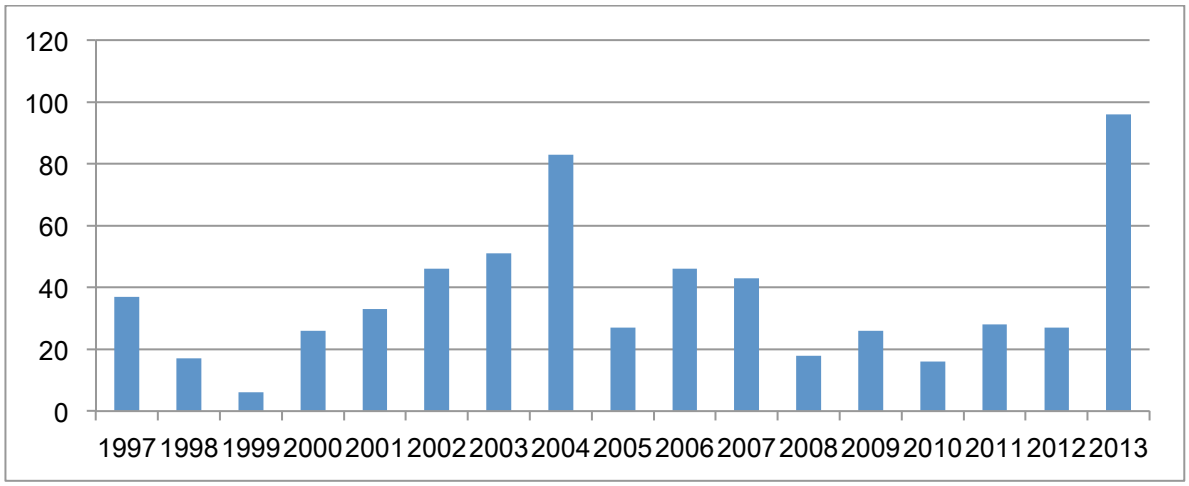


Source: Author based on Seychelles National Loss Database

The number of data cards has increased since 1997 ().

Figure 31). Before 1997, the number was always between 0 and 2. The economic loss is significant in 1997 due to heavy rain and landslides in August (USD 1.1 million), in 2004 after the Indian Ocean Tsunami (USD 3.4 million) and in 2013 after strong floods hit the country (USD 8.1 million) (Figure 32).

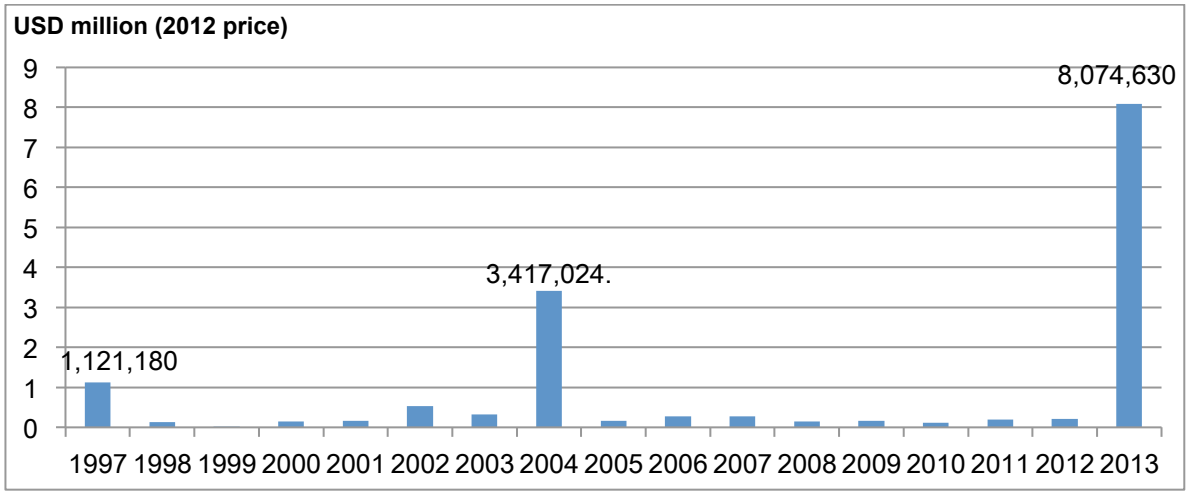
Figure 31: Number of data cards, 1997-2013



Note: Data cards before 1997 are between 0 and 2.

Source: Author based on Seychelles National Loss Database

Figure 32: Economic Loss, 1997-2013



Source: Author based on Seychelles National Loss Database

In Seychelles, the natural hazards that should be the focus of DRR policies is the increasing intensity and frequency of rain causing:

- Flood and
- Landslides

Flooding and landslides are considered major natural hazards and past trends illustrate major economic losses (50% and 13% each). Indeed, there has been major damage in terms of landslides and flooding this past year. Though there have been a minimum number of lives lost and injured, local authorities have considered the situation serious.

Flood: In the context of Seychelles, flood is classified as 'extensive' as it occurs frequently, and with most heavy rains in some geographical areas and would normally cause manageable damage and loss besides health risks attributed to septic tanks, chemical spillages and pests like mosquitoes. However, flooding, especially in the coastal zones where there is an estimated 80% of settlement and business infrastructure and resources, would have significant indirect costs like disruptions to everyday lives and major tourism sector. But they have not yet been quantified.

Landslides: The landslides are less frequent and they cause loss to major infrastructure including homes, retaining walls, roads, electrical and water networks, as indicated by the 'loss data' compiled. With the intensifying nature of the rain (result of climate change), the events are becoming increasingly serious.

Storm and Tsunamis: Though Seychelles is classified as being outside the cyclone belt and is also geographically away from potential earthquake and tsunami epicentres, the country is now experiencing more intensified storm surges and effects of tsunami.

The Indian Ocean Tsunami 2004 reached the Seychelles. According to a team of Geological Survey of Canada, the highest flood levels on Mahe ranged from 1.6 m to more than 4.4 m above mean sea level. On Praslin, they ranged from 1.8 m to 3.6 m. Maximum withdrawal of water was not recorded by the tide gauge at Mahe, because the stilling well went dry, but there are evidence from observers that it dropped as much as 4 m below mean sea level. The direct losses to infrastructure including the main fishing port was estimated at USD 30 million, which was an estimated 3.5% of GDP. As the indirect losses (socio-economic disruptions) were not fully assessed, the total costs to the country are believed to have been understated. With an estimated 80% of settlement and socio-economic infrastructure in the coastal zones and low plateaus, the whole country is considered as highly vulnerable to the tsunamis hazards.

Based on the climatology of tropical cyclone storm tracks from 1972 to 2001[29], the Seychelles is generally out of the major storm tracks. According to the records, cyclones are extremely rare in major three islands, Mahe, Praslin and La Digue. Tropical cyclone trajectories do not come close to those islands of the Seychelles located close to the equator, although there have been a few incursions[30]. The last such event occurred in 1956[31].

However, Seychelles is also increasingly experiencing storm surges, much attributed to the climate change and related phenomena like 'El Nino'. The storm surges have been recently causing major catastrophic effects in terms of flash floods and landslides. Severe storms have been hitting Seychelles initially with a four-year return period but they have been recurrent, annually, in the last few years. Major storms hit the Praslin International airport and caused major damages to its infrastructure in 1994, and more recently, brought with them torrential rain causing major losses and damages in 2013 at an estimated cost of USD 9.5 million.

At present, many experts feel that it may be beyond technical capabilities to predict how climate change will influence tropical cyclone/depression intensity or storm tracks. The JICA Study Team analysed 18 years (1993-2010) of tide observation data at Pointe Larue, Mahe, and obtained the probability curve of extreme high tide. In this extreme high tide, both astronomical tide and storm surge are included.

The definition for 'extensive' disaster would fit the local context satisfactorily as the flood and landslides have frequencies about or below 10 times during most calendar years. Therefore, both the flooding and the landslides are best classified as 'extensive' hazards. The 'extensive' disaster would not be a better fit for events like tsunamis of 2004 and the 'avalanche' of 1862 that caused major damage and disruption to socio-economic activities, and the latter claimed many lives.

Data, in terms of impact, losses and damage for the major disaster events of 2013 and 2014, are particularly well captured and documented. The recent "Seychelles Damage, Loss and Needs Assessment (DaLA)" report of July 2013 depicts the impact of the January 2013 flood that caused damage to over USD 9.3 million and post disaster recovery and reconstruction of over USD 30 million.

From the Seychelles Risk Profile developed by Denis Chang Seng and Guichard Gulliande (UNDP, 2008), the past storm surges, heavy rain and floods have caused damages and loss of around USD 1.7 million in the past, but the new storm and rain with much greater intensity are recently causing damage and losses in excess of

[29] JICA Report, 2013.
[30] The Seychelles National Climate Change Committee, 2009. *Seychelles National Climate Change Strategy*, p.96
[31] *Ibid*.

USD 10 million and the recovery and reconstruction are in excess of USD 30 million, equalling the 2004 tsunami disasters.

References

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JICA Report, Project for Study of Coastal Erosion and Flood Control Management in Seychelles, 2013

The Seychelles National Climate Change Committee, 2009. *Seychelles National Climate Change Strategy*,

UNDP (United Nations Development Programme), 2008. *Disaster risk profile of the Republic of Seychelles.* prepared by Denis CHANG SENG Consultant Bonn, Germany And Richard GUILLANDE GEOSCIENCES CONSULTANTS sarl Paris, France July 2008. Available online at: http://www.preventionweb.net/files/18276_18276disasterriskprofileofseychelle.pdf

3. Disaster Risk[32]

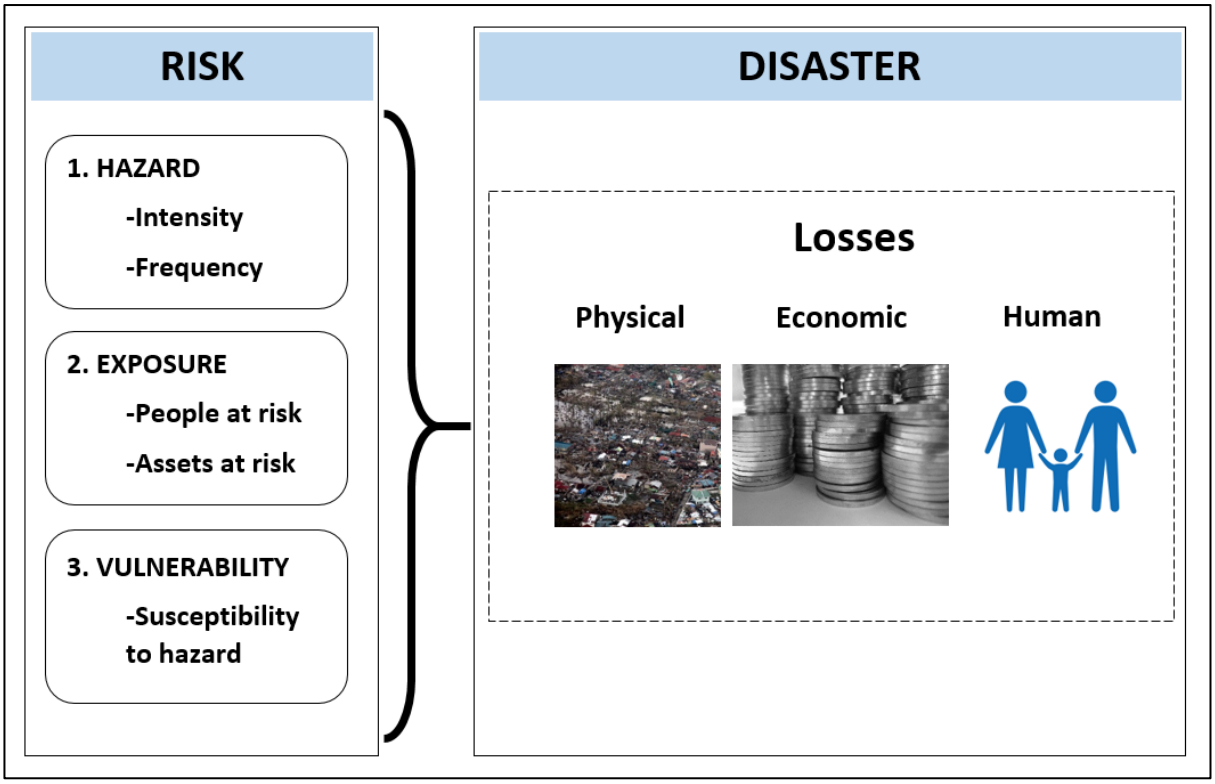
A. Overview

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 33). **Hazard** data are basically calculated from a set of stochastic scenarios and in this initiative the data were extracted from global datasets[33]. **Exposure** data measures the degree at which people and assets will be at risk when a hazard hits, and often consists of inventories of buildings, population and infrastructure. In this initiative, we used a combination of global exposure databases and data compiled by national experts (processed to construct a proxy). **Vulnerability** indicates the susceptibility of exposed population or assets to suffer damages and loss. This is important because hazard affects exposed element in different ways. For example, a certain wind speed affects a wooden house more heavily than a concrete building. In other words, vulnerability data shows the relationship between hazard intensity and the expected values of damage. In this initiative, vulnerability data were also taken from global data sets.

Figure 33: Key concepts of probabilistic risk assessment

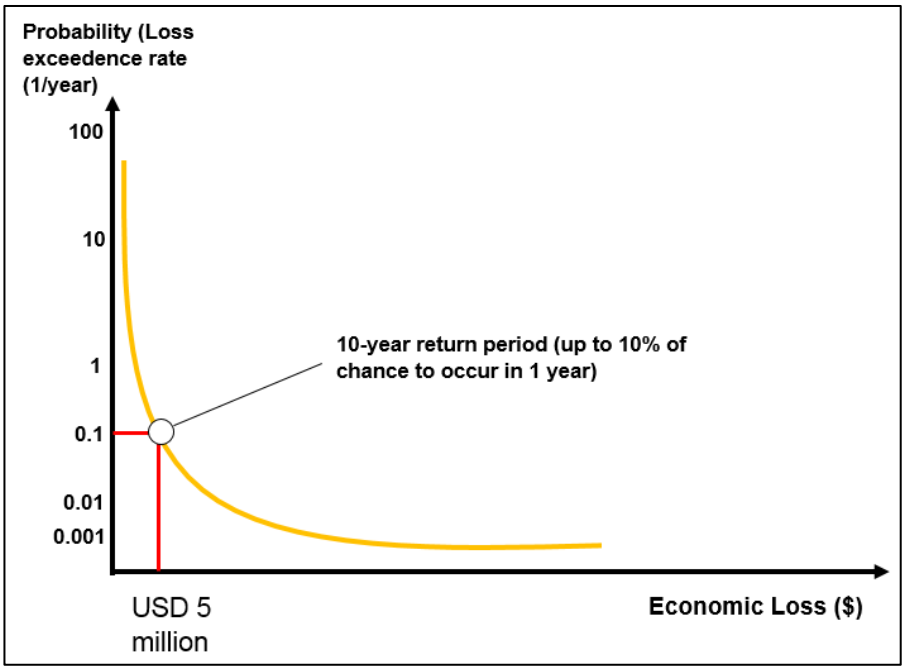


Source: Author

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

Based on probabilistic risk assessment, a loss exceedance curve for each hazard is produced (Figure 34). The curve shows the relationship between each value of the losses and the likelihood (probability) of having such loss during one year.

Figure 34: Loss exceedance curve



Source: Author

This curve enables the calculation of important national risk metrics called Annual Average Loss (AAL) and Probable Maximum Loss (PML). The AAL is basically the combination of all the potential losses that can occur every year due to a particular hazard, weighted according to their likelihood of occurrence. Simply said, the AAL is the loss that can be expected every year, regardless of whether it actually occurs or not. It gives insights into investment planning because the value shows how much risk should be reduced or transferred annually to prepare for all layers of risk. The PML is the loss associated to a specific, usually long return period. PML is a loss that is not frequent, therefore usually high, but still 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 building of probabilistic risk assessment for tropical cyclone (wind) and earthquake hazards. Tropical cyclone was selected because it was clear from the disaster loss data outlined in Chapter 2, that the region (especially Madagascar and Mauritius) has been hit by cyclone very often causing much loss. Earthquake was selected due to data availability given the short time frame of the initiative, even though it is not a major hazard for the region.

UNISDR and the national team collaborated to produce hybrid loss exceedance curves that combine probabilistic risk curves based on data collected in Component 2 with empirical risk curves based on historic loss data registered in Component 1 (see Chapter 2). Probabilistic risk assessment tends to underestimate the extensive risk and historic loss data is used to remedy this problem. In Seychelles, loss data were not sufficient to produce hybrid loss exceedance curves.

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

As described above, the probabilistic risk assessment implemented in this initiative is very often based on global data and does not have high resolution. Therefore it cannot be utilized for detailed cost benefit analysis, local planning and insurance premium calculation. The result is currently also limited to the assessment of physical assets due to data availability. However, the result can be very useful to raise awareness of disaster risk and initiate dialogues on incorporating DRM into the country's public investment planning.

In Seychelles, the Department of Risk and Disaster Management hosted the workshop, in cooperation with the Department of Planning, Ministry of Nature Utilization and Housing, Ministry of Environment, and Department of Communication, Information and Technology.

B. Probabilistic Risk Assessment in Seychelles[34]

In Seychelles, UNISDR and the national team conducted probabilistic risk assessments for tropical cyclonic winds and earthquakes. Table 6 presents the AAL and PML in absolute and relative values to exposed assets, gross fixed capital formation (GFCF) and GDP. While exposed asset value is USD 367 million, AAL and PML is zero for both hazards.

This is given the location of the country in the Indian Ocean. Regarding seismic hazard, all important seismic sources are far away from the country, rendering no threat in terms of strong motion. Tsunami hazard may be of some relevance, specially taking into account important seismic sources such as the subduction zone of the Australia Plate beneath the Eurasia Plate, south of Indonesia. Large earthquakes (magnitude Mw greater than 7) may trigger long-reach tsunamis all over the Indian Ocean. However, tsunami hazard was not taken into account for this specific project.

Regarding cyclonic strong wind, Seychelles is located quite close to the Equator, enough to be sufficiently away from the path of tropical cyclones. Given the location of the country, strong winds are not expected to reach any of the islands, and in consequence, there is no risk resulting from these events.

Table 6: AAL and PML for tropical cyclonic winds and earthquakes in Seychelles

		Exposed Assets(2014)	**GFCF (2013)**	**GDP (2013)**
	USD million	367	x	X
	Absolute			
Annual Average Loss (AAL)	0.0	-	-	-
Probable Maximum Loss (PML) in given return period (years)				
50	0.0	-	-	-
100	0.0	-	-	-
250	0.0	-	-	-
500	0.0	-	-	-
1000	0.0	-	-	-

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

[34] For detailed data source and methodology, see UNIDR/IOC (2014)

It is important to note that, even though there is no catastrophe risk for Seychelles in terms of earthquakes and tropical cyclonic winds, the country should continue the risk assessment efforts, to be able to consider other hazards and manage the derived risk. In the analysis of Chapter 2, it is recognized that flood is one of the most important hazards that Indian Ocean countries face.

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4. National DRM/DRR/CCA Framework[35]

A. Institutional Structures

Seychelles is prone to risks and major natural disasters date back to the 18th century with the landslides referred to as 'lavalas' (avalanche). Following the Indian Ocean tsunami of 2004 (including El Nino) and other storm surges, heavy rains, landslides, and recent flash floods that seem to become more intensive and extensive, the government has institutionalized disaster and risk management by creating the **Division for Risk and Disaster Management (DRDM)**, and subsequently, **the Division for Climate Change, Adaptation and Information**. Though the DRDM was initially attached to the President's Office to give it the highest level of importance, the Division is now in the portfolio of the Vice President. The DRDM is a fully-fledged risk and disaster management national coordinating body and its functions are guided and supported by the National Risk and Disaster Management Policy (finalized in April 2008) under the United Nations funded project. The Division for Climate Change, Adaptation and Information is in the portfolio of the Minister for Environment and Energy, and as a Division, great importance is attached to it.

Other institutions and organisations that play key roles and form part of the DRM, DRR and CCA framework include:

- The Ministry of Environment and Energy
- The Ministry of Health
- The Ministry of Land Use and Habitat
- Ministry of Social Affairs, Sports and Community Development (includes district administration offices)
- Ministry of Foreign Affairs
- Ministry of Natural Resources & Industry
- Ministry of Finance, Trade & Investment
- The Seychelles Planning Authority
- The Seychelles Police
- The Seychelles Fire Brigade
- The Seychelles People's Defence force
- Seychelles Land Transport Authority
- Public Utility Corporation
- Civic society such as the Red Cross

Other supporting bodies include the following:

- ***Advisories and Warnings.*** The Early Warning Centre at the Seychelles National Meteorological Service (SNMS) issues advisories and warnings during the disaster to warn people of the on-going heavy rains and of locations that are considered dangerous

- ***National Flood Task Force (NFTF).*** In the past the President convened extraordinary Cabinet meetings (like in the case of DaLA to review the situation on the ground. This situation had led to the establishment of a more permanent National Flood Task Force (NFTF) to enable high-level coordination among ministries and agencies and to mitigate the impact of any possible secondary disasters.

- ***National Disaster Relief Fund (NDRF).*** Seychelles also set up a National Disaster Relief Fund (NDRF) in order to raise funds both locally and internationally (for both monetary and in-kind contributions) for the families who were left without a home during the floods, those who will need to repair their homes, as well as for the surrounding infrastructure.

- ***National Emergency Operations Centre (NEOC).*** The NEOC was activated with all staff called in to DRDM. This was necessary to better coordinate crisis situations and other mundane risk and disaster management activities like calls received during the disaster overloading the DRDM lines.

B. Legal Structures

The Government of Seychelles has been placing great emphases on disaster and risk reduction, and has been a strong advocate of climate change adaptation, locally and globally. To further strengthen risk and disaster

[35] This chapter was drafted by William Danis Zarine.

management, DRDM presented a Disaster and Risk Management Bill/Act to Cabinet and to the National Assembly in July 2014 for approval, and it will be implemented, soon, after ratification. This adds a new dimension to the DRR, DRM and CCA operational frameworks and will essentially contribute to the attainment of sustainable development in line with Seychelles Vision 2020 and Seychelles Sustainable Development Strategy (SSDS) 2012-2020 through strengthening of national capacities to reduce risk and build community resilience to disasters.

Its core strategies are articulated in policy and strategy frameworks such as the Seychelles Strategy 2017 which places strong emphases on environmental protection whilst aiming to double the GDP, and the Seychelles Sustainable Development Strategy (SSDS) 2012-2020, which is a framework designed to promote and realize a knowledge-led and innovation-driven approach to sustainable development that guarantees an increasing quality of life inclusive of the natural environment, and achieve a balance between the social and economic needs of present and future generations whilst conserving the integrity of the natural capital.

As articulated in the new National Risk and Disaster Management Policy, national actions are guided by the following objectives:

- Minimise the loss of human life, property, livelihood and damage to the environment from hazards of natural, geological, technological, biological and ecological origin;
- Advocate an approach to disaster risk management that focuses on reducing risks especially to those sections of the population who are most vulnerable
- Advocate for a shared awareness and responsibility to reduce disaster risk in homes, communities, places of work and in society generally;
- Give effect to the application of cooperative governance on issues concerning disasters and disaster risk management among all levels of government and allocate responsibilities in this regard to the relevant stakeholders.
- Facilitate the involvement of the private sector, non - governmental organisations, communities and volunteers in disaster risk management; and to
- Facilitate partnerships in this regard between organs of state and the private sector, non-governmental organisations and communities;

A number of other legal structures (policy and regulations) ensure proper risk mitigation actions and behaviours. In summary, key policies in Seychelles that relate to DRM and help to minimise risk and disaster events include:

- Seychelles National Risk and Disaster Management Policy (NRDM Policy), 2008
- Risk and Disaster Management Act (going to National Assembly July 2014)
- Climate Change Strategy 2009
- Environmental Protection Act of 1994
- Environment Management Plan of Seychelles (EMPS 2000-2010)
- National Parks and Nature Conservancy Act (1969, as amended)
- Protected Areas Act (1967);
- Forest Reserves Act (1955, as amended);
- The National Biodiversity Strategy and Action Plan (NBSAP, 1998)
- Seychelles Biosecurity policy (draft) (being developed through an international project on Biosecurity with the UNDP/GEF)
- Town and Planning Act of 1972
- Solid Waste Master Plan 2011-2020
- Sanitation Master Plan 2010-2025
- Landscape and Waste Management Agency Regulations (2009)
- Pesticides Control Act (1996) - regulates the manufacture, distribution, use, storage and disposal of pesticides
- Energy Policy of Seychelles, 2010-2030
- Maritime Zones Act, No. 2 (1997) ; Maritime Zones (Maritime Pollution) Regulation(1981);
- Fisheries Act (1987)
- Land Reclamations Act (1961).
- Shelter Policy (provisions for people to access some form of safe and acceptable shelter pre-, during and post disaster events or situations)

Whilst there have been no specific DRR/DRM/CCA investment policies, there are some initiatives and projects to address DRR and CCA in the budget and public investment in Seychelles, and include:

- Institutionalizing disaster and risk management by creating the Department of Risk and Disaster Management (DRDM)
- Investing in environmental protection projects through Ministry of Environment and institutionalizing climate change by creating the Division of Climate Change, Adaptation and Information
- Setting up early warning systems for tsunamis and weather through the Meteorological Services and Climate Change, Adaptation and Information Divisions
- Enforcing stringent planning processes for any form of construction or infrastructure developments requiring the approval of the Seychelles Planning Authority

The Government of Seychelles has long recognized that building resilience to disaster is an on-going process of iterative review and improvement to meet changing circumstances. It furthermore recognizes the International Strategy for Disaster Reduction (ISDR) and its *Hyogo Framework for Action 2005-2015* as providing a sound, comprehensive framework for the elaboration of national initiatives and programmes to integrate Disaster Risk Reduction (DRR) across development sectors and to enable the effective elaboration and implementation of the disaster risk management cycle in the Seychelles.

Seychelles is signatory to a number of multilateral agreements, and those related to DRR/CCA include:

International:

- United Nations Convention to Combat Desertification (UNCCD) which establishes measures to prevent further loss of agricultural land through factors that encourage desertification.
- United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol 1992/ 1997
- United Nations Framework Convention on Climate Change (UNFCCC), Nairobi Convention
- Vienna Convention for the Protection of the Ozone Layer
- Convention on Biological Diversity
- International Convention for the Prevention of Pollution of the Sea, (OILPOL)
- Davos Convention and UNCCD, promoting the tourism industries reduction of the carbon footprint through the reduction of greenhouse gas emissions

Regional:

- Seychelles is actively supporting the following programmes: Common Market for East and Southern Africa (COMESA)'s Comprehensive Africa Agricultural Development Programme (CAADP) process driven by New Partnership for Africa's Development (NEPAD) and African Union.
- The Regional Agricultural Policy (RAP) initiated by South African Developing Countries (SADC)
- *Elargissement et Pérennisation du Réseau de Protection des Végétaux* administered by the Indian Ocean Commission (IOC)

In summary, the political will to address DRR and CCA has been strong over the years, though sometimes actions are marred by limited resources --one of the peculiarities of Small Island Developing States.

NGOs are also active. Sustainability for Seychelles (S4S) is a legally registered NGO established in 2007 to promote sustainable island living, and has implemented projects related to climate change, water, waste and energy funded by local, regional and international donors, including the Global Environment Fund–Small Grants Programme (GEF/SGP). The project will also contribute to the achievement of several outcomes of the Seychelles' Sustainable Development Strategy (2011-2020) under the thematic areas of climate change and waste.

C. Status of Hyogo Framework for Action

Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.

Seychelles has developed policy, legislative and institutional frameworks for disaster risk reduction and though these frameworks it has been able to start developing and tracking progress through specific and measurable indicators. Since the setting up of DRDM, the country has been successfully building greater capacity to manage risks and to achieve widespread consensus for, engagement in and compliance with disaster risk reduction measures across all sectors of society. The pulling of key stakeholders at the DRDM, the risk management coordinating centre, for the 2013 Felleng disaster and the Aux caps flood of January 2014, are great examples of such achievements.

Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning.

Much efforts and resources are committed to the identification and assessment of disaster risks following the setting up of key risk management entities such as the Division of Risk and Disaster Management (DRDM), the Climate Adaptation and Information Division, the National Emergency Committee and National Relief Fund body. Following risks and disaster events such as the tsunami in 2004, repeated storm surges leading to floods and infrastructure damages, and chikunguya and conjunctivitis epidemics, Seychelles have implemented preventive measures and reduction strategies such as Early Warning Systems (EWS), both in weather and tsunami, and surveillance systems in health. These initiatives have effectively reduced the impact of those natural disasters, and more so, allow for response time prior to any incident being monitored and captured by EWS.

Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.

Much more is needed to be done in terms of informing and motivating people towards a culture of disaster prevention and resilience, which in turn requires the collection, compilation and dissemination of relevant knowledge and information on hazards, vulnerabilities and capacities. The balance of social and economic needs against disaster and risk mitigation is still a challenge.

Seychelles is still making progress in reducing disaster risk and in promoting a culture of disaster resilience to potential hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face. Following the recent Felleng disaster and the January 2014 storm surges and floods, people are becoming more knowledgeable of the changing hazards and vulnerabilities.

Priority Action 4: Reduce the underlying risk factors.

Disaster risks related to changing social, economic, environmental conditions and land use, and the impact of hazards associated with geological events, weather, water, climate variability and climate change, are addressed in sector development planning and programmes as well as in post-disaster situations. Seychelles has mainstreamed some of desired practices to reduce risks through legal structures like the Disaster and Risk Management Act, 2014, the Climate Change Policy 2009, the Environmental Protection Act 1994 and the Town and Planning Act 1972. However, some of these laws need better and more effective enforcement.

In most cases, controls and protection come from the legal framework such as a rule that any construction of large projects needs Planning Authority or Environmental Impact Assessment, and ban of non-friendly ozone gases.

Priority Action 5: Strengthen disaster preparedness for effective response at all levels.

It is the government policy to ensure individuals and communities in hazard-prone areas are well-prepared and ready to act and are equipped with the knowledge and capacities for effective disaster management. For example, there is strong focus on contingency planning, shelter policy and risk financing, both ex-ante and ex-post financing mechanism and strategy. A National Relief Fund is set for the purpose of disaster events, and now a move to insurance policy is well under way with sectors like farmers.

5. DRR/DRM/CCA in Public Investment Planning[36]

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

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

There has not been a specific DRM/DRR/CCA investment policy, and hence, risk-sensitive public investment is not an integral part of fiscal policy and practice in Seychelles. With the growing number of risk and disaster events over the last 10 years, there is a need to strengthen the national effort in risk management and this is best achieved through proper risk assessment that will support public investment project selection based on law or guidelines.

There has been indirect funding and public investments in DRR, though there were no specific laws and guidelines governing the integration of risk assessment into cost benefit analysis for public investment project selection.

The recurrent and capital budget and expenditure in Seychelles are issued on a common classification system for different categories of budget and expenditure under different programmes for all ministries and departments. The capital projects are compiled under the Public Service Implementation Projects (PSIP) where priorities are established and they are usually based on the urgency, importance and often on cost/benefit analysis of the project or programme, but not on disaster risk. Major projects in infrastructure development are treated as exceptions, and a comprehensive Environmental Impact Assessment (EIA) is mandatory prior to planning approval.

Though not lawful, there is a common understanding that a project or programme that is viewed as addressing critical risks and catastrophic situations are usually considered favourably, unless funding is limited. A case in point is reforestation that has multiple benefits and risk reduction such as reducing soil erosion, flood flash, falling boulders, and damage on infrastructure, agriculture and tourism sectors.

Some budget activities spread across Ministries and Departments/Divisions. The construction of drains, cleaning of rivers, reforestation and coastal zone management are all forms of DRR/DRM/CCA expenditure, though not documented as such. As stated above, a number of investment projects and programmes have risk reduction impacts, but they are not necessarily labelled or coded as DRR/DRM/CCA budgets or expenditures in the recurrent and capital budgets. The Ministry of Environment and Energy, and the Division of Risk and Disaster Management (DRDM), can be viewed as the direct investment in DRR, DRM and CCA, though such classification is not yet established.

As outlined in the risk-sensitive budget review (RSBR), there have been and still are investments in environment, local government infrastructure, land drainage, reforestation, walls and coastal zone management, which can be classified as risk reduction or risk management budget lines, as their ultimate goals are the mitigation of disaster and risk events. All these investments are from the government budget as appropriated by the National Assembly, in the form of recurrent and capital budget. The exception is post disaster recovery and reconstruction which are mainly financed by the National Relief Fund, a non-governmental fund mobilisation and coordination body which gets the majority of the post disaster support (financial and other forms) from the private sector, individuals and international donor agencies and assistance.

One noticeable concern, here, is the lack of clear policy on the protection of critical infrastructure in the country. Whilst most major private facilities like hotels and buildings have risk protection mechanisms such as insurance covers, the public infrastructure are not always the case. Most infrastructure, like roads, ports, government buildings, water sewerage distribution systems have no clear protection plans. The tsunamis 2004 that damaged the critical fishing port infrastructure required assistance from the Japanese government to implement the recovery and reconstruction plans at USD 30 million.

[36] This chapter was drafted by William Danis Zarine.

The Disaster and Risk Management Act, 2014 (just put to the National Assembly) addresses core DRM issues, inclusive of DRR investments, budgeting and financing. The Act has provisions for national Risk Disaster Management Fund though the levels of funding and investments are not clearly articulated. It is to note that the composite of the funds include amounts appropriated by the National Assembly and those transferred from other divisions to the Fund, as/when required and agreed upon.

There is great opportunity to mainstream risk sensitive public investment in the government budget and public investments with the introduction of programme-based budgeting, which is being piloted in Seychelles.

B. Contingency Finance Mechanisms

Government will take not only the legal and explicit liability, but also the implicit liability where Government is expected to intervene promptly to provide relief and recovery to the affected (damaged and destroyed housing, loss of property). There are a few finance mechanisms for managing disasters, summarized in Table 7. These mechanisms mainly address recovery and reconstruction costs. Thereafter follows a discussion of the main measures listed.

Table 7: Finance mechanisms for disaster management

EX-ANTE MECHANISMS	
Contingency budget line	
Contingency funds	Contingency fund is just one consolidate amount of RS50 million (USD 4.12 million) and there is no clear allocation or indication for DRR/DRM/CCA. It is tied to disaster response, health epidemic, piracy, law suit and external shocks (fuel, food)
Insurance	Schemes for farmers insurance just initiated, personal/private insurance is an option and their uses are on the increase.
Others	Corporate Social Responsibility (CSR) tax, which goes to community and social projects. Disaster Relief Fund from private financial resources (*e.g.* donation)
EX-POST MECHANISMS	
Diverting funds from other budget items	Can be done with National Assembly approval.
Imposing or raising taxes	Not an advisable option and not practiced in small state with already high tax regimes.
Taking a credit from the Central Bank (either prints money or depletes foreign currency reserves)	Not an option, especially with stringent financial and fiscal controls and disciplines after post 2008 economic reforms (See Chapter1).
Borrowing by issuing domestic bonds	Possible with the right incentives (i.*e.* the interest rate).
Accessing international assistance	International assistance is sought only if the need arises (*i.e.* preliminary assessment results show country is out of capacity)
Borrowing from multilateral institutions	World Bank- considered within the debt ceiling (maximum/limit amount borrowed)
Issuing bonds on the international market	Not being considered at this time.

Source: Author

There is no established reserve fund in Seychelles to potentially use for disasters due to natural hazard. The 'Contingency Fund', which got a R 50 million (USD 4.12 million) allocation in 2014 is not exclusively tied to risk and disaster events. The fund is shared amongst different functions and activities such as health epidemic, piracy, lawsuit and external shocks (fuel, food). However, the fund is mainly used for disaster response and recovery, and if not used in a particular year, it is returned to the consolidated fund.

The Disaster Relief Fund (DRF) is a source of post disaster management mechanism, and it is mainly coming from private sector, individual and international donors. It has been quite successful in 2013 in raising money for response and recovery, post Felleng disaster event.

One of the major concerns on the part of the government and public institutions is risk management strategy in terms of 'risk transfer'. Whilst many of the government activities and services are outsourced, the major public infrastructure like buildings, roads, bridges, ports, utilities are not all fully insured, raising concerns over our resilience to natural hazards. The damages caused to the fishing port by the 2004 tsunamis is a classic example, and the government's assets are considered as excessively exposed.

The government has been encouraging people and businesses to opt for life and infrastructure protection plans, and the farmers are already getting insurance covers for their farms, animals and crops, which are often wiped out during storm surges, flooding and landslides. The insurance companies in Seychelles are all-accessible and offer a whole range of protection plans including life, professional indemnity, businesses and infrastructure. Whilst there are no official figures on the penetration rates, it is believed that many more people are opting for some form of protection plan, inclusive of their houses, walls, businesses and life.

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 8 below summarizes the scope of the budget review.

Table 8: Scope of the risk sensitive budget review

Year	The budget 2012/2013/2014
Coverage	The focus was on those listed below: ▪ Vice President's Office (especially the DRDM) ▪ The Ministry of Environment and Energy (especially, the Climate Change Adaptation and Information, Environmental Division, Landscape and Waste Management, Environmental Education, Coastal Adaptation Management, Wildlife Enforcement and Permit, National Park Authority, National Botanical Gardens) ▪ Ministry of Land Use and Habitat (including the Planning Authority) ▪ Ministry of Education ▪ Ministry of Health (Public Health Authority) ▪ Public Utilities Corporation ▪ Ministry of Internal Affairs and Transport (esp. Police and Fire Services) ▪ Ministry of Local Government, Social Services and Sports (Agency for Social Welfare Protection) ▪ Ministry of Foreign Affairs ▪ Ministry of Natural Resources ▪ Seychelles Agricultural Agency ▪ Seychelles Fishing Authority ▪ Ministry of Labour and Human Resource Development ▪ Ministry of Tourism and Culture ▪ Seychelles Tourism Board

	▪ Public Utilities Corporation ▪ Public Service Implementation Projects (PSIP)
Budget or expenditure	Both the budget and expenditure were included
Current or Capital	Both recurrent and capital budgets were examined
Targeted hazards	Geological (*e.g.* earthquake, tsunami, landslide), meteorological (*e.g.* cyclone, heat wave) and hydrological disasters (*e.g.* flood, landslide, drought). Epidemics and other hazards (*e.g.* fire)

Source: Author

Results: With respect to current budget/expenditure, an initial high level analysis of the budget (wide approach) revealed that the total average budget for DRM as per the analytical interpretation for the last three years (2012-2014), possibly stands at RS 198.8 million (USD 16.5 million), which is equivalent to an average of 3.75% of the total budget. DRM has been marked for programs totalling RS 104.6 million (USD 8.7 million) for 2012, RS 267.8 million (USD 22.2 million) for 2013 and RS 223.8 million (USD 18.5 million) for 2014, which are, respectively, 2.04%, 4.93% and 4.3% of the total annual budget (Table 9).

A marking of “Principal” was attributed to 0.04% of the total budget in 2012; 1.63% in 2013 and 0.5% in 2014. The rise in 2013 is very much attributed to the Felleng disaster, whereby, there have been move to have the Climate Change, Adaptation and Information centre being developed and other initiatives to mitigate the impact of the flood disaster. The proportion of efforts marked “Significant” funding were 2% in 2012, 3.3% in 2013 and 3.8% in 2014 (Table 9). This includes a horizontally integrated investment in DRR, reflecting a positive move towards mainstreaming DRR.

A more in-depth analysis (considered the ‘narrow’ approach to budget review) was then carried out, covering roughly the whole budget. It is noteworthy that in the last three years, an average of 90% of the DRM budget targets prevention/mitigation and preparedness (Table 10), and this reflects the fact that post disaster events (response and reconstruction) are not necessarily budgeted and mitigated in any way but they are catered for mainly by the Disaster Relief Fund, which is not government/public funding..

Table 9: DRM Marker by Sector/Organization

DRM Marking ĂIJŎPÑ FÑŎPĄŃŎĂ	2012 (RS'000)		2013 (RS'000)		2014 (RS'000)	
Entities	Principal	Significant	Principal	Significant	Principal	Significant
Division: Climate Affairs, Adaptation and Information	276	-	83,733	-	25,419	-
Division: Risk and Disaster Management	283	-	3,441	-	673	-
Seychelles Planning Authority	1,384	-	1,186	-	-	-
Landscape and Waste Management	-	77,873	-	79,326	1,340	86,138
Seychelles Land Transport Agency	-	-	-	38,652	-	31,086
Ministry of Education	-	13,912	-	18,669	-	20,082
Division: Wildlife Enforcement and Permit	-	250	-	14,273	-	25,225
Ministry of Health	-	3,542	-	7,560	-	14,982
Division: Coastal Adaptation Management	6	111	-	6,132	-	6,200
Agency for Social Welfare Protection	-	1,801	-	3,150	-	2,475
Ministry of Land Use & Habitat	-	1,129	-	2,639	-	299
Ministry of Home Affairs	-	46	-	2,074	-	513
National Botanical Gardens	-	1,319	-	1,639	-	1,556
Ministry of Community Development	-	-	-	1,573	-	517
Seychelles Agricultural Agency	-	-	-	750	-	3,750
Seychelles National Parks Authority (Div: Nat. Parks)	-	918	-	694	-	156
Ministry of Tourism	-	-	-	622	-	813
Division: Human Resources and Financial Management	-	322	-	618	-	1,170
Ministry of Foreign Affairs	-	211	-	504	-	583
Tourism Board	-	-	-	390	-	581
Ministry of Labour and Human Resources Development	-	-	-	155	-	220
Division: Environmental Education	-	1,296	-	50	-	-
Sum	**1,949**	**102,727**	**88,360**	**179,471**	**27,432**	**196,344**
% of PBB	**0.04%**	**2.0%**	**1.6%**	**3.3%**	**0.5%**	**3.8%**
Total Marked (%)		**104,676**		**267,830**		**223,777**
GRAND TOTAL		**5,190,000**		**5,423,000**		**5,200,000**

Table 10: DRM/CCA investments in 4 components, average of 2013-2014 (RS billion)

Budget allocations per Risk Management phase/category	Significant RS billion	Principal RS billion	Total RS billion	Percentage (%)
Prevention/mitigation (1)	0.103	0.021	0.124	62.6
Preparedness (2)	0.045	0.009	0.054	27.4
Response (3)	0.016	0.003	0.019	9.4
Reconstruction (4)	0.001	0.000	0.001	0.6
Total budget allocations	**0.16**	**0.04**	**0.20**	**100**
Share of total budget (%)	3.03%	0.74%	3.77%	

Component 2 of the project determined an average annual loss of USD 0 million to tropical cyclonic winds and earthquakes. A simple comparison of estimated AAL to the most current annual investment in DRR indicates a **positive balance**: greater investment than expected loss in the present year (Table 11). However, it is important to keep in mind that AAL is only estimated for tropical cyclonic wind risk and go back to the actual marked activities to determine their link to cyclonic wind risk. If this investment could be reasonably linked to tropical cyclonic wind mitigation or DRR, it would seem to offset the AAL by many years.

Table 11: Checking the gap: DRM budget, loss and risk

USD million	DRM investment (budget), 3-year average of 2010-2012	AAL (tropical cyclonic wind and earthquake only)	Loss, 1980-2014 (636 of data cards)
Value	USD 15.6 million	0	USD 15.6 million (annual average: USD 0.4 million)
Status		NO GAP	NO GAP

As reference, loss data were also compared to the budget. Again this comparison shows a positive balance. `Total investment exceeds even the total loss over the period 1980 to 2014.

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

The challenges include lack of expertise, manpower and other resources, lack of policy and guideline for budget review and access to relevant financial and project data. Further collaboration across sectors is required and budget classifications and coding should be introduced.

In Seychelles, all public investments in DRR/DRM/CCA are integrated within the budget of different ministries/public institutions and they are not classified or coded according to DRR or DRM, and this makes it difficult to identify budget and expenditures that are related to or have impact on DRR and DRM.

Interpretation and classification in the review has been subjective and can be misleading. For example, the whole budget for DRDM was considered and classified as DRR/DRM as DRR/DRM budget/expenditure. Similarly, projects or expenditures for any Ministry related to security and enforcement or upgrading/rehabilitation of infrastructure like road, bridges, beaches and general eco-system were also classified as DRR/DRM budget/expenditure.

It is therefore difficult to track sectorial DRM investment, and DRR investments cannot be easily separated from entire project or budget reports. The structure of budget by type of expenditure and programmes (very much a mixed functional, economic and administrative classification), rather than specific projects or project category, constituted a difficulty when attempting to identify DRR in a specific programme. As most programmes or even

sub-programmes consist of multiple objectives and activities, retrieving and consolidating the information related to DRR is a very delicate task.

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

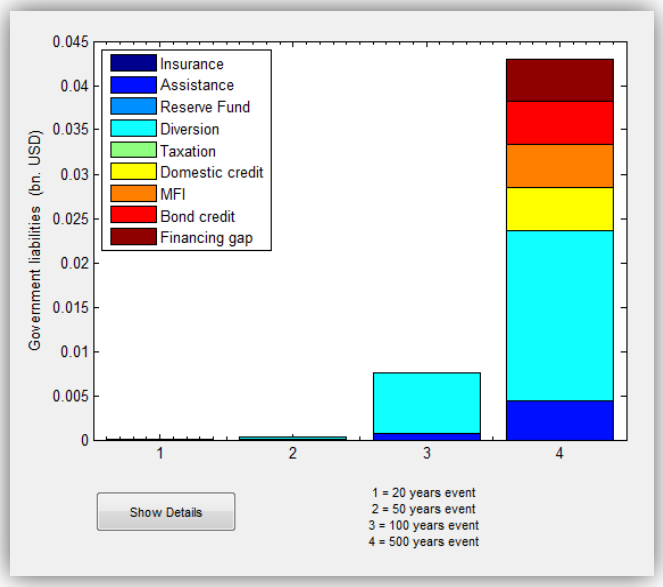
AAL was estimated to be USD 0.59 million. Total liabilities of Seychelles Government were estimated as USD 1.7 billion based on capital stock data. Then, the options to finance reconstruction and recovery were examined and same assumptions across IOC countries are applied. In conservative case, USD 33.7 million was estimated to be assured through diversion from budgets, domestic bonds and credit and international market borrowing.

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

Results: The fiscal resources gap years for Seychelles are between 102 years and 329 years. Facing an AAL of USD 0.59 million (0.05% of GDP), Seychelles was found to face a fiscal resources gap at year 329 (CAPRA estimate). There is significant uncertainty regarding the backward loss distribution estimated such as one used in Hochrainer-Stigler (2014) in case of very limited information. For Seychelles only three entries of past disaster economic damage available from the EM-DAT (2014) over the past 17 years, this severely limits our ability to estimate risk of higher return period events, but there are some indications that the financing gap will be around the 100 year loss return period.

Based on the CAPRA estimate, the reconstruction and recovery capital needs are estimated at: USD 0.22 million (100 year event) and USD 43 million (500 year event) respectively (Figure 35). Budget diversion constitutes a larger portion of reconstruction and recovery costs where approximately 89% and 44% of the costs will be financed through these means for the 100 year and 500 year events. The financing gaps are expected to increase to USD 5 million in the 500-year event.

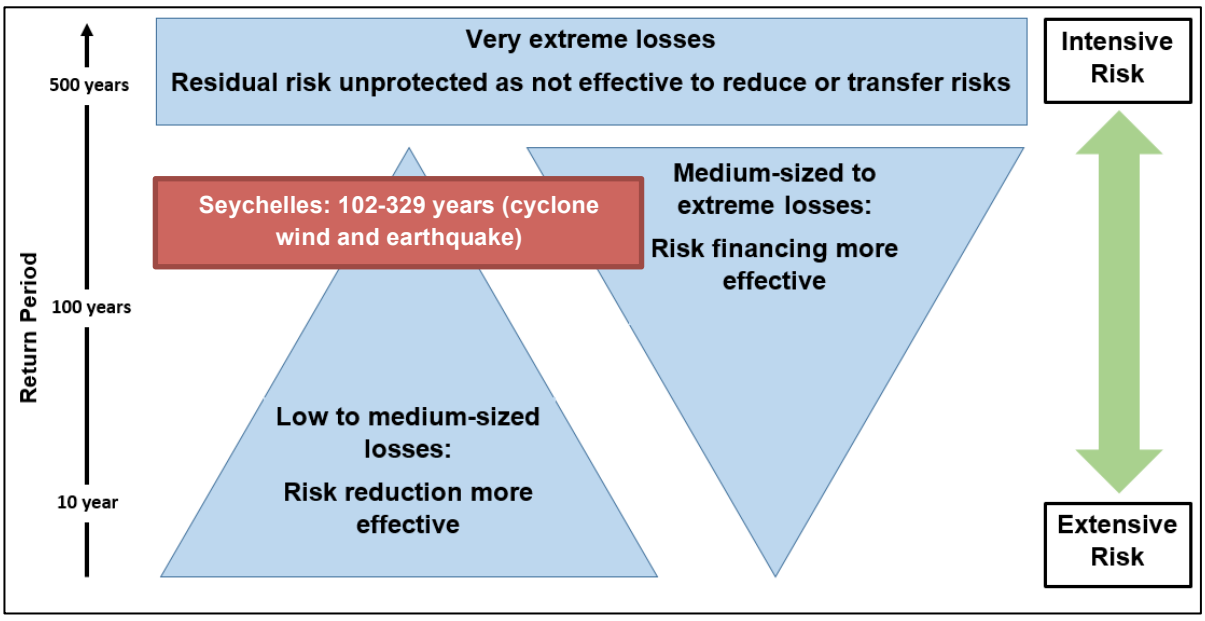
Figure 35: Fiscal resource gap year analysis for Seychelles



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 36). The CATSIM analysis conducted from Steps 1 to 3 has illustrated the need for improved management of disaster risk in Seychelles. It appears that risk-financing options can be effective for Seychelles regarding tropical cyclone (wind) and earthquake hazards.

Figure 36: Risk layering approach



Source: IIASA

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

Risk assessments of additional hazards including cyclone (rain/storm surge) and floods are certainty needed to conclude on a more comprehensive assessment of fiscal risks that Seychelles 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 Seychelles and other IOC countries (Table 12). 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 Seychelles.

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 Seychelles 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 12: 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 A large discrepancy in risk information is identified for Seychelles; thus further validation is advisable
Technical capacity needs:	-Technical training on risk assessment and economic modeling including CAPRA and CATSIM training. -Further sensitization of risk-based thinking. General familiarity of risk based terms such as the annual average loss, the probable maximum loss, exceedance probability must be explained to decision-makers.
Institutional capacity needs:	-Coordination, where both risk and socio-economic data are jointly collected and managed by relevant agencies (DRM agency plus Ministry of Finance). -Clarity on the specification of the role of each agency in data collection and analysis to avoid the duplication of the efforts.

Source: 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. As probabilistic risk assessment for flood has not been developed, historic disaster loss data was used as input (backward- looking probabilistic CBA). The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment.

Case study on flood alleviation project in Point La Rue: Case study on probabilistic CBA, evaluating the costs and benefits of a proposed storm channel construction project in Point La Rue was implemented. Given there is no probabilistic risk assessment of flood, backward looking CBA was applied.

Using data from past flood events as well as precipitation data over the last 40 years, risk in terms of a loss distribution was estimated showing that the Pint La Rue region faces an average annual loss (AAL) of approximately USD 169,000. The cost of the tidal channel project is SR 23.5 million (USD 1.95 million). Assuming a project lifespan of 30 years, with a 5% discount rate and an annual increase in exposure of 1.5%, the project is found to be cost-efficient with the net present value of USD 433,000 and a Benefit/Cost (B/C) ratio 1.2.

It is important to note that for a backward looking CBA as was performed in the present study the data on previous disaster losses and severity of the weather events (precipitation amounts) is critical to making accurate estimates for the AAL. Some of the previous loss data was found to be associated with robustness challenges, which leads to significant uncertainty of the present backward looking CBA. Working towards more complete and robust loss data when conducting backward looking CBA is an area of work that needs attention. It is also important to keep in mind that the present assessment did not take into account many of the indirect and intangible losses. 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 most important Stakeholders for risk sensitive public investment processes in Seychelles are:

- Ministry of Finance
- Ministry of Environment and Energy
- Ministry of Health
- Ministry of Land Use and Habitat (Planning)
- Ministry of Youth, Sports and Community Development
- Division of Risk and Disaster Management
- Meteorology and Climate Change Division
- Land Transport Division
- Seychelles Police and Fire Services
- Public Utilities Corporation (PUC)
- Seychelles Chamber of Commerce and Industry (official body of the local businesses)
- Red Cross Society
- NGO and Civic Society

In the case of Seychelles, external donors such as the United Arab Emirates (UAE), Global Environmental Fund (GEF), China and India, and other governments and bodies are instrumental in assisting and supporting Seychelles through loans or grants. The Government of Japan assisted Seychelles with the reconstruction of the USD 30 million damages caused by the 2004 tsunamis and the World Bank has just secured a USD 10 million facility that can be drawn on the event of major catastrophic events, going forward.

6. POLICY RECOMENDATIONS[37]

There has been no tradition of risk analysis for budget purposes in Seychelles, and the lack of consistent information and data do not make such exercise easy. However, it has been common practice for Seychelles to undertake basic risk analysis, and in particular, loss and impact analysis post disaster events was the case for tsunamis in 2004 and Felleng in 2013. The JICA and Felleng reports have been good examples of risk assessment of disaster and risk analysis of past events and much more information and data points would be required to give the more desirable and useful future and probabilistic view and impact of disaster and risk events.

A culture of information and data tracking and documenting is critical, and must be implemented and maintained, and these are required for some of the common tools such as disaster loss database, risk assessment (CAPRA), the Catastrophic Simulation Model (CATSIM) and the Cost-Benefit Analysis (CBA). These analyses have been conducted for the Seychelles through this project, but it has to be noted that the lack of reliable information and data points, may have undermined the risk probability and impact assessment of any chosen hazard. The seriousness of recent flood events and impact have raised awareness of the importance of information/data tracking and documenting as well as risk analysis.

Policy guidelines have been long lacking in the area of risk investments and financing. But the new Risk and Disaster Management Policy is set to address many of the shortfalls and it equally gives a great boost to the DRR/DRM/CCA undertakings. As stated earlier, clear risk reduction and response strategies are essential, and clear policy on risk investments and financing are critical if we are to achieve maximum impacts as/when it comes to disaster and risk management. The Disaster and Risk Management Act, 2014, which is being ratified, is an important framework for the risk and disaster management.

On the institutional side, many stakeholders are already involved, directly and indirectly, in DRM and they are supported a central coordinating mechanism, namely, the Division of Risk and Disaster Management or DRDM. In spite of all, there are critical gaps and this includes a lack of DRM expertise, lack of financial resources, lack of reliable and relevant information and data, and lack of DRM/DRR/CCA awareness and ownership across sectors and Ministries. However, it is to note that collaboration across sectors have been commending during crisis situation, much driven by the commendable political will on behalf of the country and the general community.

Another challenge is lack of dedicated trained and competent people in the Ministries and Divisions who will understand and appreciate the disaster and risks rhetoric and their political impact on lives of the people, the institutions and the local community. This project has indicated the need to have committed and to support the risk analyses and to help the different Ministries and Divisions to incorporate the risk elements into their operations and their budget provisions and proposals.

The ease of identifying DRR projects and spending within the public sector is a major challenge as many projects are not directly or explicitly related to DRR, although they directly or indirectly contribute to disaster mitigation. This is exacerbated by the fact that the budget items are classified in a manner that renders identification very difficult if not impossible. The budget review was a first step to understand and establish the current budget situation and the level of direct and indirect DRR/DRM/CCA investment and funding but there are still some limitations in establishing an accurate picture of the level of investments and funding. No clear coding and DRR project descriptions.

Though Seychelles is signatory to many international conventions as listed in Chapter 4, the country has not developed a big network of professionals locally and internationally to promote the awareness of DRR policy, besides the Hyogo Framework that offer a regional DRR platform for DRR initiatives and exchange and sharing of relevant information and expertise.

Training and development in DRR have been priority for many countries in recent years, and Seychelles is of no exception. Training in DRR was facilitated by the United Nation was the Disaster and Loss Assessment (DaLA) attended by 37 local Officers across sectors including people from the local Insurance Companies.

Risk analysis in the context of public finance is, therefore, one important and urgent point of intervention for Seychelles, as it is critical that we identify, assess and prioritize the risks. We are, then, all well informed of

[37] This chapter was drafted by William Danis Zarine

potential risks so as to build resilience, in terms of reducing the negative impacts (mitigate), transferring the risks (outsource or insure), accepting or avoiding (eliminate) them, altogether. Ultimately, we would be required to establish a more objective and accurate level of government budgets and financing strategies as/when it comes to public infrastructure and assets, the local community and individual households as a measure of building our resilience.

In conclusion, it is fair to note the Seychelles is increasingly prone to a number of natural disasters, and prevention, reduction, response and reconstruction measures needs to be in place for high risk situations. The risk reviews through the budget review, the CATSIM and Cost Benefit analyses (though there was lack of coherent data) give the following pointers:

- The level of public financing for DRR/DRM/CCA is on average 3% of the total annual budget, and there is no clear provisions for post disaster response and reconstruction besides the disaster relief fund that depends on and is financed by private funds
- The effectiveness of funds used towards DRR/DRM/CCA related activities and programmes
- We often focus on direct loss (physical infrastructure) and not effectively measure the indirect losses (disruption to business, loss income, etc.) and tend to understate the real financial impacts of the disaster events
- Lack of institutional strategies and capacity to address DRR/DRM/CCA
- Need for enhanced DRR/DRM/CCA awareness and commitments
- Better financing mechanisms
- Need for better policy reviews and enforcements

Consequently, this leads to the following recommendations:

Recommendation 1: **Awareness Building**

- Reinforcing the communication of DRR/DRM/CCA issues and sending clear/accurate message to the community with a view to change behaviours
- Bolstering political will to ensure full ownership, belongings and engagement of policy/decision makers
- Consideration to integrate/incorporate DRR/DRM/CCA in the national curriculum and workplace human resource development programmes and they become part of their responsibilities
- Awareness of the local community of risk financing mechanisms like insurance for personal and private assets

Recommendation 2: **Capacity Building**

- Capacity building in DRR/DRM/CCA technical areas such as data collection, management and analysis for the purpose of policy decisions and financing/budgeting
- Development of sufficient people who can undertake DRR/DRM/CCA issues for their organizations, and in particular, in Ministry of Finance, Ministry of Environment, Ministry of Land Use and Habitat, Ministry of Health, Ministry of Education, Ministry of Natural Resources and Fisheries, Public Utilities Corporation (PUC), Seychelles Petroleum Company (SEYPEC) and the Division of Risk and Disaster Management (DRDM)

Recommendation 3: **Integration into National Development Processes**

- Integrate DRR/DRM/CCA in the National Development Strategy 2014-2018 currently under development
- Integrate DRR/DRM/CCA issues with the Seychelles Sustainable Development Strategy (SSDS) 2012-2020
- Mainstream DRR/DRM/CCA in the Government Budget and Public Investments – and establish clear DRR/DRM/CCA financing policies and strategies
- Support public institution with the integration of critical risk elements into their plans, programmes and future programme based budget so that the right resources go to DRR

Recommendation 4: **Implementation Framework:**

- Institutional Roadmap: A more effective DRR/DRM/CCA implementation framework that will enhance the coordination strategy, bring synergy and consistency to the process
- Reinforce the role of DRDM as a national coordinating role of the initiatives, projects and programmes related to DRR/DRM/CCA
- Establish clear responsibilities and accountabilities
- Ensure monitoring, supervision and audits of the process, projects/programmes implemented and use of resources
- Ensure full data collection and documentation

Recommendation 5: **Financing**

- Establish and articulate clear DRR financing policies and guidelines
- Public institution allocates budget to DRR
- The Ministry of Finance supports DRR through their programme based budget process

Recommendation 6: **International Partnership**

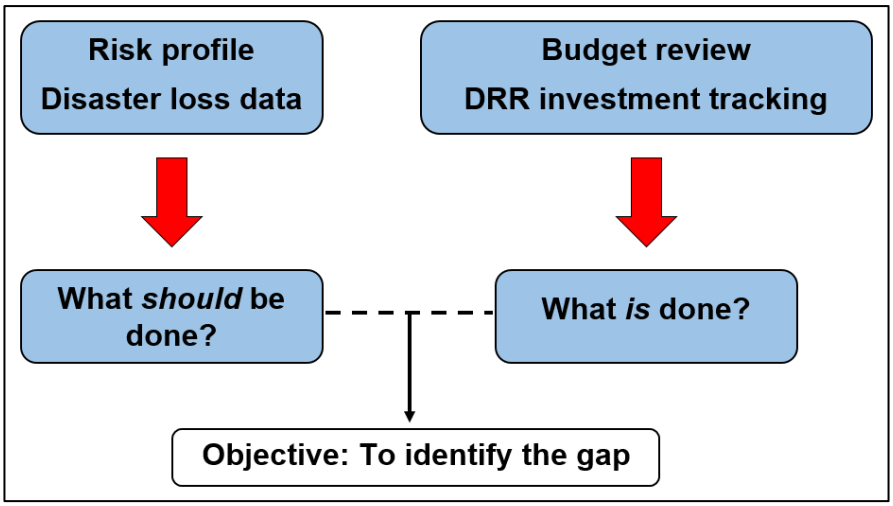
- Leverage more on regional body like the HYOGO FRAMEWORK
- Work more closely and in partnership with expert from regional bodies like the Indian Ocean Commission (IOC), Southern African Development Cooperation (SADC) and Common Market for Eastern and Southern Africa (COMESA)
- Continue to work with financing institutions and partners such as World Bank, UAE Governments, Japanese Governments for technical, expert and budget support

Annex A. Risk-Sensitive Budget Review (RSBR) [38]

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 37). 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 37: 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 13 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.

[38] Section A-C of this chapter were drafted by Kazuko Ishigaki (UNISDR) and Section D was drafted by William Danis Zarine.

Table 13: 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

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[39]. 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 Seychelles.

B. DRM Marker

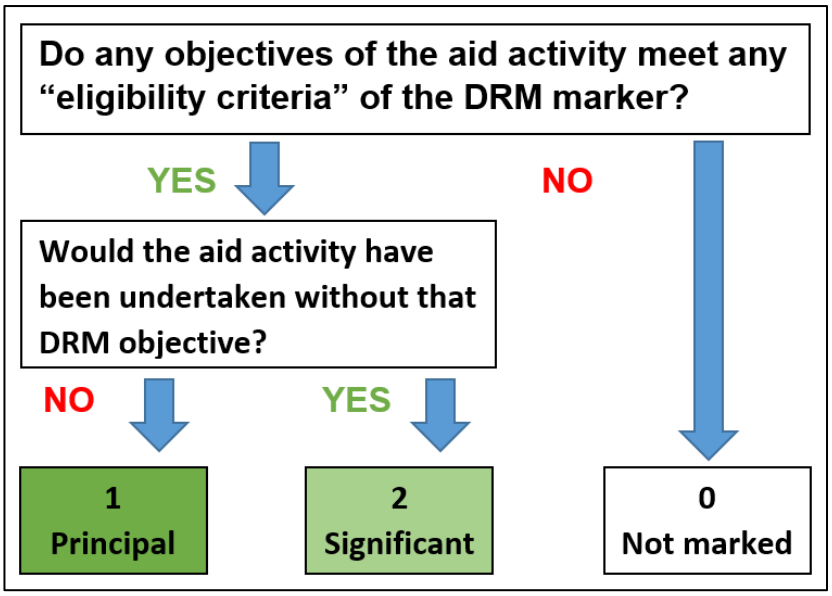
The DRM marker allows (a) capturing "embedded" investment by distinguishing between stand-alone versus mainstreamed DRR investment (*e.g.* retrofitting in school renovation program), (b) strengthening the ability to analyse, measure and report activities in DRR, and (c) improving regulatory conditions 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 38). 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[40]). 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"[41].

[39] The Rio Marker monitors CCA aid activity since 2011. DRM Marker is proposed using the similar methodology.
[40] 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
[41] Still certain level of ambiguity remains. For example, distinction between principal and significant is not clear and might require subjective judgment. However this is a notable progress for systematic monitoring.

Figure 38: DRM Marker process



Source: OECD (2014)

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

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

C. The budget review methodology: Application of DRM marker

In applying the methodology of the DRM Marker in a risk-sensitive budget review, the following three steps were taken (Figure 39, 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 39: 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[42].

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).

[42] 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 Seychelles

D.1. Scope of analysis

The scope of the budget review is defined as follows (Table 14).

Table 14: Scope of the risk sensitive budget review

Year	2012, 2013 and 2014
Coverage	The focus was on those listed below: ▪ Vice President's Office (especially the DRDM) ▪ The Ministry of Environment and Energy (especially, the Climate Change Adaptation and Information, Environmental Division, Landscape and Waste Management, Environmental Education, Coastal Adaptation Management, Wildlife Enforcement and Permit, National Park Authority, National Botanical Gardens) ▪ Ministry of Land Use and Habitat (including the Planning Authority) ▪ Ministry of Education ▪ Ministry of Health (Public Health Authority) ▪ Public Utilities Corporation ▪ Ministry of Internal Affairs and Transport (esp. Police and Fire Services) ▪ Ministry of Local Government, Social Services and Sports (Agency for Social Welfare Protection) ▪ Ministry of Foreign Affairs ▪ Ministry of Natural Resources ▪ Seychelles Agricultural Agency ▪ Seychelles Fishing Authority ▪ Ministry of Labour and Human Resource Development ▪ Ministry of Tourism and Culture ▪ Seychelles Tourism Board ▪ Public Utilities Corporation
Budget or expenditure	Both the budget and expenditure were included
Current or Capital	Both current and capital budgets were included
Targeted hazards	Geological (*e.g.* earthquake, tsunami, landslide), meteorological (*e.g.* cyclone, heat wave) and hydrological disasters (*e.g.* flood, landslide, drought). Epidemics and other hazards (*e.g.* fire)

Year/Period

National risk-sensitive budget review has been implemented for the year 2012, 2013 and 2014. There were no yet finalized expenditure projections post 2014 and the list of the Public Sector Investment Project (PSIP) for 2014 was still a listing with no firm commitments to the exact future implementation, which are usually subject to funding or availability of funds.

Coverage:

The budget review has looked at all government ministries and public institutions in attempt to establish budget and expenditure lines that have elements of and impact on DRR/DRM/CCA, The review was also based on the assumption that the budget for institutions like Division of Risk and Disaster Management, Climate Affairs, Adaptation and Information Division, Department of Environment, The Planning Authority, were all assigned for the purpose of DRR, DRM and CCA, and hence, the total budget was reviewed.

The main Ministries/Institutions reviewed include Environment and Energy (parent ministry for climate change, meteorology services), DRDM, Ministry of Land Use and Habitat, Department of Transport, Community

Development and Planning and the Solid Waste Agency (SWAC) were major areas of the review. Other main ministries like health are also critical as they feature DRR related costs mainstreamed in their budgets; they were also examined and analysed in the review.

Budgets for parastatal organizations such as Seychelles Petroleum Company (SEPEC), Public Utilities Company (PUC), Seychelles Civil Aviation Authority (SCAA), Island Development Company (IDC) and Seychelles Trading Company (STC) that do not operate on government budget were not included in the main review.

The budget for the National Disaster Relief Fund was also not examined as part of the main review as it is not directly funded by the government budget and funds are mostly raised post events and managed by an independent body.

Budget or Expenditure

Seychelles has traditionally focused on a combined budget and expenditure approach, and the level of funding is based on budget proposals and the expenditure trends are taken into consideration. For the purpose of the risk-sensitive budget review both the budget and expenditure have been examined.

Capital (investment) or Current budget

The present budgetary process for Seychelles makes provisions for capital (investments) and current (consumption), and they are a combined budget for each ministry or institution, though there is a centralized pooling for all capital projects under Public Sector Investment Projects (PSIP) for the purpose of national planning, prioritising and budgeting. Therefore, capital investments are mainly linked to the PSIP and other unforeseen/urgent capital projects may have not been on the PSIP list.

Both recurrent and capital expenditure have been examined in the risk-sensitive budget review and they were not separated in the processing of establishing DRR funding in terms of disaster risk reduction (prevention/mitigatioin and preparedness) and disaster management (response and reconstruction) categories.

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). Epidemics and other hazards such as fire were also considered.

Documents available and used for the risk sensitive budget review

The budget and expenditure documents used in this review included the following:

- Land Transport Department
- Ministry of Environment and Energy (includes CCA)
- Ministry of Land Use and Habitat
- Ministry of Transport and Internal Affairs
- Ministry of Sports, Social Affairs and Community Developments
- Ministry of Health
- Ministry of Education
- Ministry of Foreign Affairs
- Ministry of Tourism and Culture
- Division of Risk and Disaster Management

D.2. RSBR Results: Current Expenditure inclusive of capital expenditure

In terms of defining and establishing the current expenditure and investment, the budgets for 2012, 2013 and 2014 were analysed and high-level summaries of the outcomes are illustrated in Table 15.

Table 15: Results of budget review applying methodology of DRM Marker (Unit: RS Thousand)

DRM Marking ĂJŎPÑ FÑŌPØÑCÅ	2012 (RS'000)		2013 (RS'000)		2014 (RS'000)	
Entities	Principal	Significant	Principal	Significant	Principal	Significant
Division: Climate Affairs, Adaptation and Information	276	-	83,733	-	25,419	-
Division: Risk and Disaster Management	283	-	3,441	-	673	-
Seychelles Planning Authority	1,384	-	1,186	-	-	-
Landscape and Waste Management	-	77,873	-	79,326	1,340	86,138
Seychelles Land Transport Agency	-	-	-	38,652	-	31,086
Ministry of Education	-	13,912	-	18,669	-	20,082
Division: Wildlife Enforcement and Permit	-	250	-	14,273	-	25,225
Ministry of Health	-	3,542	-	7,560	-	14,982
Division: Coastal Adaptation Management	6	111	-	6,132	-	6,200
Agency for Social Welfare Protection	-	1,801	-	3,150	-	2,475
Ministry of Land Use & Habitat	-	1,129	-	2,639	-	299
Ministry of Home Affairs	-	46	-	2,074	-	513
National Botanical Gardens	-	1,319	-	1,639	-	1,556
Ministry of Community Development	-	-	-	1,573	-	517
Seychelles Agricultural Agency	-	-	-	750	-	3,750
Seychelles National Parks Authority (Div: Nat. Parks)	-	918	-	694	-	156
Ministry of Tourism	-	-	-	622	-	813
Division: Human Resources and Financial Management	-	322	-	618	-	1,170
Ministry of Foreign Affairs	-	211	-	504	-	583
Tourism Board	-	-	-	390	-	581
Ministry of Labour and Human Resources Development	-	-	-	155	-	220
Division: Environmental Education	-	1,296	-	50	-	-
Sum	1,949	102,727	88,360	179,471	27,432	196,344
% of PBB	0.04%	2.0%	1.6%	3.3%	0.5%	3.8%
Total Marked (%)		104,676		267,830		223,777
GRAND TOTAL		5,190,000		5,423,000		5,200,000

Source: Author based on Government Budget

With respect to current budget/expenditure, an initial high level analysis of the budget (wide approach) revealed that the total average budget for DRM as per the analytical interpretation for the last three years (2012-2014), possibly stands at RS 198.8 million (USD 15.6 million), which is equivalent to an average of 3.77% of the total budget. DRM has been marked for programs totalling RS 104.6 million (USD 8.7 million) for 2012, RS 267.8 million (USD 22.2 million) for 2013 and RS 223.8 million (USD 18.5 million) for 2014, which are, respectively, 2.04%, 4.93% and 4.3% of the total annual budget (Figure 35).

It appears to have doubled between 2012 and 2013. This increase in the total DRM-marked activities in 2013 is attributed, for example, to increase in the budget for Climate Affairs, Adaptation and Information for the construction and equipment of the office building, the Land Transport Agency (construction of new infrastructure such as road, footpaths, bridges), Ministry of Education (security and enforcement), Wildlife (conservation and rehabilitation of eco-system), Coastal Adaptation Management (upgrade of drainage, improvement/rehabilitation of beaches and rivers) and Ministry of Community Development (emergency disaster work and other disaster works). Some of the increases also reflect the 2013 Felleng disaster.

A marking of “Principal” was attributed to 0.04% of the total budget in 2012; 1.63% in 2013 and 0.5 % in 2014. The rise in 2013 is very much attributed to the Felleng disaster, whereby, there have been move to have the Climate Change, Adaptation and Information centre being developed and other initiatives to mitigate the impact of the flood disaster. The proportion of efforts marked “Significant” funding were 2% in 2012, 3.3% in 2013 and 3.8 % in 2014 (Figure 35). This includes a horizontally integrated investment in DRR, reflecting a positive move towards mainstreaming DRR.

It is noteworthy that the most important DRM-marked “Principal” items (projects/programmes/activities that would not have been implemented without DRR objectives) are for the Divisions of Climate Affairs and Risk and

Disaster Management, and Seychelles Planning Authority. Most of their budgets and expenditure have clear DRR/DRM objectives.

This analysis has established that the large majority of the budgeted activities are geared towards risk reduction, and more so, for risk prevention/mitigation purposes (Table 16). This includes activities/projects such as road upgrading; new building for DRR Agents, security and enforcement, pesticides and solid waste management. This is explainable since the recovery and reconstruction activities are mostly outside the government budget and are mainly financed by the Disaster Relief Fund (except for minor urgency disaster), which is managed and funded by private entities, grants, and so on. This disaster fund raised an estimated RS 123 million (USD 10 million) for disaster management of the flood and landslides that occurred in January/February 2014, affecting the districts of Aux Caps, Anse Aux Pins and Pointe La Rue.

Table 16: DRM Marker by DRM sub-category

[illegible]	1. Prevention/ - Mitigation	2. DRR/ Prepar-edness	3. Response	4. Reconstruc-tion
2012	96.72%	3.12%	0.16%	0.00%
2013	50.81%	44.05%	3.88%	1.25%
2014	60.75%	18.75%	20.35%	0.15%

Source: Author based on Government Annual Budget

D.3. RSBR Results: Capital Investment

Under the PSIP (Table 17), Seychelles has implemented projects of around RS1 billion annually and a portion estimated at RS108 million (USD 8.9 million) is related to DRR/DRM in 2013 and RS109 million (USD 9.0 million) related to DRR/DRM in 2014. These amounts are based on the assumption that the capital projects for Department of Transport and the Ministry of Environment and Energy are the direct DRR/DRM projects under the PSIP. For both 2013 and 2014, the projects marked for DRR/DRM are about 10% of the PSIP of the public sector excluding the parastatals (*e.g.* Public Utility Corporation). The 2012-2014 capital investment has been included in the budget review.

Table 17: Review of capital investment

PUBLIC SECTOR INVESTMENT PROGRAMME FINANCING							
DESCRIPTION	ACTUAL 2012	BUDGET 2013 R ('000)	REVISED 2013 R ('000)	BUDGET 2014 R ('000)	FORECAST 2015 R ('000)	FORECAST 2016 R ('000)	FORECAST 2017 R ('000)
1. Loan Financing	**80,349**	**157,046**	**112,184**	**109,227**	**98,160**	**109,800**	**109,800**
2. Grant Financing	**660,572**	**538,968**	**386,767**	**385,754**	**341,591**	**305,391**	**294,898**
Cash Grant	83,058	165,897	136,824	122,004	91,617	89,567	89,567
Benefit in Kind	577,514	373,071	249,943	263,750	249,974	215,824	205,330
3. Domestic Financing	**602,514**	**519,879**	**516,582**	**530,030**	**481,444**	**527,100**	**569,214**
Seychelles Broadcasting Corporation	0	15,000	15,000	16,318	10,000	10,000	10,000
Domestic Financing	**602,514**	**504,879**	**501,582**	**448,312**	**411,603**	**475,700**	**500,000**
PUBLIC PRIVATE PARTNERSHIP	**0**	**0**	**0**	**65,400**	**59,841**	**41,400**	**59,214**
TOTAL: CAPITAL PROJECTS	**1,343,435**	**1,215,892**	**1,015,533**	**1,025,010**	**921,194**	**942,291**	**973,912**

Source: Author based on Government Annual Budget

D.4. Gap between loss, risk and budget

AAL for cyclonic winds and earthquakes is estimated to be zero, and the estimated annual investment in DRM is roughly USD 16.5 million, there is a positive balance between historic annual loss and investment. If the budget is compared to AAL that is zero, it is found out positive balance and there is no gap. (Table 18).

Table 18: DRR budget, loss and risk

USD million	DRM investment (budget), 3-year average o 2010-2012	AAL (tropical cyclonic wind and earthquake only)	Loss, 1980-2014 (636 of data cards)
Value	USD 16.5 million	zero	USD 15.6 million (annual average: USD 0.4 million)
Status		NO GAP	NO GAP

However, it is important to keep in mind that AAL is only estimated for tropical cyclonic wind and earthquake risk and to go back to the actual marked activities to determine their link to these risks. If the studied investments had no discernable link to these risks, of course, these statements would have limited value.

As reference, loss data were also compared to the budget. Again this comparison shows a positive balance. Total investment exceeds even the total loss over the period 1980 to 2014.

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

D.5. Challenges Experienced in Conducting Risk Sensitive Budget Review

In general, the challenges include lack of expertise, manpower and other resources, lack of policy and guideline for budget review and access to relevant financial and project data. Further collaboration across sectors is required and budget classifications and coding should be introduced.

In Seychelles, all public investments in DRR/DRM/CCA are integrated within the budget of different ministries/public institutions and they are not classified or coded according to DRR or DRM, and this makes it difficult to identify budget and expenditures that are related to or have impact on DRR and DRM.

Interpretation and classification in the review has been subjective and can be misleading. For example, the whole budget for DRDM was considered and classified as DRR/DRM as DRR/DRM budget/expenditure. Similarly, projects or expenditures for any Ministry related to security and enforcement or upgrading/rehabilitation of infrastructure like road, bridges, beaches and general eco-system were also classified as DRR/DRM budget/expenditure.

It is therefore difficult to track sectorial DRM investment, and DRR investments cannot be easily separated from entire project or budget reports. The structure of budget by type of expenditure and programmes (very much a mixed functional, economic and administrative classification), rather than specific projects or project category, constituted a difficulty when attempting to identify DRR in a specific programme. As most programmes or even sub-programmes consist of multiple objectives and activities, retrieving and consolidating the information related to DRR is a very delicate task.

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

Public Utility Corporation

The main state owned enterprise is the Public Utility Corporation (PUC) which is mandated to manage the electricity, water and sewerage systems, facilities, production and distribution, and it has full monopoly. PUC is responsible for the treatment and distribution of potable water. Similarly, it is mandated to the safe production and distribution of the indispensable fossil fuel energy and electricity. PUC, therefore, play a major role in providing reliable utilities and infrastructure that resist to damages that may be caused by natural hazards such as storm surges, floods, landslides and tsunamis.

The PUC has driven several major investments in exploring new water sources, upgrading and extending pipes networks in various parts of the country and guaranteeing continuous supplies of potable water to the local households and population, as well as the tourism establishments. The service reservoirs are instrumental in sustaining supply and altogether provide a total storage capacity of 238,000 cubic metres scattered all around the

island. The PUC's accounts for 2014 shows that capital expenditure amounted to RS 298 million (USD 24.7 million) of which RS 88 million (USD 7.3 million) are loans and RS 210 million (USD 17.4 million) are PUC's own funds. The projected capital investment for 2015 is RS 221 million which are mainly allotted to the improvement of electricity supplies and distribution, water reservoir, pumps and network, and the sewage plant maintenance and upgrade. (Table 19).

Table 19: Funding Capital Projects for PUC (RS thousand)

	2013	2014	2015
Loans		88, 089	
Grants			
PUC Own Funds		210, 041	
Total Capital Investments	300, 719	298, 129	221, 058

Source: Author based on Government Budget

Maintaining the dams and water networks and supplies, managing the sewerage system, and generating and supplying energy, maintaining a highly reliable systems and structures in all three cases that are resistant to natural hazards and risks are concerns of the PUC. The PUC is also involved in actively implementing demand management measures, especially at a time where climate change has showed that average drought periods are becoming longer and more severe. The management of water in periods of drought additionally concerns the PUC. In the aftermath of calamities such as storm surges, floods, landslides or tsunamis, it also has to provide quick response to re-establish electricity, water and sewerage systems the most quickly possible so as to minimize losses to society and to the economy. It is however difficult to estimate the share of investment that relates to disaster risk management.

Local Authorities

It is to note that the budget and expenditure in Seychelles still remains centralized. The main local district authorities have their centralized budget under the Ministry of Sports, Social Affairs and Community Developments. Any district or regional project, if not implemented by the parent Ministry, is referred to the appropriate Ministry or public institution. For example, any disaster or risk related to road infrastructure will be referred to the Land Transport Agency for implementation, which has been included in the budget review.

External finance

International donors and financial institutions have financed various projects implemented by Government. Sources of funds include lines of credits, loans and grants. Some of them are not reflected in the PSIP. It is worth mentioning the Global Environment Fund (GEF), the *Agence Française de Developpement* (IFAD) and the United Nations (UNEP, UNDP), the European Union (EU), the African Development Bank (ADB) and the World Bank (WB) as key partners in the financing of DRR/DRM related activities, projects and programmes. Other bilateral partners include the Emir/Ruler of the United Arabs Emirates (UAE), India Government and Chinese Government.

The Global Environment Fund (GEF): Seychelles has received grants from the Global Environment Fund (GEF) for financing and co-financing national projects that are, more or less, environmental protection in nature, which are ultimately DRR/CCA projects. In 2012, GEF financed environmental management project to the sum of RS 18, 682,000 (USD 1.48 million), and most were small projects not exceeding USD 50, 000. In 2013 GEF financed environmental related projects to the sum of RS 23, 804,000 (USD1.89 million) and RS 31, 614,000 (USD 2.51 million) is provided to date. The GEF support for Seychelles has been strong over the years and the trend continues.

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

- RS 324,693,000 (USD 27 million) for installing Wing Power Generation infrastructure in 2012 and further support of RS 67,702,000 (USD 5.6 million) in 2013
- RS 218, 959 (USD 18,100) for the coastguard base in 2012
- RS 168, 000 (USD 13,000) in 2012 and RS 1.68 million (USD 139,200) in 2013 for land use and habitat. It has also committed RS 72, 333, 000 (USD 5,740,714) for land use and habitat in 2014

India Government: Traditionally, the India Government has assisted Seychelles in its socio-economic development and a number of areas in recent years and the main ones are as follows:

- RS 133, 643,000 (USD 10.6 million) for security in 2013
- RS 5 million (USD 414,230) in foreign loan for the purchase of bitumen

Arab Bank for Economic Development in Africa (BADEA): BADEA has been providing continuous support to strengthen the capacity of the Seychelles Government and civil society to achieve continued growth and sustainable development. However, the projects have been more in the field of Hospitality and Tourism, the main being the construction of and equipment for the Seychelles Tourism Academy.

References

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

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

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

1. DETERMINE WHAT SHOULD BE COUNTED

a. IDENTIFY YEAR / PERIOD that is appropriate and feasible

EXAMPLE: last fully-completed year or current year underway

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

b. DETERMINE COVERAGE

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

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

c. IDENTIFY BASIS FOR REVIEW

EXAMPLE 1: budget or expenditure?

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

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

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

2. OBTAIN COPIES of budgets covering all elements determined above

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

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

3. MARK and TAG BUDGETARY ELEMENTS

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

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

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

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

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

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

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

4. CALCULATE AND COMPARE DRM INVESTMENT

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

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

c. Document lessons learned

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

Annex B: Macro / CATSIM Assessment[43]

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 30): In the first step, direct risk assessment is performed integrating information regarding the probability of natural hazard occurrence, the level of exposure and physical vulnerability (see Hochrainer-Stigler, 2012 for details). Direct risk is expressed in terms of economic value of asset at risk and return periods of natural hazards. In this initiative, we utilized the data collected in Components 2 to the maximum degree.

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

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

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

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

Since Seychelles has not conducted CATSIM to date, as a first trial, this initiative has implemented only Steps 1 to 3 (Table 20).

[43] 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 Seychelles team and UNISDR.

Table 20: 5 Step CATSIM Modules

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

Source: Author

B. CATSIM analysis in Seychelles

Step 1: Direct Risk Assessment

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

This study evaluated fiscal resources gap using both the current CAPRA estimates and statistical estimates available from Hochrainer-Stigler et al. (2014) (Table 21). In general, the estimates based on CAPRA GIS shows lower loss estimates than those from Hochrainer-Stigler et al. (2014). In particular, the aggregate risk of Seychelles appears small relative to the previous estimate, and also to the empirical observations: in 2013 there was a storm event that results in estimated USD 9.3 million in damage; in 2004 there was an earthquake that resulted in USD 30 million in damage; and in 1997 there was a flood event that resulted in USD 1.7 million in damage (EM-DAT 2014). Based on the current CAPRA estimate, this 2013 storm would have a return period of approximately 200 years, while the 2004 earthquake would have a return period of 300 years and 1997 flood 140 years. The probability that such rare events happen three times in the past 17 years is very small, suggesting that the CAPRA estimates may be significantly underestimating the existing risk of Seychelles.

Table 21: Estimated PML at varying return periods (in USD million)[44]

Return period	CAPRA estimate (implemented in this initiative)	Hochrainer-Stigler et al. 2014
5	0	-
10	0	-
20	0	0
50	0(0.02)	4
100	0(0.4)	28
500	78	2,753
1000	175	-
AAL	0.59	-

Source: Author

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

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

[44] The data collected from Component 2 was 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.

Total contingent liabilities of Seychelles Government were estimated as outlined in Table 22.

Table 22: Estimated Government Direct and Contingent Liability

Item	Value in USD billion	References
Total Capital Stock	3.4	Penn World Table (2014)
Public Capital (a)	1.0	Assumed as 30% of total capital stock based on Hochrainer-Stigler (2012)
Private Capital	2.4	Assumed as 70% of total capital stock based on Hochrainer-Stigler (2012)
Relief Spending (b)	0.7	Assumed as 20% of total capital stock based on Hochrainer-Stigler (2012)
Governments Total Liability (a+b)	1.7	N/A

Source: Author

Step 2: Fiscal Resilience Assessment

The options to finance reconstruction and recovery may be divided into: i) ex-ante and ii) ex-post resources depending on whether arrangements are made prior to or after a disaster event. The below are some of the ways in which governments typically raise fund to finance reconstruction:

Ex-Ante Resources

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

Ex-Post Resources

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

In this study, we have estimated fiscal resources availability based on available economic and fiscal statistics. Table 23 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 Seychelles. We also did not consider ex-ante options because of data availability issues.

Table 23: Estimated Ex-post Fiscal Resources Availability

Sources	Assumptions	Value
International Donor Assistance	10.4% of public liability based on international average[45]	10.4% of liability
Diversion from budget	5%>deficit, then 0 5%<deficit, then 5% of total revenue	USD 19.1 million
Domestic Bonds and Credit	1% of gross domestic credit from private bank	USD 4.9 million
MFI/ International bond market borrowing	SDR allocation	USD 9.7 million
Total excluding international assistance		USD 33.7 million

Source: Author

Assumptions for fiscal resource availability

International assistance

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

Diversion from budget

Budget diversion, representing the amount of funding from the central government's budget which can be re-directed and focused towards recovery, is assumed to be only possible if a government has a budget surplus or small deficit. For this analysis, we assume that countries with a 5% or larger budget deficit relative to GDP are unable to divert funding; as Seychelles 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"

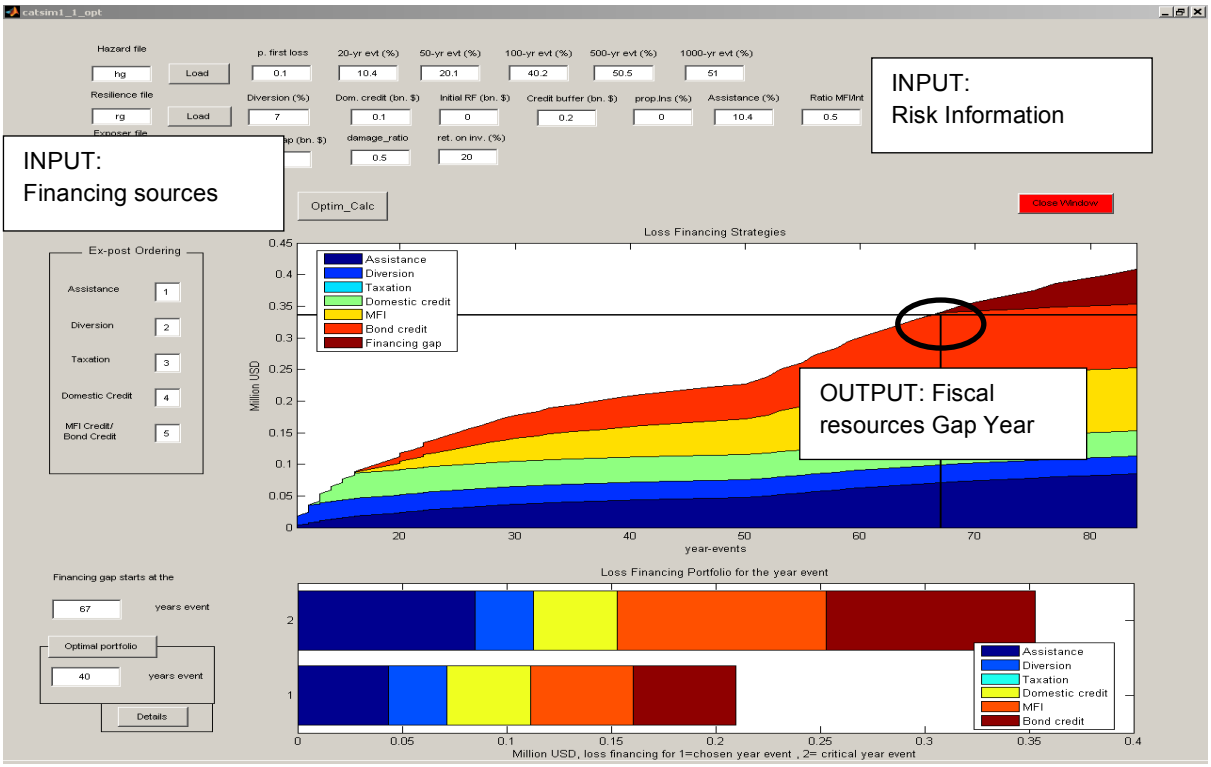
Combining direct risk and fiscal resources availability information obtained in previous steps, this section estimates the governments' potential fiscal resources gap year — the return period at which the government will face difficulty in raising sufficient funds for reconstruction (Figure 40). Given the considerable uncertainty

[45] 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.

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

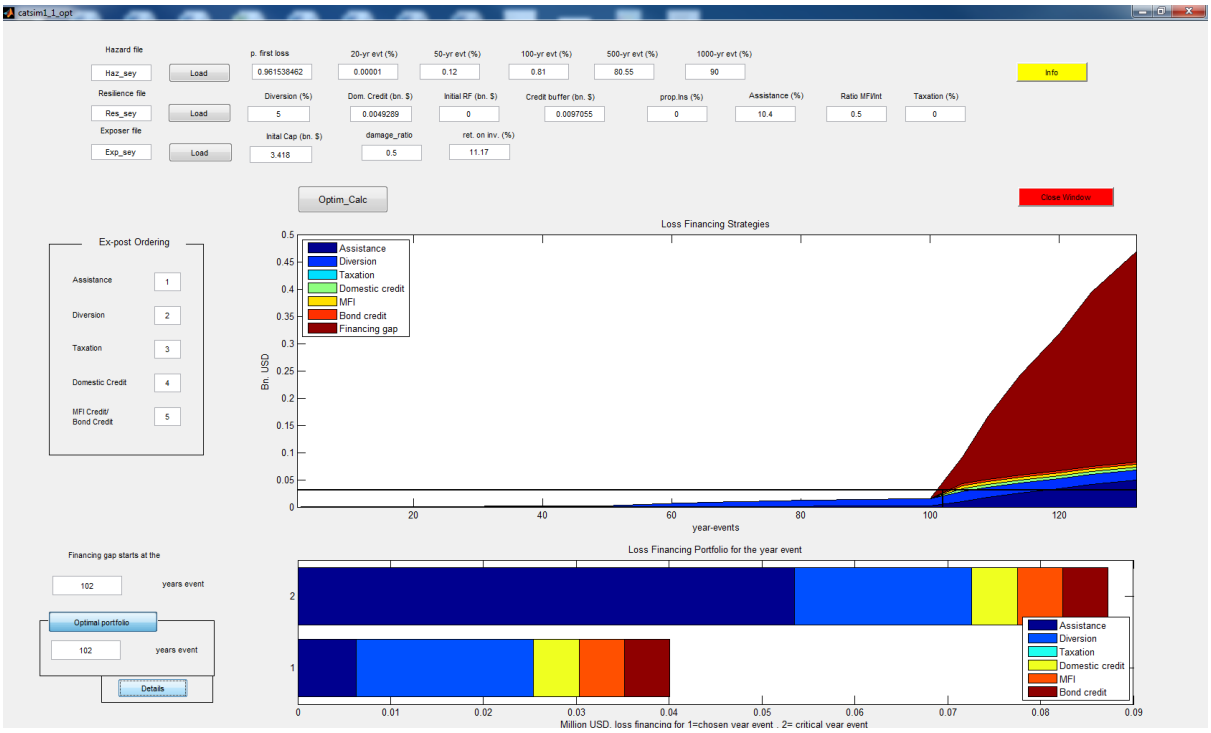
While the concept of 'fiscal resources gap' illustrates the snapshot estimate of the country's resource availability, it is important to note that a large proportion of resources that will be used to meet this one-time disaster event is loan-based, suggesting that there will be a longer-term cost of 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 40: Display of results of fiscal resources gap year



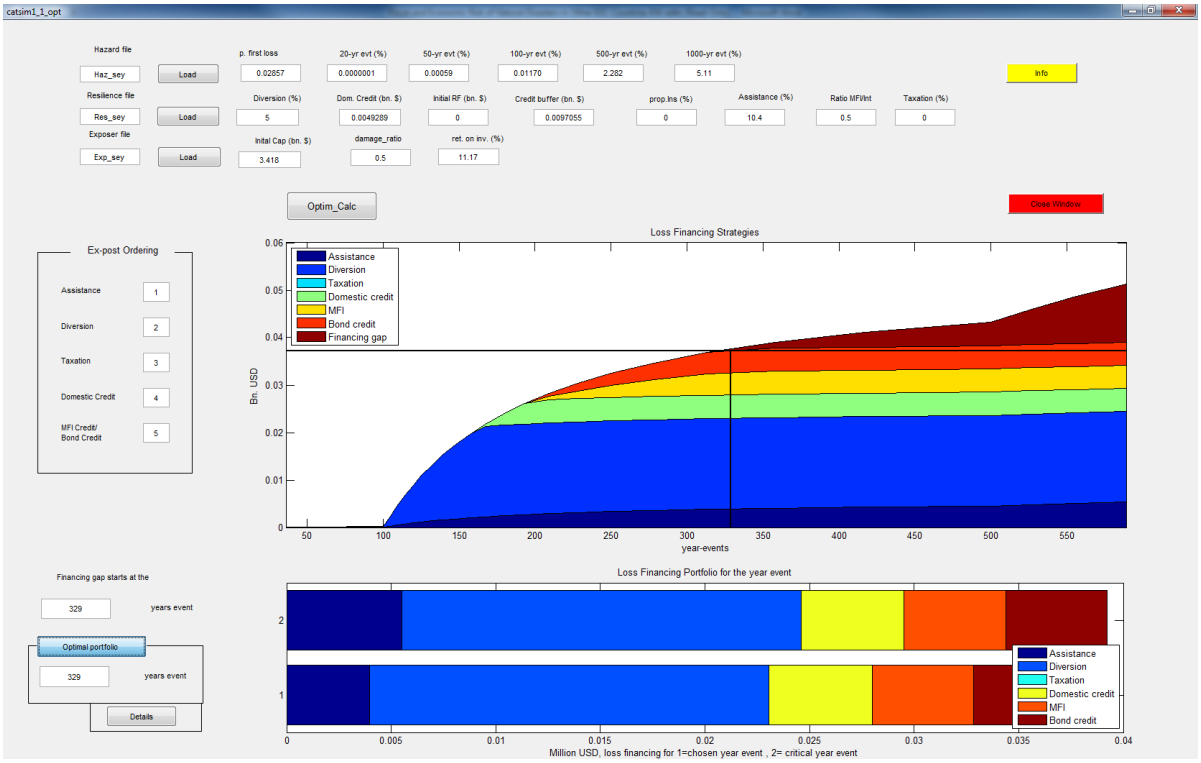
Source: Author

Figure 41: Fiscal resources gap year estimate for Seychelles (Based on Hochrainer-Stigler et al. 2014)



Source: Author

Figure 42: Fiscal resources gap year estimate for Seychelles (Based on CAPRA)



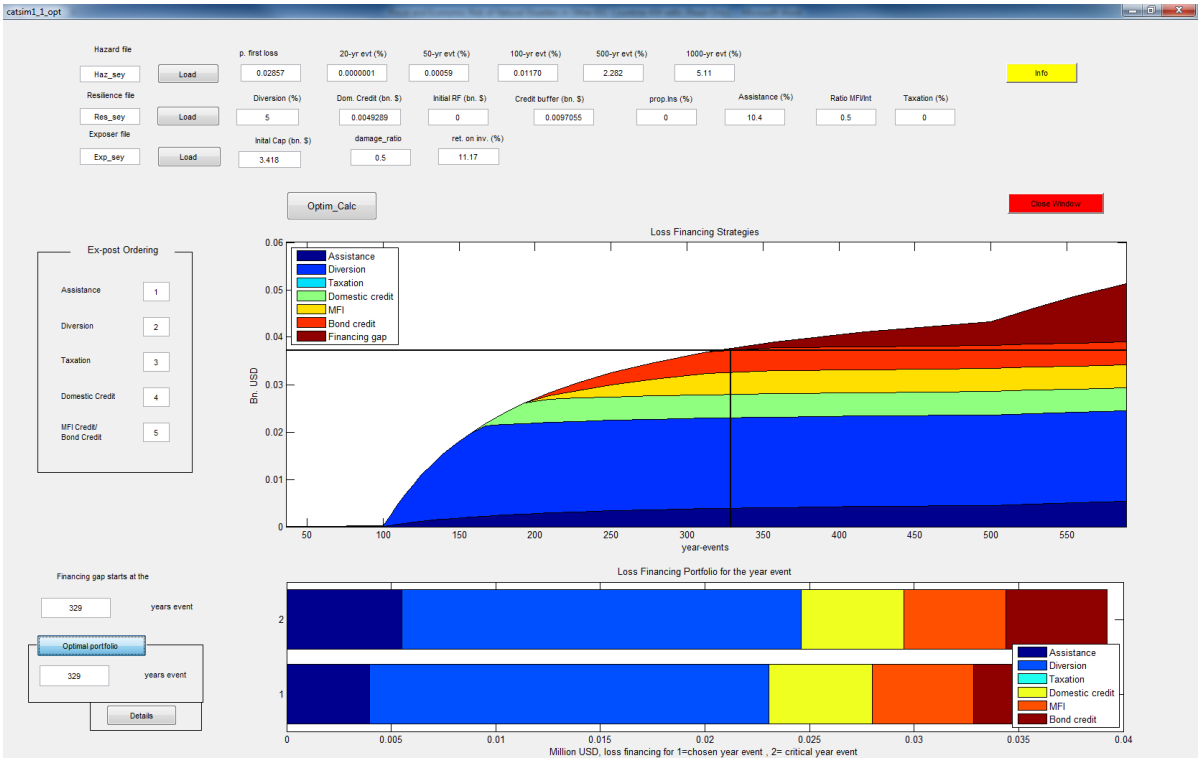
Source: Author

Figure *43* Source: Author

Figure 41 shows the estimates of fiscal resources gap years for Seychelles. The fiscal resources gap years for Seychelles are between 102 years and 329 years. Assuming an AAL of USD 0.59 million (0.05% of GDP), Seychelles was found to face a fiscal resources gap at year 329 (CAPRA estimate) (Figure 42). There is significant uncertainty regarding the backward loss distribution estimated such as one used in Hochrainer-Stigler (2014) in case of very limited information. Limited loss data (only three entries of past disaster economic damage available from the EM-DAT (2014) over the past 17 years) severely limits our ability to estimate risk of higher return period events. However there are some indications that the financing gap will be around the 100 year loss return period (Figure 43).

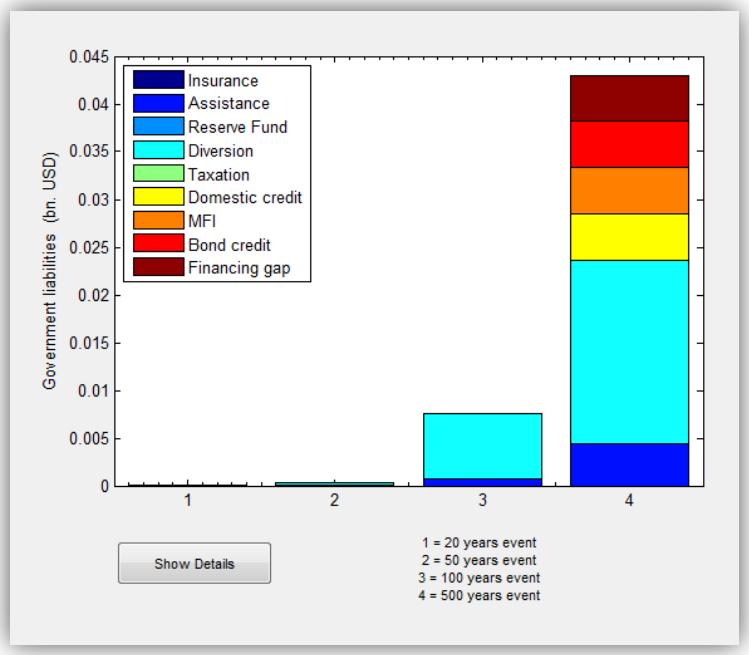
Based on the CAPRA estimate, the reconstruction and recovery capital needs are estimated at: USD 0.22 million (100 year event) and USD 43 million (500 year event) respectively (Figure 42). Budget diversion constitutes a larger portion of reconstruction and recovery costs where approximately 89% and 44% of the costs will be financed through these means for the 100 year and 500 year events. The financing gaps are expected to increase to USD 5 million in the 500-year event.

Figure 42: Fiscal resources gap year estimate for Seychelles (Based on CAPRA)



Source: Author

Figure 43: Fiscal resource gap for Seychelles

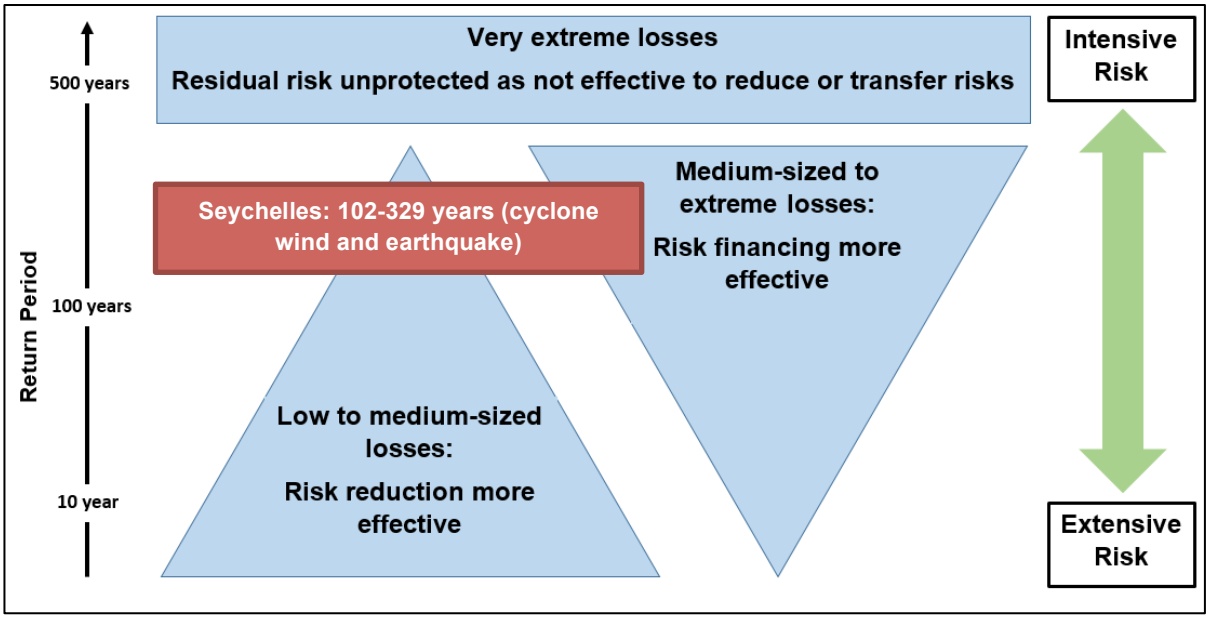


Source: Author

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 44). The CATSIM analysis conducted from Steps 1 to 3 has illustrated the need for improved management of disaster risk in Seychelles. It appears that risk-financing options can be effective for Seychelles regarding tropical cyclone (wind) and earthquake hazards.

Figure 44: Risk layering approach



Source: Author

Further challenges: Data gaps and ways 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 Seychelles 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 Seychelles and other IOC countries (Table 24). 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 Seychelles.

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 Seychelles 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 24: 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 A large discrepancy in risk information is identified for Seychelles; thus further validation is advisable
Technical capacity needs:	-Technical training on risk assessment and economic modeling including CAPRA and CATSIM training. -Further sensitization of risk-based thinking. General familiarity of risk based terms such as the annual average loss, the probable maximum loss, exceedance probability must be explained to decision-makers.
Institutional capacity needs:	-Coordination, where both risk and socio-economic data are jointly collected and managed by relevant agencies (DRM agency plus Ministry of Finance). -Clarity on the specification of the role of each agency in data collection and analysis to avoid the duplication of the efforts.

Source: IIASA

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Annex C: Micro / Cost-Benefit Analysis (CBA)[46]

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 25). 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 25: 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.

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

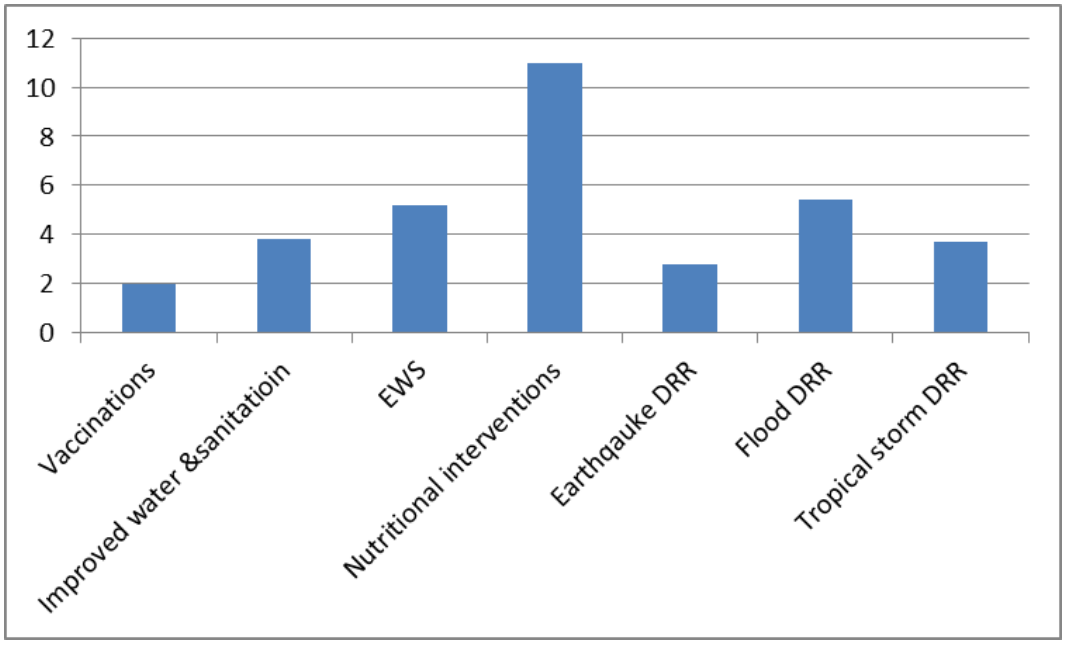
However, there are complex methodological problems that survive to date with no consensus of even modern economists (*e.g.* how to set the discount rate? How to assign monetary value to immeasurable, intangible items?). Furthermore, there are concerns regarding who conducts the CBA in order to retain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

When we assess from HFA Monitor the current status of CBA applications to DRR related projects, two issues arise. The first is that disaster risk is very often not accounted for in CBA for public investments, for example investment in infrastructure for transportation, education and health. The second issue is that direct risk preventive projects such as flood control infrastructure are often implemented without the routine grounding of a CBA framework.

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

Figure 45 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 45: 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 26). Now that more countries have risk profiles, more accurate forward-looking benefit estimation is increasingly possible.

Table 26: 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 46). 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 46: 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)

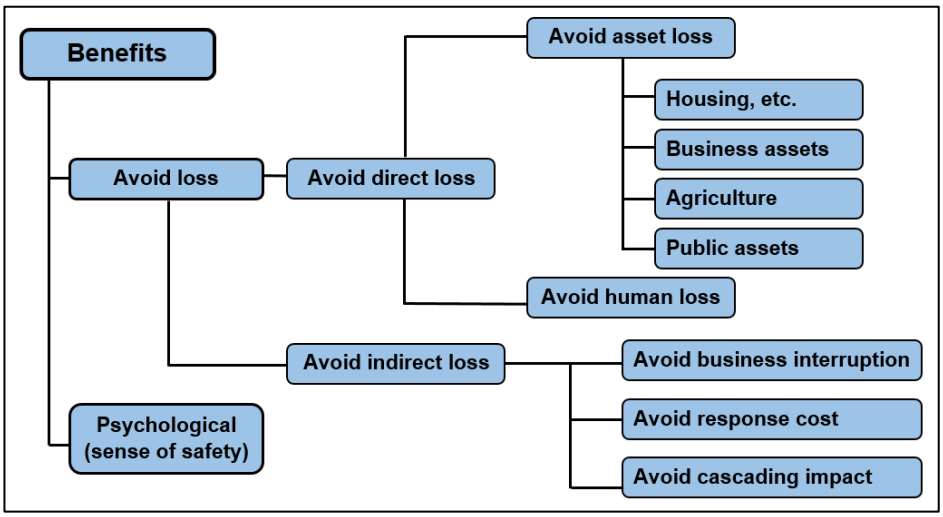
STEP 4: Sensitivity Analysis

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 47).

Figure 47: Expected benefits from DRR investment

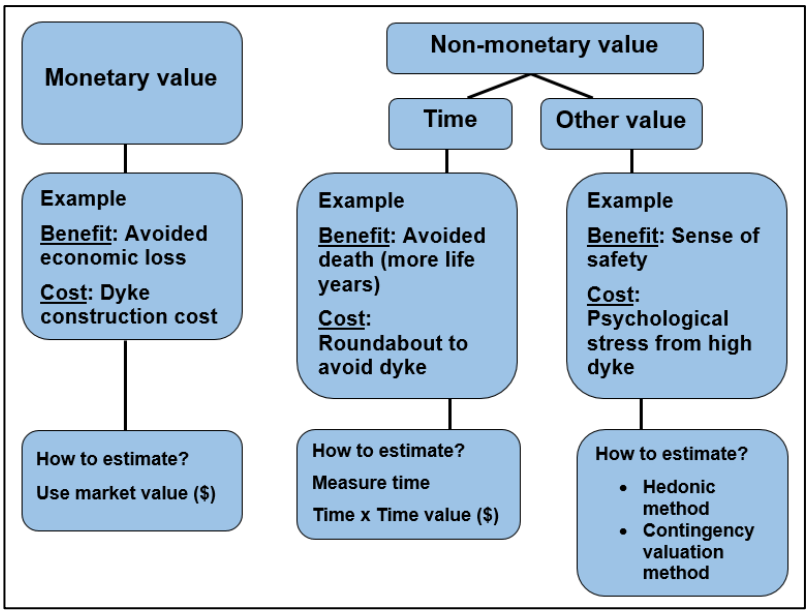


Source: Author

In estimating benefit, a main challenge is to assign monetary values to each expected benefit (Figure 48). If the benefits and costs have monetary values, the government can use them[47]. 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 48: Expected benefit classification



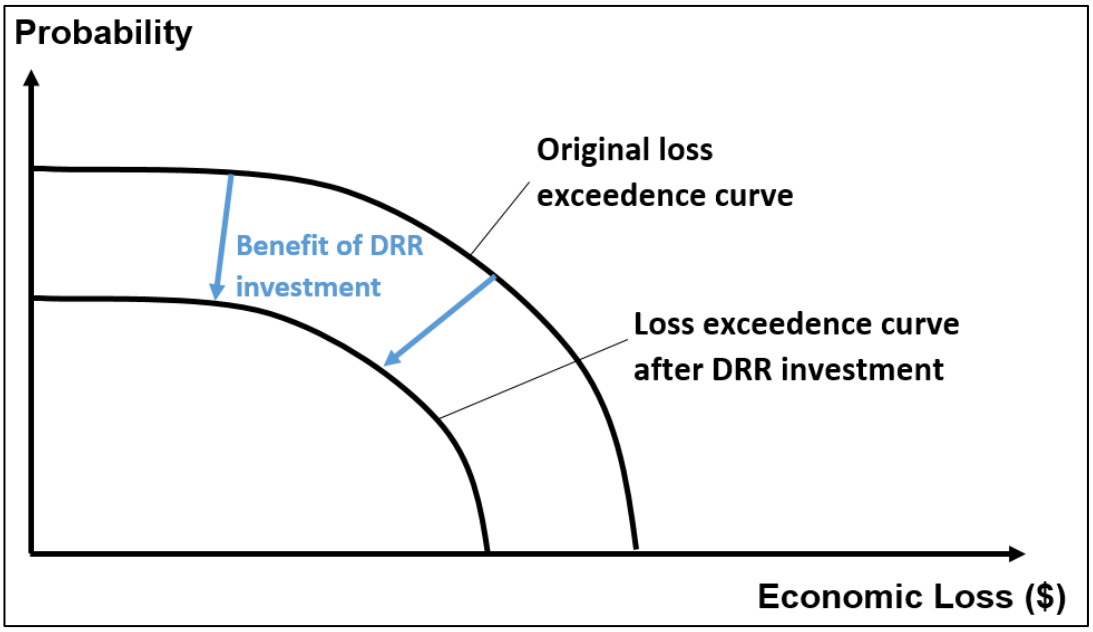
Source: Author

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

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

The benefit is estimated by measuring how much annual average loss (AAL) will be reduced after the investment (Figure 49). 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[48]).

Figure 49: 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[49]. 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 27). If the government considers opportunity cost of capital, with more market based consideration, then discount rate tends to be

[48] 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.

[49] 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.

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

Table 27: Discount rates in several countries

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

Source: 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.

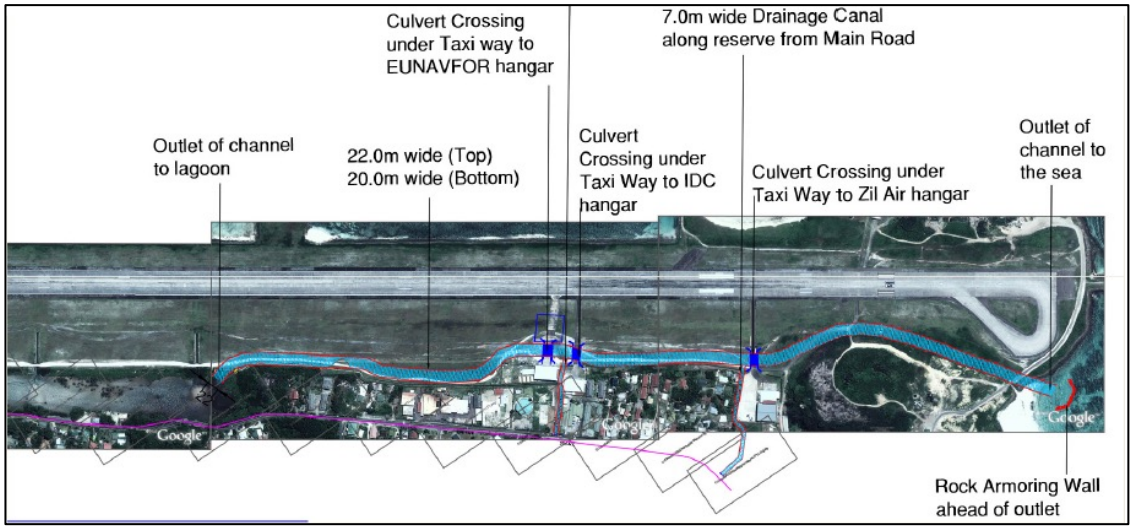
C. CASE STUDY: Flood alleviation project in Point La Rue

I Project Proposal

Point La Rue is an administrative district of the Seychelles located on the eastern part of the island of Mahe. The region has a population of 3,172 inhabitants (2009 census). Also in Point La Rue is the Seychelles international Airport. The proposed flood alleviation project is to build a 1.5 km tidal channel running from Anse Francois Lagoon to the southern end of the Airport, and from there flowing into the sea.

The lack of adequate drainage resulted in significant economic losses in the region in January, 2013. DaLA Report following the 2013 identified major concerns regarding the lack of water outlets from the Point La rue plateau to the sea (DaLA report, 2013). Therefore, the goal of the project is to limit future losses resulting from precipitation events by enhancing the region's disaster resilience. Figure 50 below shows an image of the proposed tidal channel.

Figure 50: Point La Rue proposed tidal channel, running from Anse Francois lagoon into the sea at the southern end of the Seychelles International Airport



Source: Senaratne (2013)

II Approach

Given there is no probabilistic risk assessment of flood using hazard, exposure and vulnerability information, we decided to implement **backward looking** probabilistic CBA. Our approach to analyzing the costs and benefits of the project is to use probabilistic rainfall and damage distributions to assess the amount of Average Annual Loss (AAL) due to rainfall. We rely on past rainfall and damage data to create estimations of future losses. Using a number of flood events with associated precipitation amounts as well as estimations of the resulting economic loss, we can estimate the AAL caused by flood events. The result of the tidal channel project should lead to a reduction in the losses caused by floods. Based on assumptions of the flood risk reduction as a result of the tidal channel, benefits of the alleviation measures can be estimated. These benefits will be aggregated over 30 years at a discount rate to obtain the total benefits of project. The costs of the project will be subtracted from these benefits to identify the net benefits, or Net Present Value (NPV) of the proposed project. We follow the general methodology for conducting Cost-benefit analysis laid out by Mechler (2005).

III Probabilistic Flood Damages

Using data from past flood events as well as precipitation data over the last 40 years (based on DaLA 2013), a loss distribution was estimated to show, based on the amount of rainfall, the amount of economic loss expected from events with different return periods.

In Point La Rue, the largest rainfall event in the last 40 years occurred in 2013 and resulted in an estimated USD 1.5 million in economic loss (the authors' estimate based on DaLA 2013 Seychelles). All other reported flood events since 1997 in national disaster loss database prepared in Component1 resulted in significantly less economic loss in which only one or four houses had been damaged. Given the relatively flat topography of Point La Rue coastal-lines, it is hard to imagine that a flood event will only affect a few houses at one time. We suspect that this extremely low numbers of houses damaged are due to mis-reporting (or a lack of documentation) rather than an accurate reflection of local risk conditions[50].

Therefore, we decided not to use data from national disaster loss database and chosen to base our analysis on one of the catastrophic flood events recorded in 2013 DaLA report, in which a detailed Post Disaster Needs Assessment (PDNA) was carried out and economic damage and loss estimates are assumed to be of credible quality. Table 28 below shows the estimation of damages in Point La rue according to the PDNA on the 2013 flood event

[50] Another issue is that if there are multiple entries of disaster recorded in a particular week, then we need to decide whether those data should be counted as one disaster or be treated separately. Likewise, if landslide and flood happened in close proximity in time and space, we have to decide to treat that disaster as one or several disasters. That type of analysis will take quite a bit of time.

Table 28: Loss from 2013 flood estimated from PDNA for Point La Rue

Items	Estimated Cost (USD)
Direct Losses:	
Housing damage	284,386
Damage to infrastructure	761,548
Damage to airport	1,600
Damage to education facility	188,000
Indirect Losses:	
Cost of clean-up and emergency response	77,686
Personal income loss	50,131
Additional expenditure for medical purposes etc:	140,000
Total:	1,503,351

Source: Author based on DaLA (2013)

It is important to keep in mind that risk curve estimation generally requires more than three credible data points (Mechler 2005), and the use of single data point with the probability of first loss estimate[51] adopted here cannot give as accurate loss estimate as recommended. Despite this data limitation, we have estimated a risk curve based on the extreme value statistics to perform illustrative probabilistic CBA. We have pre-tested the suitability of various distribution parameters, in which the Gumbel distribution is found to fit the data best and was used in the subsequent analysis.

Using this precipitation and loss data, the annual average loss (AAL) for Point La rue was estimated and is shown in Table 29 below. The expected annual loss is estimated by applying the Simpson rule[52]. For example, based on the return periods identified, the expected loss up to a 5-year event is the cumulative probability of the 5-year event (0.8) minus the cumulative probability of the 4-year event (0.75) multiplied by the average loss between the 4 and 5-year events. In numerical terms:

EL (5-4 years)= (0.8-0.75)*((158.3+0)/2)= 4.0

This process is then done for all other intervals. For the last interval, it is assumed for this CBA that losses associated with events of more than a 200-year return period will result in the same losses as the 200-year event. Therefore in the last interval, 0.995 to 1, the expected loss is simply (1-0.995)*2523.8, yielding the value of 12.6. Cumulating the losses for all events, the AAL in Point La Rue is roughly USD 170,000. This value will be used as baseline when estimating the benefit as a result of the tidal channel project.

[51] First loss estimate means probability that a disaster event (of any magnitude resulting in some loss) will occur.
[52] Please see the footnote 48 regarding Simpson rule.

Table 29: Return period and associated losses, AAL (in USD thousand)

Return period	Exceedance probability	Maximum loss	Expected Annual loss
4	0.25	0.0	0.0
5	0.2	158.3	4.0
10	0.1	626.0	39.2
20	0.05	1074.5	42.5
40	0.025	1514.5	32.4
50	0.2	1655.2	7.9
100	0.01	2090.3	18.7
200	0.005	2523.8	11.5
>200			12.6
AAL			168.9

Source: Author

IV Benefits

To assess the benefits of the proposed tidal channel project, assumptions have to be made about the economic losses that would be reduced as a result of the project. There is no clear data on the expected amount of loss reduction resulting from the tidal channel. However, since the proposal was made in response to the highly damaging 2013 event, it is assumed that the tidal channel would be designed to protect against all damages caused by a 40-year event (with loss of USD 1.5 million). Events with larger return period would have losses reduced, but not eliminated (Table 25). As the actual reduction in losses is not known, particularly for extreme events, we set strong assumptions. With probabilistic CBA, it is difficult to determine if, and if so, to what extent a project designed to reduce loss for more frequent events will reduce loss against intensive (less frequent, more severe) events.

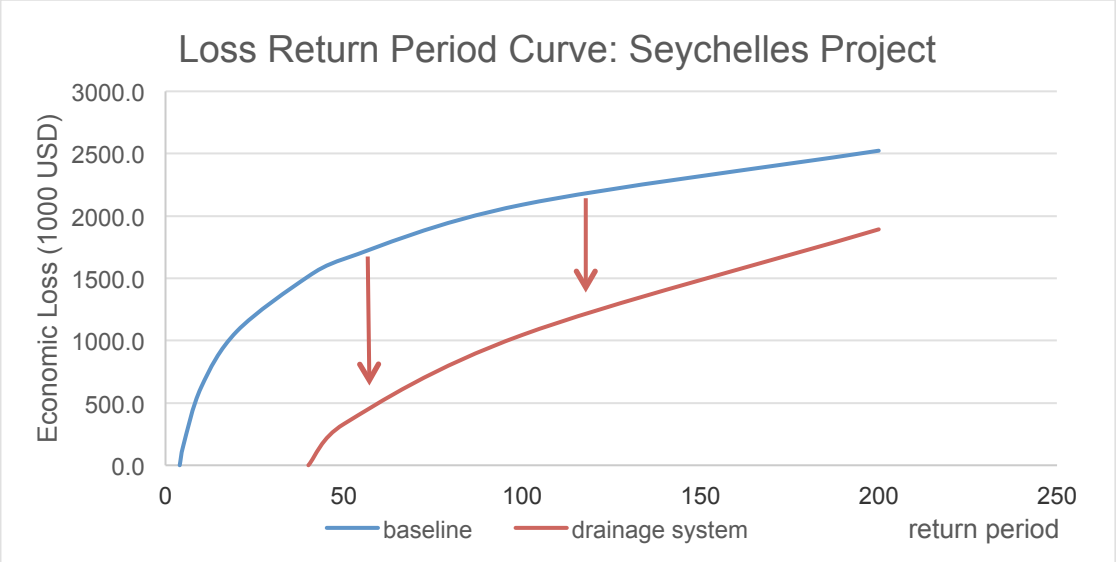
Table 30 below shows the estimated benefits as a loss reduction in individual events and AAL as a result of the drainage project. As can be seen, the reduction in AAL, representing the annual benefit, is USD 139,200. Figure 51 displays the reduction in losses as a result of the project in graphic form. The shift in the loss return period curve represents the risk reduction of the region.

Table 30: Estimated annual benefits as a reduction in AAL due to the drainage project (in USD thousand)

losses without tidal channel (baseline)				losses with tidal channel		
return period	Exceedance probability	Maximum loss	Expected annual loss	Maximum loss	Loss reduction (%)	Expected annual loss
4	0.25	0.0	0.0	0.0	100.0	0.0
5	0.2	158.3	4.0	0.0	100.0	0.0
10	0.1	626.0	39.2	0.0	100.0	0.0
20	0.05	1,074.5	42.5	0.0	100.0	0.0
40	0.025	1,514.5	32.4	0.0	100.0	0.0
50	0.02	1,655.2	7.9	331.0	80.0	1.6
100	0.01	2,090.3	18.7	1045.1	50.0	9.4
200	0.005	2,523.8	11.5	1892.9	25.0	8.7
			12.6		20.0	10.1
AAL			**168.9**			**29.7**
					Reduced AAL: Benefit	**139.2**

Source: Author

Figure 51: Loss return period curve



Source: Author

V Costs

The cost of the tidal channel project is a RS 23.5 million, or, based in the average exchange in 2013, USD 1.95 million (Senaratne 2013). The Table 31 below shows breakdown of the project costs.

Table 31: Breakdown of the cost associated with the tidal channel project

MAIN CHANNEL Excavation	Unit	Qty	Rate	Value (SR)
Cross section area (22m width)	m^2	30.75		
Length	m	1,550.00		
Volume of excavation	m^3	47,662.50	60	2,859,750
Transportation of material to tip offsite	m^3	47,662.50	100	4,766,250
Slabs over channel				
EUNavfor hangar (28m wide x 25m long)	m^2	700.00		3,000,000
IDC Hangar (28m wide x 10m long)	m^2	280.00		1,500,000
Zil Air hangar (28m wide x 10m long)	m^2	280.00		1,500,000
South runway service road	m^2	196.00		1,200,000
Quarry access road	m^2	196.00		1,000,000
TRANSVERSE CHANNELS TO MAIN ROAD				
Between IDC Hangar and church				
Length	m	125.00		
Width	m	7.00		
Volume of excavation	m^3	875	60	52,500
Concrete lining @0.12m thick	m^3	150	4000	600,000
Between Zil Air hangar and houses				
Length	m	210		
Width	m	7		
Volume of excavation	m^3	1470	60	88,200
Concrete lining @0.12m thick	m^3	252	4000	1,008,000
SEA OUTFALL				
Structure 28m wide with shore protection				6,000,000
		Total		**23,574,700**

Source: Senaratne 2013)

While there has been no data available on the maintenance cost of the project, an estimated 0.5% of the project cost per year is included as a maintenance cost (this assumption may be considered conservative as it is a half of what was assumed as maintenance costs for a drainage improvement project in Nepal (Mechler 2005)). This amounts to an undiscounted amount of 9,774 USD per year. The lifetime of the project is reported at an estimated 30 years.

VI Time factors

VI.1 Discount rate

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

VI.2 Increase in Exposed Assets

As the drainage project is assumed to protect against flooding for a period of 30 years, it is assumed that the amount of exposed assets in the region of Point La Rue will increase in a yearly basis. The GNP per capita has increased by an average of 6% annually of the last decade, and the population has grown at an average of 1% per year over the same period (World bank development indicators 2014). For a baseline level, an increase of 1.5% of exposed assets per year will be applied to the analysis (Mechler 2005). This will be represented as an annual increase of 1.5% to the annual benefits.

VII Results

Using the data, provided information, and assumptions described to this point, we are able to conduct a cost-benefit analysis for the project. Table 32 below shows the net present value of the project with a 30-year lifespan,

a 5% discount rate, and an annual increase in exposed assets of 1.5%. In this scenario, the results of the CBA suggest the project to be cost-efficient with a net present value of USD 432,982. Table 33 and Table 34 below show sensitivity analysis with regards to the discount rate and the increase in exposed assets.

Table 32: CBA of tidal channel project with a 30-year lifespan, 5% discount rate, a 1.5% annual increase in exposed assets (amounts in USD)

Project Year	Year	Benefits (1.5% annual exposure increase)	Costs	Net benefits	Discounted costs (5%)	Discounted benefits (5%)	Discounted net benefits
				(benefits-costs)			-5%
1	2013	0	1,954,784	-1,954,784	1,954,784	0	-1,954,784
2	2014	139,159	9,774	129,385	9,308	132,532.	123,224
3	2015	141,246	9,774	131,472	8,865	128,115	119,249
4	2016	143,365	9,774	133,591	8,443	123,844	115,401
5	2017	145,516	9,774	135,742	8,041	119,716	111,675
6	2018	147,698	9,774	137,924	7,658	115,725	108,067
7	2019	149,914	9,774	140,140	7,293	111,868	104,575
8	2020	152,162	9,774	142,389	6,946	108,139	101,193
9	2021	154,445	9,774	144,671	6,615	104,534	97,919
10	2022	156,762	9,774	146,988	6,300	101,050	94,750
11	2023	159,113	9,774	149,339	6,000	97,682	91,681
12	2024	161,500	9,774	151,726	5,714	94,426	88,711
13	2025	163,922	9,774	154,148	5,442	91,278	85,836
14	2026	166,381	9,774	156,607	5,183	88,235	83,052
15	2027	168,877	9,774	159,103	4,936	85,294	80,358
16	2028	171,410	9,774	161,636	4,701	82,451	77,750
17	2029	173,981	9,774	164,207	4,477	79,703	75,225
18	2030	176,591	9,774	166,817	4,264	77,046	72,782
19	2031	179,240	9,774	169,466	4,061	74,478	70,416
20	2032	181,928	9,774	172,154	3,867	71,995	68,127
21	2033	184,657	9,774	174,883	3,683	69,595	65,912
22	2034	187,427	9,774	177,653	3,508	67,275	63,767
23	2035	190,238	9,774	180,464	3,341	65,033	61,692
24	2036	193,092	9,774	183,318	3,182	62,865	59,683
25	2037	195,988	9,774	186,214	3,030	60,770	57,739
26	2038	198,928	9,774	189,154	2,886	58,744	55,858
27	2039	201,912	9,774	192,138	2,748	56,786	54,037
28	2040	204,941	9,774	195,167	2,617	54,893	52,275
29	2041	208,015	9,774	198,241	2,493	53,063	50,570
30	2042	211,135	9,774	201,361	2,374	51,295	48,920
31	2043	214,302	9,774	204,528	2,261	49,585	47,323
Total		5,223,845	2,248,002	2,975,843	2,105,033	2,538,016	**432,982**

Table 33: Sensitivity analysis with regards to the discount rate (at 1.5% increase in exposed assets)

Discount rate	0%	2%	5%	7%	10%	15%
NPV	2,975,843	1,641,189	**432,982**	-65,443	-556,411	-1,012,487
B/C ratio	2.32	1.76	**1.21**	0.97	0.73	0.50

Table 34: Sensitivity analysis with regards to rate of increase in exposed assets (at 5% discount rate)

Asset exposure increase	0%	1.5%	3%	5%	10%
NPV	34,181	**432,982**	945,236	1,870,938	6,348,592
B/C ratio	1.02	**1.21**	1.45	1.89	4.02

VIII Conclusion

The results of the CBA for the proposed tidal channel project suggest a cost efficient project, assuming that the social discount rate is less than 7%. Under the baseline assumption with a project lifespan of 30 years, a 5% discount rate, and an annual increase in exposed assets of 1.5%, the net present value is estimated at USD 432,982. It is also possible that asset exposure could be greater than the baseline of 1.5% per year.

Additional information regarding past damage and losses could also significantly change the results of present analysis. For a backward looking CBA as was done here, the data on previous disaster losses in combination with data on the severity of the weather events is critical to making accurate estimates for the AAL. Some of the previous loss data were rather limited, which suggests that potentially there was more unreported damage. This further emphasizes the importance of complete and accurate loss data when conducting backward looking CBA.

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.

References

International Monetary Fund (2013), “Unification of Discount Rated Used in External Debt Analysis for Low-Income Countries” Unification of Discount Rates Paper, October 4, 2013.

Mechler, R. (2005) “Cost-benefit Analysis of Disaster Risk Management in Developing Countries”, Sector Project “Disaster Risk Management in Development Cooperation”, Federal Ministry for Economic Cooperation and Development.

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DaLA 2013 Seychelles Damage, Loss and Needs Assessment: 2013 Floods Available at: http://www.gfdrr.org/sites/gfdrr/files/Seychelles_DaLA_2013_Floods.pdf

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Annex D: Workshops and Meetings in IOC region

Inception meeting

Dates: 15-17 April 2013

Venue: ICCS, Seychelles

Host: Ministry of Environment

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

Participants: 34

Component 1: capacity building for national disaster loss database

Comoros national workshop:

Dates: June 11-13, 2013

Venue: Hotel Retaj

Host: the Civil Protection and the Ministry of Environment.

UNISDR staff in charge: Sylvain Ponserre and Julio Serje

Participants: 25

Seychelles national workshop:

Dates: 14 - 19 Jul 2013.

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

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

UNISDR staff in charge: Sylvain Ponserre

Participants: 22

Madagascar national workshop:

Dates: 28 Jul - 01 Aug 2013.

Venue: Hotel Colbert

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

UNISDR staff in charge: Sylvain Ponserre

Participants: 36

Mauritius national workshop:

Dates: 24 - 29 Aug 2013.

Venue: Indian Ocean Commission headquarters

Host: Ministry of Environment

UNISDR staff in charge: Sylvain Ponserre

Participants: 40

Zanzibar national workshop:

Dates: 11-14 June 2013

Venue: Zanzibar Ocean View Hotel

Host: NBI Office

UNISDR staff in charge: XXXXX

Participants: 37

Component2: Capacity building for Probabilistic Risk Assessment:

First regional workshop

Dates: 21-23 October 2013

Venue: Indian Ocean Commission headquarters, Mauritius

Host: Ministry of Environment

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

Participants: 40

Second regional workshop

Dates: 20-22 November 2013

Venue: Indian Ocean Commission headquarters, Mauritius

Host: Ministry of Finance

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

Participants: 22

Third regional workshop

Dates: 19-21 March 2014

Venue: Indian Ocean Commission headquarters, Mauritius

Host:

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

Participants: 31

Mauritius national workshop:

Dates: 17-18 February 2014

Venue: Indian Ocean Commission Secretariat

Host:

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

Participants: 10

Seychelles national workshop:

Dates: 23-27 June 2014

Venue:

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

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

Participants:

Component 3: economic analysis and public investment planning

First regional workshop

Dates: 24-26 June, 2014

Venue: ICCS, Seychelles

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

Host: Ministry of finance

Participants: 15

Second regional workshop

Dates: 20-22, October, 2014

Venue: Indian Ocean Commission headquarters, Mauritius

Host: Ministry of Finance

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

Participants: 19

Zanzibar national workshop:

Dates: 10 December, 2014

Venue: Zanzibar Ocean View Hotel

Host: Department of Environment

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

Participants: 30

Seychelles national workshop:

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

Comoros national workshop:

Dates: 05-06 Feb 2015

Venue: Direction générale de la Sécurité Civile

Host: Direction générale de la sécurité civile

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

Participants:55

Madagascar national workshop:

Dates: 28-30 Feb 2015

Venue: STC

Host: Ministry of Finance

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

Participants: 30

Mauritius national workshop:

Dates: tbc

Venue: tbc

Host: tbc

UNISDR staff in charge: tbc

Participants: tbc

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

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

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

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

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

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

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

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

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