



REPUBLIC OF MAURITIUS

NATIONAL AUDIT OFFICE

PERFORMANCE AUDIT REPORT

GOVERNMENT RESPONSE TO MITIGATE THE IMPACT OF FLOODING

**Ministry of Social Security, National Solidarity
and Environment and Sustainable Development**
(Environment and Sustainable Development Division)

FEBRUARY 2019

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ABBREVIATIONS AND ACRONYMS

DIA	Drain Impact Assessment
DRR Report 2013	Disaster Risk Reduction Strategic Framework and Action Plan
EIA	Environment Impact Assessment
ESA	Environmentally Sensitive Areas
LDA	Land Drainage Authority
MoESD	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development
National Council	National Disaster Risk Reduction and Management Council
NDRRMC	National Disaster Risk Reduction and Management Centre
NDU	National Development Unit

EXECUTIVE SUMMARY

Mauritius is affected by the adverse effects of climate change, such as temperature rise, sea level rise and increase in frequency and intensity of extreme weather events, like flash floods. According to the National Disaster Risk Reduction and Management Council (commonly referred to as the National Council), in the Republic of Mauritius, flooding that are caused by heavy/torrential rains account for more than 70 per cent of disaster event every year. Of the several flash floods experienced by the country, the one that occurred in Port-Louis on 30 March 2013 caused one of the highest fatalities. In addition, according to the Disaster Risk Reduction Strategic Framework and Action Plan (DRR Report 2013), it has been estimated that damages to buildings and infrastructures due to flooding in the next 50 years will cost around US \$ 2 billion for Mauritius.

The audit assessed the effectiveness of Government response to mitigate the impact of flooding.

Key Findings

Persistent Causes of Flooding

The study carried out by the Environment and Sustainable Development Division of the Ministry of Social Security, National Solidarity and Environment and Sustainable Development (MoESD) on the real causes of flooding in February 2016 at 128 affected regions revealed that regions in low lying areas account for 50 per cent of the cases, while in the others, they were due to drainage issues with new development, capacity of drainage network, development in backfilled ex-wetland and flooding of river floodplain. Since 2003, these causes had already been highlighted in the report of the National Development Strategy and Policies of the Ministry of Housing and Lands.

Some 15 years after since the causes were identified by the Ministry of Housing and Lands, in July 2018, during a meeting of the Technical Committee on Legal Assistance at the National Development Unit (NDU), members were still raising issues, such as improper inventory of drains and canals, inadequate maintenance and cleaning of drains, surface run off from sugar cane fields, backfilling of wetlands being persistent, and for new developments, there was no proper plan for channeling storm water overflowing from absorption drains.

Strategy and Plan

In 2012, the MoESD commissioned a study for the preparation of the DRR Report 2013, as part of the Africa Adaptation Programme. The objective was to address systematically within an integrated and holistic framework both the sustainable development issue and the climate change related issue, involving economic, environmental, social and technological aspects. The National Disaster Risk Reduction and Management Centre (NDRRMC), which is the body that acts as the main institution for the State of Mauritius for the planning, organising, coordinating and monitoring of disaster risk reduction and management activities at all levels, was assigned the task to monitor the implementation of the recommendations of the DRR Report 2013.

However, the recommendations were only partially implemented due to factors, such as complexity of projects, involvement of different players and shortage of funds.

Land Drainage

For the period 2015-16 to 2017-18, the NDU spent some Rs 594.1 million on construction and upgrading of drains. For Local Authorities, the total amount spent on the construction of drain was some Rs 279 million, and some Rs 37 million on cleaning of drains, rivers and canals during financial years 2016-17 and 2017-18¹. However, these works were undertaken following flood events and was of a reactive nature rather than a pro-active one as described below:

- There was no centrally and scientifically drawn database on flood prone areas to be used by both the NDU and Local Authorities in determining priority drainage works. At the start of each financial year, they prepared plan for drainage work based on a priority list drawn from a list of areas already affected by flood, and not where flooding is likely to occur.
- These drainage works were not evaluated under flood conditions. Hence, the effectiveness of the work in reducing the impact could not be determined.
- After each flooding, the same reason put forward was that drains were not regularly maintained. At most Local Authorities, maintenance, cleaning and rehabilitation works were carried out on an ad-hoc basis, and most of them were complaints driven.

Land Development

According to the study carried out by the MoESD in 2016, there were also issues of water accumulation and flooding in new morcellement as one of the causes of flood. These issues were attributed to the fact that drain return period of morcellement was 10 years only, which was considered not sufficient to cater for excess water during extreme rainfall.

Development on Wetlands

Development is controlled to some extent through the National Ramsar Committee which oversees wetland management by providing Ramsar Clearance. In the Environment Protection Act, which provides for the requirement of an Environment Impact Assessment (EIA) for development in wetlands, backfilling of a wetland without a Preliminary Environmental Report or EIA is an offence under the Act. Moreover, in the National Development Strategy 2003, it is stated that the provisions of the Rivers and Canal Act which prohibit the construction of a building within 33 metres of a river, stream and canals should be complied with.

In spite of these controls, stakeholders were facing difficulties in managing wetlands for the following reasons:

- As at September 2018, an updated inventory on wetlands was not available for stakeholders to take appropriate decision with regard to their management.

¹ Breakdown of construction and maintenance of drains not available for the period 2015-2016

- In a Study on Environmentally Sensitive Areas (ESA) carried out in 2008, it was recommended to have an Environmentally Sensitive Areas Act to better manage ESAs, including wetlands. However, since 2009, some nine years after the completion of the ESA Study, an Environmentally Sensitive Areas Act had not yet been adopted.
- To better manage wetlands, the preparation of a draft Wetland Bill started prior to 2005. However, as at September 2018, it had not yet been finalised.
- There was no clear demarcation as to who was responsible to carry out post monitoring to ensure compliance with the conditions of the Ramsar clearances and licences issued. Hence, post monitoring of these clearances were not being carried out.

Conclusion

Since 2003, the same causes of flooding had been repeatedly highlighted in several studies. Government has been taking several initiatives to mitigate its impact by addressing its causes, but it has not derived the full benefits of its efforts to address the problem of flood at source as these have been more reactive than proactive. The identified causes will continue to contribute to future flooding unless proactive and timely actions are taken.

A holistic and a risk based approach to prevention and protection has not been adopted. Recommendations made in the DRR Report 2013 for a proactive, integrated and source-solution approach, have not been fully implemented.

With the implementation of the new measures, such as Drain Impact Assessment, review of Wetland Bill and Land Drainage Master plan, some improvements may be expected to the problem of flooding. Otherwise, the number of areas exposed to flood hazards will keep on increasing, with potential risk to the life of people and damage to the infrastructure.

Key Recommendations

Implementations and Monitoring of Activities

The implementation of the measures will require constant monitoring of all infrastructural and non-infrastructural works undertaken by the stakeholders involved in risk-reduction. In line with its functions, this task should be carried out by the NDRRMC, and any corrective actions deemed necessary brought to the attention of the National Council.

Monitoring of activities in relation to drains by the Land Development Authority, and those related to flood hazard by other stakeholders should also be brought to the attention of the National Council for better coordination.

Develop a Risk-Based and Pro-Active Approach

Once a scientific list of flood prone areas is completed, a risk-based approach should be adopted to achieve the best results possible using efficiently the resources available. An assessment of flood risk must be undertaken to understand which regions are at risk. These regions can be delineated as high, medium and low risk. This risk-based approach will help in

determining the area where infrastructural and non-infrastructural measures should be prioritised in a pro-active manner.

Improved and Well Maintained Drains

In situation where resources are limited, a programme of work for the construction and maintenance of drains based on a risk assessment of likelihood of floods and their impacts should be developed by each stakeholder. Different return period of drains based on the risk assessment of the area should also be considered.

Planned Development

Areas delineated as high risk flood prone should not be subject to development.

For those areas not delineated as high risk flood prone areas, development should be controlled by a proper planning to prevent and reduce the risk arising from new developments, and to ensure that development in one place does not cause problems in another. Thus, the incorporation of the Drain Impact Assessment as part of the EIA should not be further delayed given the urgent need of controlling the risk of flooding. Additionally, the Drain Impact Assessment Guideline should contain conditions that must be strictly followed.

For those morcellement projects not falling under the requirement of an EIA, the Land Development Authority, in collaboration with other stakeholders, should investigate on whether the possibility of flooding is real in that particular area. The promoters of those projects should then be required to submit a plan on how to reduce the likelihood of flood from surface water run-off, as in Singapore where all new developments and re-developments of 0.2 hectares or more required the implementation of 'source' solutions to slow down storm water run-off entering the public drainage system.

Better Wetland Management

Wetlands and any other environmentally sensitive areas should be subject to close monitoring as clearances are often given to development within or near wetlands. This responsibility should be clearly determined and assigned to a Ministry/Department.

Both public and private wetlands found in areas which are considered to be critically prone to flood, after a thorough analysis on risk of flooding, should not be subject to development.

CHAPTER ONE

INTRODUCTION

This Chapter provides a background of the subject matter examined and described the approach used in carrying out the audit.

1.1 Climate Change and Flooding

Climate change, as per the United Nations Framework Convention on Climate Change, refers to a change in the state of climate that alters the composition of the global atmosphere, and that is in addition to natural climate variability observed over comparable time periods.

One of the potential impacts of climate change for Small Island Developing States identified in the Intergovernmental Panel on Climate Change Fourth Assessment Report of 2007 was an increase in frequency and intensity of natural disasters, like cyclone and flooding.

Climate change knows no boundary. Mauritius is also affected by the adverse effects of climate change, such as temperature rise, sea level rise, accentuated beach erosion, and increase in frequency and intensity of extreme weather events, like flash floods. The World Risk Report of 2017 ranked Mauritius as the 13th country with the highest risk worldwide, and 7th on the list of countries most exposed to natural hazards.

According to the National Disaster Risk Reduction and Management Council (commonly referred to as the National Council), flooding caused by heavy/torrential rains account for more than 70 per cent of disaster event that the Republic of Mauritius faces every year.

1.2 Motivation

According to the Mauritius Meteorological Services, the impacts of climate variability and extreme weather events are a concern for the country. The frequency of extreme weather events, heavy rains and storms of tropical cyclone strength has increased significantly over the last two decades in Mauritius. Heavy rainfall happenings have led to numerous flash floods, causing an increase in the temporary interruption of certain socio-economic activities, damage to infrastructure, such as roads and houses, and loss of lives.

For the past few years, Mauritius has been experiencing an increase in the frequency of occurrence of high intensity rainfall events which resulted in flash floods on several occasions. Flash floods that occurred on 26 March 2008, 30 March 2013 and 10 February 2016 affected different localities, including Port Louis, Canal Dayot, Piton, Fond du Sac, Flacq, Curepipe, Quatre Bornes, St Aubin and Mahebourg. The flash flood of 30 March 2013 in Port-Louis caused one of the highest fatalities in recent times.

Some of the main factors that explained the recurrent accumulation of water, according to the press, are lack of planning, especially with regard to water drainage system, improper maintenance of drains, and illegal and unplanned construction works.

As per the Disaster Risk Reduction Strategic Framework and Action Plan 2013 (commonly referred to as the DRR Report 2013), short-term economic interests hold sway over medium to long term development goals, and too much development is situated in risk prone areas. Continuing in this trend will mean that years-long growth can be lost due to natural hazards, and the country may get off the sustainable path.

As per the DRR Report 2013, it has been estimated that damages to buildings and infrastructures due to flooding in the next 50 years will cost around US \$ 2 billion for Mauritius.

It was against this background that the National Audit Office carried out this Performance Audit on Government’s response to mitigate the impact of flooding.

1.3 Causes of Flooding

In 2016, a study on the real causes of flooding in 128 affected regions during February 2016 was carried out by the Environment and Sustainable Development Division of the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoESD). The study revealed that flooding arose as a combining effect of the following factors:

- Inherent topography (Low-Lying Areas);
- Changes brought by new development, such as reduction in surface area for water infiltration;
- Encroachment on floodplains of watercourses, thereby reducing carrying capacity of natural drains;
- Backfilling of wetlands;
- Hindrances to the performance of drainage systems, like obstructions and siltation.

Of the 128 cases, 50 per cent were reported to be due to low lying areas and the remaining 50 per cent to drainage issues with new development, capacity of drainage network, development in backfilled ex-wetland and flooding of river floodplain as detailed in Table 1.

Table 1: Causes of Flooding

Causes of Flooding	No. of Cases	% Occurrence
Topography – Low Lying Areas	64	50
Drainage Issues with new Development	26	20
Capacity of Drainage Network	23	18
Development in Backfilled ex-Wetland	10	8
Flooding of River Floodplain	5	4
Total	128	100

Source MoESD

1.4 Audit Objective

The audit assessed the effectiveness of Government response to mitigate the impact of flooding.

1.5 Audit Questions

The following audit questions, which covered the main issues related to the audit objective, were developed:

1.5.1 Main Questions and Sub Questions

- Were the drainage systems appropriate, with regard to construction and maintenance?
 - Were drains in new developments designed and constructed according to risk features of the area?
 - Were drains cleaned and maintained to ensure that their drainage capabilities were kept?
- Was Government adequately managing development in risk areas?
 - Were developments along river banks, flood plains and on wetlands controlled and monitored?
 - Were the requirements of the Act and Regulations with regard to development on wetland, rivers and flood plains complied with?
- Was Government developing strategies and plans to mitigate the factors causing flood?

1.6 Audit Scope

This audit examined the activities of Government through its agencies relating to their response to flooding in Mauritius (excluding Rodrigues) and covered the period July 2015 to November 2018. Data prior to July 2015 was included in some cases to show long term trends and to add value to the analysis. The main auditee is the MoESD through the National Disaster Risk Reduction and Management Centre (NDRRMC).

Contract management on construction and maintenance of drains by the different stakeholders are not the focus of this Performance Audit.

1.7 Audit Criteria

Audit criteria are the standards to be met by the audited entity. These were used as a basis for evaluating the evidence collected, developing audit findings and reaching conclusions on the audit objective, and were extracted from the following sources:

- Laws and Regulations
 - Environment Protection Act;
 - Forest and Reserves Act;
 - The Land Drainage Authority Act;
 - The National Disaster Risk Reduction and Management Act;
 - Rivers and Canal Act;
 - Morcellement Act.
- Standards from research, literature, professional and/or international organisations
 - European Union Best Practices on Flood Prevention, Protection and Mitigation 2004.
- Internal document
 - Disaster Risk Reduction Strategic Framework and Action Plan Report 2013.

Details on the audit criteria used are in the relevant Sections in this Report.

1.8 Audit Methodology

The audit was conducted in accordance with International Standards of Supreme Audit Institutions. Different methodologies were used to understand the audit area, along with obtaining sufficient, relevant and reliable audit evidence to support conclusion and recommendations.

1.9 Methods of Data Collection

Data was collected from files, documents review and interviews.

1.9.1 Review of Documents

Information relating to policies, guidelines, regulations, structures, processes, systems, procedures and practices was collected through review of files and documents kept at selected Ministries and Departments.

1.9.2 Interview

Interviews were carried out with key personnel at operational, middle and senior management levels at the selected Ministries and Departments. The interviews were used to confirm the information obtained from the documents reviewed and for providing more explanation where information was not available in the reviewed documents.

CHAPTER TWO

DESCRIPTION OF THE AUDIT AREA

This Chapter describes the roles and responsibilities of key players involved in flood management. Key aspects of the current system for the promotion of sustainable development, coordinating and monitoring of disaster risk reduction and management activities are also described.

2.1 Background

According to the United Nations Guideline for Reducing Flood Losses, management of activities within the flood prone area can significantly reduce flood damages to existing development and prevent the amount of damages from rising in the future.

Over the years, Government has been taking measures to reduce the likelihood of flood, and consequently, its adverse impact. Managing flood involves several activities which are implemented by different key players. There are six of them in the present arrangement that are involved in flood management, namely MoESD, NDRRMC, the National Development Unit (NDU) operating under the aegis of the Prime Minister's Office, LDA, the Ministry of Local Government and Outer Islands and Local Authorities. All these key players have the vision to have a safer Mauritius, and have as their mission to effectively respond to emerging challenges to enhance the safety and security of the citizens. The Vision and Mission of the different key players are in the Appendix.

Their main roles and responsibilities with regard to flooding are described below.

2.2 Roles and Responsibilities of Key Players

2.2.1 Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)

Under the Environment Protection Act, MoESD through the Environmental Assessment Division plays a key role in developing control and ensures that environmental impacts of major development projects are foreseen and addressed at the very inception stage through the Environment Impact Assessment (EIA) mechanisms. It ascertains that appropriate measures are taken to mitigate adverse environmental impacts, enhance the positive impacts and promote sustainable development. The Division also works in close collaboration with other Ministries for development projects falling under the latter's purview. Examples include application for Morcellement Permit or Land Conversion Permit from the Ministry of Housing and Land, and advisory support as regards other development projects.

2.2.1.1 National Disaster Risk Reduction and Management Centre

The NDRRMC is the body that acts as the main institution for the State of Mauritius for the planning, organising, coordinating and monitoring of disaster risk reduction and management activities at all levels. It coordinates with all stakeholders to ensure that risk reduction and preparedness planning is included at all levels of the country, from individuals and

communities, to Government policy and strategy. It monitors projects undertaken by other stakeholders through meetings and site visits.

2.2.2 National Development Unit

The NDU, under the aegis of the Prime Minister's Office, operates to contribute towards the enhancement of the quality of life through the provision of community-based infrastructure and amenities and implementation of the Land Drainage Programme.

It is also responsible for the construction and management of drains, and provides, among others, services related to socio-economic infrastructural development and protection and improvement of the environment.

2.2.2.1 Land Drainage Authority

Following the promulgation of the Land Drainage Authority Act in 2017, a Land Drainage Authority (LDA) under the aegis of the Ministry responsible for the NDU was established. The Authority is responsible for, among others:

- the development and implementation of a land drainage master plan;
- coordinating the construction of drainage infrastructure by the Local Authorities, the NDU, the Road Development Authority and any other relevant stakeholders;
- ensuring that there is a routine and periodic upgrading and maintenance of the drainage infrastructure.

Its functions are defined in the Act.

2.2.3 Ministry of Local Government and Outer Islands

The Ministry of Local Government and Outer Islands is responsible for local government matters in Mauritius. Its main functions include overseeing the Local Authorities and formulating appropriate policies and legislative framework to ensure that they operate smoothly. The Ministry has under its aegis the Local Authorities.

2.2.3.1 Local Authorities

With regard to flooding, the Local Authorities, subject to their financial capability and within the limits of their respective administrative areas, are mainly responsible for

- the construction, care, maintenance, improvement, cleaning of all pavements, bus shelters, drains and bridges, and lighting of all roads other than motorways and main roads;
- the removal of any physical obstruction on road reserves;
- the construction, control, care, management, maintenance, improvement and cleaning of all beds and banks of lakes, rivers, rivulets and streams.

2.3 Development of Plans to Address Flooding

In 2012, the MoESD commissioned the preparation of the DRR Report 2013 as part of the Africa Adaptation Programme. The main aim of the Report was to develop an inundation, flooding and landslide national risk profile for the Republic of Mauritius, along with the development of a strategic framework, including the integration of disaster management in urban planning and development. The Report was regarded both as a sustainable development issue and a climate change related issue, involving economic, environmental, social and technological aspects to be systematically addressed within an integrated and holistic framework.

The Report was produced in January 2013 as part of the Hyogo Framework for Action 2005-2015, now known as the Sendai Framework 2015-2030². Some of the recommendations in the DRR Report 2013 in respect of prevention and protection measures and their justifications are listed below:

- Development of Flood Management Plan for different water basins and land drainage study - Plan of interventions defines various steps to reduce or mitigate the damage caused when floods happen.
- Development of Danger Zoning Plans - In order to face up efficiently the land-use planning and to propose measures to reduce risk.
- Preserve Healthy Natural Environment - Over the past years, the area occupied by coastal and inland wetlands and riparian vegetation has declined. This trend should be reverted, and more emphasis should be laid to ability of ecosystems to mitigate or offset the effects of the natural hazard.
- Development of Sound (special) Data Infrastructure - Modern disaster risk governance is conceivable with an effective data infrastructure.

2.4 Promoting Sustainable Land Development

The Planning and Development Act, in relation to land development, provides for, among others:

- the proper management, development and conservation of natural and man-made resources for the purposes of promoting the social and economic welfare of the community, and a better environment;
- ecologically sustainable development.

Under the Act, any land development should be in line with the National Development Strategy which aims at promoting development in a sustainable and equitable manner, so as to maintain

² The Sendai Framework 2015-2030 for Disaster Risk Reduction is the successor instrument to the Hyogo Framework for Action 2005-2015: 'Building the Resilience of Nations and Communities to Disasters'. The Sendai Framework charts the global course over the next 15 years. During the consultations and negotiations that led to its finalisation, strong calls were made to develop practical guidance to support implementation, ensure engagement and ownership of action by all stakeholders, and strengthen accountability in disaster risk reduction.

and enhance the natural and built environment. The Strategy provides guidance and recommendations on design of drainage systems and the development in wetlands.

The Ministry of Housing and Land was in the process of reviewing the National Development Strategy.

Where an application for land development has or is likely to have significant environmental effects and the applicant is required to prepare a Preliminary Environmental Report or an EIA, the permit authority consults with the MoESD. The Fifth Schedule of the Environment Protection Act describes the circumstances where the Preliminary Environmental Report and EIA are required.

CHAPTER THREE

FINDINGS

This Chapter presents the findings on the effectiveness of Government response to mitigate the impact of flooding.

3.1 Introduction

As per the United Nations Guideline on Reducing Flood Losses 2004, there is seldom a single approach to reduce and manage risk of flooding, but rather an array of measures. Emphasis should be placed on arriving at solutions that are practical, appropriate and sustainable for the community at risk. The Guideline lays emphasis on the importance of prevention and protection measures.

The DRR Report 2013 emphasised that prevention and protection measures to reduce the flood impacts include both structural activities (for example flood defence works) and non-structural activities, such as restricting the development of flood plains and flood-sensitive land use, and considering future hazard when planning the expansion of urbanised areas.

3.2 Response to the Causes of Flood

Government response through prevention and protection measures to mitigate the impact of flooding was examined. It focussed on strategies and plans developed and measures taken to address land drainage and land development issues. These are presented at paragraphs 3.3 to 3.4.

3.2.1 *Persistent Causes of Flooding*

In 2003, the causes of flood had already been identified in the report of the National Development Strategy and Policies of the Ministry of Housing and Lands. These were again highlighted in the study carried out by the MoESD in 2016 as described in paragraph 1.3. The causes were mainly

- Deficiencies in the drainage system (inadequate culverts and lack of maintenance);
- Lack of capacity of main drainage channels;
- Inappropriate development in depressions (low-lying regions) and marshy land.

During a meeting of the Technical Committee on Legal Assistance at the NDU in July 2018, members present were still raising issues, such as improper inventory of drains and canals, inadequate maintenance and cleaning of drains, surface run off from sugar cane fields, backfilling of wetlands being persistent, and for new developments, there was not a proper plan for channeling storm water overflowing from absorption drains.

Stakeholders responsible for different activities in flood management faced difficulties in addressing the factors causing flood, and hence, the occurrence of floods and their

consequences continued over the years. Recently in December 2018, the country witnessed the impact of one of the flood events that affected people lives and infrastructure at Cottage, Mont Gout, Pamplermousses and Bel Air amongst others.

Practices adopted by different countries were scrutinised to identify how they responded to flood. The case of Singapore is described below.

Case Study - Singapore

The Case Study below, provides an indication on how Singapore is responding to flood.

1. Quick Response

An Expert Panel on Drainage Design and Flood Protection Measures to review flood protection and risk management measures that would be implemented in Singapore over the next decade was appointed by the Ministry of the Environment and Water Resources on 30 June 2011. The Panel reviewed the Public Utilities Board's drainage planning assumptions and parameters, identified innovative and cost-effective solutions, and proposed improvements to ensure public resilience to floods. The Panel recommended a 'Source-Pathway-Receptor' approach. This approach was adopted by the Board in 2012.

'Source' Solutions

Since January 2014, all new developments and re-developments of 0.2 hectares or more were required to implement "source" solutions to slow down storm water runoff entering the public drainage system. These on-site measures could include detention tanks or rain gardens and bio-retention swales.

'Pathway' Solutions

In 2011, to enhance 'pathways' to cope with higher intensity storms, the Public Utilities Board raised the design standards for drains to cater for more intense rainfall events. Depending on the size of the catchment, this could mean an increase between 15 and 50 per cent in drainage capacity.

'Receptor' Solutions

'Receptor' solutions aimed to provide additional flood protection for buildings and key infrastructure. Some of these measures included setting minimum platform and crest levels and placing flood barriers to prevent floodwaters from entering buildings.

2. Singapore Good Work

The Panel noted that much good work had been done by the Public Utilities Board in managing the drainage and flood situation in Singapore over the past 30 – 40 years, despite the rapid urbanisation. In terms of storm drainage, Singapore compared well with other metropolitan areas.

3.3 Strategies and Plans

To mitigate the factors causing flood, Government commissioned the development of the DRR Report 2013, and was also considering the preparation of two other reports, namely the National Disaster Risk Reduction and Management Policy, Strategic Framework and Action Plan and a Land Drainage Master Plan. The paragraphs below elaborate on the issues which have arisen in strategies and plans.

3.3.1 Disaster Risk Reduction Strategic Framework and Action Plan

In the DRR Report 2013, several recommendations were made to address the problem of flood. However, Government faced difficulties in implementing them.

In September 2013, the DRR Report was referred to relevant Ministries/Departments for the implementation of the recommendations contained therein. The NDRRMC was assigned the task to monitor the implementation of the recommendations.

The NDRRMC identified the various actions which fall under the purview of different stakeholders, and they were requested to ensure the implementation of these actions (Table 2) and to report progress to the NDRRMC on a quarterly basis. The budgetary requirements for the implementation of these actions were to be considered by the stakeholders under their own budget. The cost of implementation of various measures in relation to flood was estimated to be some Rs 3.55 billion as shown in Table 2.

3.3.1.1 Implementation of Recommendations

Since 2013, the NDRRMC had repeatedly highlighted the different factors rendering the implementation of recommendations difficult, and as a result, they were partially implemented. A summary of the factors are listed below.

- Shortage of funds by stakeholders.
- Some of the actions did not fall solely under the main stakeholder's mandate.
- Implementation of some actions required different players. Some disaster risk reduction actions were interlinked, and therefore, would have to be implemented together.
- There was a shortage of expertise in some of the relevant fields, such as the collection and interpretation of data from remote sensing. In view of the scope of certain actions, the services of Consultancy Firms were needed and recruiting Consultants was too costly.
- Complexity and magnitude of the measures.

The Action Plans of the DRR Report 2013 were not broken down into short-term manageable ones, with overall and immediate outcomes target to facilitate their implementation.

Details on the various measures related to flood as at September 2018 are shown in Table 2.

Table 2: Details on Measures Related to Flood

Measures	Time Frame	Estimated Cost (Rs million)	Remarks and Status as at September 2018
Flood Management Plan for different water basins and land drainage study	2013 -2025	3,000	Will be taken up by the Land Drainage Authority
Development of Danger Zoning Plans (including Rodrigues and other hazards)	2013 -2018	230	<ul style="list-style-type: none"> • Involve many players; • Action interlinked with other actions; • Production of topographic maps encountered slow response; • Shortage of funds; • Lack of expertise; and • Zoning plan for 15 instead of 37 original sites is being developed.
Preserve healthy natural environment (Environmentally Sensitive Areas) and wetlands)	2013 -2018	45	<ul style="list-style-type: none"> • Involve many players; and • Partly already taken into consideration through the Ministry of Housing and the Ramsar Committee.
Sound (spacial) data infrastructure (including other hazards)	2013 -2018	270	<ul style="list-style-type: none"> • Complexity of project • Magnitude of project • Not completed
Total		3,545	

Source: DRR Report 2013 and Auditor's Analysis

3.3.2 Government Current Planning Initiatives

Mauritius, as a member state of the Common African Position to the Global Platform for Disaster Risk Reduction, has taken the commitment to implement the seven global targets enunciated in the Sendai Framework 2015-2030. In line with this commitment and in compliance with the National Disaster Risk Reduction and Management Act, in 2018, Government took the initiatives to prepare a National Disaster Risk Reduction and Management Policy, Strategic Framework and Action Plan and Land Drainage Master Plan.

These Plans aimed to provide a roadmap for the implementation of the disaster risk reduction strategies, including flood.

As at September 2018, issues arising with respect to the preparation of the two Plans are presented below.

3.3.2.1 National Disaster Risk Reduction and Management Policy, Strategic Framework and Action Plan

The National Disaster Risk Reduction and Management Act provides for the National Council, which has among its main functions the formulation of the National Disaster Risk Reduction and Management Policy, as well as the oversight of the implementation of the National Strategic Framework and Action Plan.

During a meeting of the National Council in May 2017, it was pointed out that, Mauritius, as a member state of the Common African Position to the Global Platform for Disaster Risk Reduction, had taken the commitment to implement the seven global targets enunciated in the Sendai Framework 2015-2030. Hence, the Policy on Strategic Framework and Action Plan for Disaster Risk Reduction is an important tool for the country.

The targets are:

- Substantially reduce global disaster mortality by 2030;
- Substantially reduce the number of affected people globally by 2030;
- Reduce direct disaster economic loss in relation to global Gross Domestic Product by 2030;
- Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;
- Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
- Substantially enhance international cooperation to developing countries by 2030;
- Substantially increase the availability of an access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.

During 2017, the project for the Development of a National Disaster Risk Reduction and Management Policy, Strategic Framework and Action Plan was submitted to MoESD to seek fund under the Green Climate Fund. As the project did not satisfy the required funding criteria under the Green Climate Fund, finance was not obtained.

In December 2017, the Working Group set up to look into the implementation of the seven global targets enunciated in the Sendai Framework was of the view that, in order to be in line with the Common African Position and the Sendai Framework, it was mandatory for the National Council to have its National Disaster Risk Reduction and Management Policy, Strategic Framework and Action Plan. Unfortunately, funding for the project was not obtained

under the National Adaptation Programme. In February 2018, during meeting of the National Council, it was again pointed out that the development of the Policy, Strategic Framework and Action Plan was a must for the implementation of the Sendai Framework.

Finally, the Agence Française de Développement agreed to fund the Strategy and Action Plan under the Adapt Project, and the Terms of Reference was being worked out. Consultation work for the preparation of the Action Plan has already started, and it was expected to be completed by April 2019.

3.3.2.2 Land Drainage Master Plan

The Land Drainage Act provides for the formulation of a Land Drainage Master Plan.

The Plan, amongst others, will include:

- a detailed inventory of the infrastructure and hydraulic diagnosis on the island drainage infrastructure and mapping of all flooded and vulnerable areas on the basis of field survey;
- a technical and economic comparison between different levels of protection scenarios and recommendations for the optimal design drainage network frequency;
- the final preliminary design for drainage infrastructures and the flood hazard mapping;
- an environmental and social impact study;
- an institutional analysis and the elaboration of policies to award constructions permits and guidelines for all new designed hydraulic infrastructures.

The preparation of the Plan required the acquisition of a Digital Elevation Model of high resolution at an estimated cost of Rs 40 million. As at October 2018, procurement procedures were still ongoing. According to the LDA, the Master Plan was expected to be ready by mid-2020.

3.4 Land Drainage

In order to respond to flood events, Government increased the budget on construction and upgrading of drains of NDU from Rs 300 million in 2015-16 to Rs 720 million in 2017-18. During the same period, some Rs 594 million were spent. For Local Authorities, the total amount spent on construction of drains was some Rs 279 million and some Rs 37 million on cleaning of drains, rivers and canals during financial years 2016-17 and 2017-18.³

Furthermore, a sum of Rs 20 million was provided for in 2018-19 under the National Environment Fund for the conduct of an audit of rivers and water courses to assess their carrying capacity to better protect lives and properties. As November 2018, the process for the procurement of consultancy services was in progress.

³ Breakdown of construction and maintenance of drains not available for financial year 2015-16.

3.4.1 Database on Flood Prone Areas

A proper database can help to formulate both long and short term plan for drainage work and assist in monitoring of flood prone areas.

3.4.1.1 Flood-prone Areas and Planning of Land Drainage Work

The Environment Agency of the United Kingdom uses a model to predict where flooding will occur and takes a risk-based approach to all its flood and coastal risk management activities. In the United Kingdom Report on Strategic Flood Risk Management 2014, it was stated that most stakeholders responding to their call for evidence felt that flood models in the United Kingdom were well developed and supported strategic decision-making.

There was no centrally based and regularly updated database on flood prone areas, which stakeholders could use in their flood management activities. As at November 2018, a list of flood prone areas was available at the NDRRMC. The list, established in 2017, was drawn based on input from various sources, such as the Fire and Rescue Services and Local Authorities' actual experience of flood on sites. It is used for the purpose of the Protocol on Heavy Rainfall for the Public Sector, and is not meant to be relied on or used by entities or individuals other than those involved in the implementation of the Protocol. However, according to the NDRRMC, the list was not scientifically prepared, based on an assessment of flood risk.

At the beginning of each financial year, both NDU and Local Authorities prepare plans of drainage work to be carried out based on their different priority lists drawn from information on areas already affected by flood, and not on scientific information on those areas where floods may occur.

According to the European Union, the flood history of individual communities, combined with damage estimates from previous floods, can assist to give some indication of the type of flood forecasting and warning system that may be most appropriate. However, the different stakeholders interviewed agreed that given the dynamic nature of flooding areas which required regular updating with time, there was a need to have a well-developed list of flood prone areas that could help in prioritising drainage works.

The LDA, established under the Land Development Authority Act, has as one of its objectives to identify flood risk areas in collaboration with stakeholders, such as the Local Authorities, NDU, Road Development Authority, NDRRMC and any other relevant stakeholders. In its Annual Report on Performance 2016-17, the NDU mentioned that in order to identify priorities for drainage work, the LDA would work in close collaboration with the NDRRMC. It was explained that the identification of flood prone areas would be undertaken once the development of a Land Drainage Master Plan would be finalised.

3.4.1.2 Evaluation of Land Drainage Work

The evaluation and reporting of land drainage work can assist stakeholders to assess the risk exposure of the regions, determine whether the design and construction are appropriate and/or to take other measures, such as controlling the source of the flood. This in turn can assist stakeholders in taking pro-active decision and help in resource allocation in most risky- areas, especially in the absence of a scientific and updated list of flood prone areas.

Drainage work undertaken by NDU and Local Authorities, to the tune of some Rs 850 million in 2016-17 and 2017-18, were not evaluated under flood conditions. It was explained that this was not possible as there were no agencies responsible for these activities. In the absence of such evaluation, it was difficult to determine whether drains constructed had been effective in reducing risk.

According to information received from LDA, the evaluation would be effected once the Land Drainage Master Plan was ready.

3.4.2 Maintenance of Drains

At the beginning of each financial year, Local Authorities prepare a programme of work for the cleaning, rehabilitation and upgrading of drains, bridges and rivers.

Despite having a programme of work, after each flood, there was public outcry that drains were not regularly maintained. Cases, as identified by the NDRRMC, where the obstruction of drains was the cause for the abnormal water flow after heavy rainfall, are shown in Table 3.

Table 3: Examples of Cases of Improper Maintenance of Drains

Month	Region	Description
February 2014	Souillac	Obstructed and inadequately maintained drains
April 2014	Coromandel, rue des Longanniers	No proper maintenance of drain
December 2014	Prison Street at Mont Roches	Obstructed drains
February 2018	Pailles SSS	Some drains need to be cleaned

Source: NDRRMC

Local Authorities pointed out that their statutory responsibilities were not always matched with their available resources. During meetings of the Committee on Maintenance and Coordination of Land Drainage Infrastructure, it was pointed out that at most Local Authorities, maintenance, cleaning and rehabilitation works were effected on an ad-hoc basis, and often, these were complaints driven. Moreover, the main barriers to regular maintenance were inadequate staffing, ageing staff and limited mechanised means.

During financial year 2018-19, a sum of Rs 75 million for the acquisition of machinery and equipment for maintenance of drainage infrastructure by the Ministry of Local Government and Outer Islands was provided under the National Environment Fund. As at November 2018, procurement procedures for the acquisition of machinery and equipment were ongoing.

3.4.3 Land Development

In the DRR Report 2013, recommendation was made to develop a strategy in order to ensure that areas exposed to higher level of hazards were not further developed, or only if appropriate protection was put in place. Specific guidelines and regulations should be adopted to clarify and strengthen the strict interplay between activities falling under EIA and those related to disaster risk reduction, in the light of increasing environmental protection and sustainable development.

Development is controlled under the Morcellement Act and the Environment Protection Act. Under the Morcellement Act, except for those exempt under the First Schedule, a permit to develop a morcellement is issued after obtaining a morcellement plan which must show, in addition to any existing rivers, rivulets, feeders, canals, and drains on or adjoining land, the proposed drainage system. Under the Environment Protection Act, all promoters of projects listed in the Fifth Schedule Part B of the Act are required to provide an EIA. Guidelines on the preparation of EIA are also available to assist promoters of Land Parcelling, Integrated Resort Scheme and construction of Marina and Golf Course. These guidelines have already made references to the importance of having drains in the respective projects.

The National Development Strategy Policy DR1 – ‘Design of Drainage System’ stipulates that all major developments should provide appropriate systems to ensure that they are adequately drained, that neighbouring developments are not adversely affected and the implications for the catchment area are taken into account in the planning of new schemes.

In spite of these safeguards, in the study carried out by the MoESD on the real causes of flood, it was concluded that there were flooding issues in new morcellements. These are detailed below.

3.4.3.1 Return Period of Drains

In the Study carried by the MoESD in 2016, it was reported that out of 128 areas affected by flood in February 2016, 26 cases (some 20 per cent) were due to drainage issue in areas newly developed.

It was also reported, in the Study, that there were water accumulation and flooding issues in morcellements. One condition favouring this problem was that ‘drain return period’⁴ of morcellement was 10 years only, which was considered not sufficient to cater for excess water during extreme rainfall. In July 2018, Government proposed to review the granting of Morcellement Permit, with the provision for a Drain Impact Assessment (DIA) to be undertaken as part of the EIA Report. The LDA, in collaboration with MoESD, NDU, Local Authorities, Water Resources Unit and Road Development Authority had prepared a draft Drain Impact Assessment Guideline to assist promoters in the preparation of the Assessment, and to ensure a holistic catchment-based approach was adopted. The possibility of the development leading to increased flood risk elsewhere would be dealt with in the DIA. The Guideline was submitted to MoESD in October 2018, for incorporation in the existing EIA

⁴ A return period is an average length of time (in years) for an event (such as precipitation or discharge) of given magnitude (that is, mm of rainfall per unit of time) to be equalled or exceeded (DRR Report 2013). For example a 1-in-100 years flood has a probability of 1 per cent to occur in any given year.

Guideline. The Direct Impact Assessment Guideline would consider different drain return period as per Table 4.

Table 4: Drains Return Periods

Infrastructure	Minimum Rainfall Return Period (years)
Drains	1:25
Discharge into watercourses	1:50
Culverts	1:50
Bridges	1:100

Source: Land Drainage Authority

In the DRR Report 2013, recommendation was made for the development of danger zoning plans in order to face up efficiently the land-use planning and to propose measures to reduce risk. However, this recommendation was difficult to implement as mentioned in paragraph 3.3.1.1.

3.4.3.2 Morcellement Permits

As per Guideline for the application of Morcellement Permits, a promoter should obtain an EIA Licence for an extent of land of more than five hectares.

As stated at paragraph 3.4.3.1 above, the granting of Morcellement Permit would be reviewed with a provision for a DIA to be undertaken as part of the EIA Report. An analysis of the Morcellement Permits for the period January 2015 to November 2018 showed that, out of a total of 843 Permits issued for a total area of 858 hectares, 821 were for those below five hectares each. Unless, additional measures are taken, those Permits for less than five hectares will not fall under the requirement to provide a DIA. It will not be practical to require the promoters to submit a DIA, but it may be appropriate for relevant authorities to consider the impacts of these morcellements on flooding before issuing the Permits. These 821 permits for less than five hectares can have important changes in the land drainage system as the total area relating to them is some 372 hectares, representing some 43 per cent of the total area.

3.4.3.3 Flood Risk Reduction in Development Process

In the DRR Report 2013, it was recommended that the regulatory framework relating to buildings, should take into account the Disaster Risk Reduction aspects, when issuing a building permit, as listed below.

- Permitting authorities shall grant potential building permits in disaster risk prone areas subject to a more detailed scrutiny;
- Improving building rules and codes in order to include disaster risk reduction concerns and goals with the view to ensuring safety and resilience in public and private buildings and infrastructures.

In 2013, a Sub-Committee on Climate Change, with the main objective to formulate a Guideline for Mainstreaming Climate Change Adaptation in Building and Land Use Permit and to develop toolkits for vulnerability assessment by Local Authorities, was set up. The Committee completed his work in January 2017.

The Guideline proposed the incorporation of climate risks reduction measures into the Building and Land Use Permit process at conception, planning, design and implementation stages of all development projects, with special emphasis on development projects in climate risk prone areas. The toolkit was also meant to help Local Authorities to proactively address the prevention, protection and preparedness to the adverse effects of climate change and extreme events.

As at November 2018, nearly two years after, the Guideline was not yet endorsed by MoESD.

3.4.4 Development on Wetlands

Wetlands perform several hydrological functions, such as ground water recharge, water storage and flood mitigation. Loss of coastal wetlands in the North of Mauritius is known to be contributing to increased incidences and intensity of flooding as their water storage capacity, as well as their capacity to filter sediment and waste waters is significantly reduced.

Issues on inventory and protection of wetlands are described below.

3.4.4.1 Inventory of Wetlands

An Environmentally Sensitive Areas (ESA) Map, including wetlands, was available since 2009. This Map was being used by MoESD for the identification of Wetlands for EIA purposes. However, the Map was not a legally binding tool for EIA. In order to preserve healthy natural environment, in the DRR Report 2013, recommendation was made to update the inventory of ESA, including wetlands.

As at September 2018, an updated inventory of wetlands across the island was not available for stakeholders to take appropriate decision with regard to its management, contrary to the requirements of the DRR Report 2013. The inventory is an important tool for management of wetlands, as studies carried out in certain parts of the island over different time periods indicated a gradual decline in the percentage of wetlands as follows:

- Studies made by the Department of Environment in 1998 indicated that some 20 per cent of wetlands in the Northern Tourist Zone, and some 50 per cent in the Western area of Flic en Flac had been backfilled, and that 50 per cent of remaining wetlands were under pressure, including the Belle Mare Tourist Zone on the East coast;
- In 2008, a survey carried out in the Grand Baie region revealed a gradual decrease of the wetlands area as shown in Table 5.

Table 5: Percentage Decrease in Wetlands in Grand Baie - 1980 to 2008

Period	% Decrease in Area of Wetlands
1980-1990	10
1990-2000	30
2000-2008	23

Source: MoESD's records

It was explained that the preparation of the Wetlands Bill which was in progress would consider an updating of the inventory of wetlands.

3.4.4.2 Protection of Wetland

Another recommendation in the DRR Report 2013 was to preserve healthy natural environment which included actual protection of wetlands and other ESA, and the restoration of those which had been degraded, especially where this was cost effective and efficient, compared to concrete flood protection.

Development in wetlands is controlled to some extent through the National Ramsar Committee which oversees wetland management by providing Ramsar Clearance. In the Environment Protection Act, which provides for the requirement of EIA for development in wetland, backfilling of a wetland without a Preliminary Environmental Report or EIA is an offence under the Act. Moreover, in the National Development Strategy 2003, it is stated that the provisions of the Rivers and Canal Act which prohibit the construction of a building within 33 metres of a river, stream and canals should be complied with.

In spite of these controls, stakeholders were facing difficulties in managing wetlands. This could be attributed to

- The ESA Study had not been formally recognised. In January 2008, the MoESD commissioned the study of environmentally sensitive areas in Mauritius and Rodrigues for a total sum of some Rs 11.8 million. The study was completed in April 2009. One of the objectives was the development of a comprehensive policy and legislation for the protection, conservation and sustainable development of these areas in Mauritius and Rodrigues, and the preparation of an Environmentally Sensitive Areas Classification Report. In the Report, it was concluded that over the long term, adoption of an Environmentally Sensitive Areas Act was the better choice, as it would provide a unified and coherent structure and binding legal obligations that could not be reversed through the adoption of regulations.

However, since 2009, some nine years after the completion of the Environmentally Sensitive Areas Study, the Environmentally Sensitive Areas Act has not yet been adopted.

- The 2005 National Development Strategy included two policies relating to wetlands, namely wetlands need priority protection (Policy Env2), and many wetlands require ecological restoration (Policy Env3).

The recommendations of the National Development Strategy are embodied in the text of the Draft Wetland Bill (2013) which provides for ‘The protection, conservation and sustainable management of wetlands and wetlands resources in the Republic of Mauritius’. Once enacted, this legislation would require that a management plan be produced for each Ramsar site, and also for each Category 1 Wetland, within which, no development should be permitted. Currently, any activities on wetlands that are not Ramsar sites are regulated solely through the EIA provisions, after consultation with the National Ramsar Committee. The draft Bill provides for the prohibition of draining or filling of ecological interference with, and a range of other activities in wetlands and their buffer zones. Some important features of the Draft Wetland Bill 2013 are:

- management plan for wetlands;
- classification of wetlands into Categories 1 to 3, and where development in Category 1 is prohibited;
- any person who commits an offence shall restore the wetlands to its natural state.

The preparation of the Wetland Bill started prior to 2005, and as at September 2018, it was not yet completed. It was explained that the Bill could not be finalised due to constitutional issues concerning private wetlands. Access to private land is important in order to establish offences, issues of notices and prosecution in case of back filling of wetlands, development on wetlands without the approval of the Local Authorities and without an EIA licence;

- From January 2016 to mid-2018, 24 Ramsar Clearances were granted out of 29 applications received, representing some 82 per cent approval.

One of the recommendations of the Ramsar Convention is that each contracting party shall arrange to be informed at the earliest possible time if the ecological character of any wetlands in its territory is changing or is likely to change as a result of technological development, pollution, or other human interference.

Further to the National Ramsar Committee held in July 2015, it was agreed that a sub-committee would be set up to look into mechanism to be set up in order to monitor and follow-up on compliance with Ramsar clearances that were granted to applicants.

It was finally decided in October 2015, given that Ramsar clearances were issued by the Ministry of Agro Industry and Food Security, the responsibility to prosecute in case of non-compliance would rest with that Ministry.

The terms of reference of the sub-committee changed with time. The sub-committee is actually carrying out site visits prior the issue of Ramsar clearance. According to the National Ramsar Committee, it is the Local Authorities which carry out Post Monitoring. However, from information obtained from the Local Authorities, it is the responsibility of the relevant Ministry to ensure compliance with the conditions of the clearances and licences provided by the relevant Ministry. The absence of clear demarcation as to responsibilities for monitoring, resulted in that post monitoring of Ramsar clearances not being carried out.

The consequence of the above was that some regions have been flooded due to the development in wetlands as revealed by the report of MoESD in 2016. During 2018, the persistent backfilling

of wetlands for development in the regions of Pereybere, Grand Baie and Flic en Flac caused those areas to be continually affected by flooding during rainy season. Reactive actions were being taken in these regions, which were being provided with drains to reduce the impact of flooding.

CHAPTER FOUR

CONCLUSION AND RECOMMENDATIONS

This Chapter concludes against the audit objective based on analysis and findings supported by audit evidence as elaborated in the previous Chapter, and also presents the recommendations based on the findings and conclusions reported in previous Chapters

4.1 Conclusion

After each flood event, there is a national effort by all stakeholders to undertake essential works, mainly the cleaning of rivers, canals, drains and other water courses and construction of drains. However, these efforts were more reactive than proactive and did not adequately address the causes of flooding at source.

Several studies undertaken on the problem of flood repeatedly highlighted the same causes. Merely commissioning studies with partial implementation of their recommendations is not considered to be a sustainable solution to address the problem of flooding. Unless pro-active and timely actions are taken, the identified causes of flooding will continue to contribute to future flooding.

Recommendations in the DRR Report 2013 which called for a proactive, integrated and source-solution have not been fully implemented due to the difficulties faced by the different stakeholders. A holistic approach to prevention and protection has not been adopted as there is no institution responsible for coordinating these issues.

Government has not adopted a risk based approach to address flood. This could have ensured a proper classification of flood prone areas into high, medium and low risk and facilitated the compilation of a central database of those risky areas.

Government has also not derived the full benefit of its efforts to address the problem of flood. It has now taken some other initiatives aiming to shift towards more proactive actions, such as the requirement of a DIA for new development, review of the Wetland Bill, developing Land Drainage Master Plan and the National Disaster Risk Reduction and Management, Policy Strategy and Action Plan for a more holistic approach, audit of rivers and water courses to determine their carrying capacity and increasing the maintenance budget.

With the implementation of these new initiatives, some improvements may be expected to the problem of flooding. Otherwise, the number of areas exposed to flood hazards will keep on increasing with potential risk to the life of people and damage to the infrastructure.

4.2 Recommendations

4.2.1 Implementations and Monitoring of Activities

The implementation of the measures will require constant monitoring of all infrastructural and non-infrastructural works undertaken by the stakeholders involved in risk-reduction. In line

with its functions, this task should be carried out by NDRRMC and any corrective actions deemed necessary brought to the attention of the National Council.

Monitoring of activities in relation to drains by the LDA and those related to flood hazard by any other stakeholders should also be brought to the attention of the National Council for better coordination.

4.2.2 Monitoring Mechanism

For a smooth implementation of activities, such as infrastructural works (construction of drains) and non-infrastructural work (DIA, review of National Development Strategy, finalisation of Wetland Bill, development of Land Drainage Master Plan, Disaster Risk Reduction in Development Process), there is a need to have an appropriate monitoring mechanism.

All stakeholders should be required to submit a plan of work with proper actions and targets to the NDRRMC. It should be broken down into manageable short term plan with appropriate timelines and deliverables, and any difficulties faced by the different stakeholders should be discussed in meetings of the National Council.

4.2.3 Studies and Surveys

The problems of flooding call for action, and the recommendations of studies and surveys to look into the issue of flooding should be considered for implementation.

The difficulties faced in the implementations of the DRR Report 2013 should be used as a lesson in developing future plan by relevant authorities, such as the LDA and the NDRRMC.

The LDA and the NDRRMC must ensure that the recommendations of their policies and plans are practicable before requiring implementation by the different players involved. This can be done by having consultations with various players, including the Consultants, before allocation of tasks and ensure responsibilities as per mandate, relevant expertise and availability of fund. As stated above, the plan should be broken down into manageable short term plan with appropriate timelines and deliverables, and it is important that it is endorsed by the different players. Once endorsed, the execution of the plan of work should be subject to supervision and monitoring by the NDRRMC.

4.2.4 Develop a Risk-Based and Proactive Approach

Once the scientific list of flood prone areas is completed, a risk-based approach should be adopted to achieve the best results possible using efficiently the resources available. An assessment of flood risk must be undertaken to understand which places are most at risk and in what circumstances, so that areas can be delineated as high, medium and low risk.

This risk-based approach will help in determining the area where infrastructural and non-infrastructural measures should be prioritised in a proactive manner.

4.2.5 Evaluation of Measures Taken

Evaluation of the results of infrastructural and non-infrastructural works must be undertaken to assess progress. To be able to evaluate the measures, stakeholders should develop overall and immediate outcomes target and indicators for those under their respective responsibilities.

4.2.6 Improved and Well Maintained Drains

In situation where resources are limited, a programme of work for the construction and maintenance based on a risk assessment of likelihood, and impacts of flood should be developed by each stakeholder, and adopting different return period of drains based on the risk assessment of the area should be considered.

4.2.7 Planned Development

Areas delineated as high risk flood prone should not be subject to development.

For those areas not delineated as high risk flood prone areas, development should be controlled by a proper planning to prevent and reduce the risk arising from new developments, and to ensure that development in one place does not cause problems in another. Thus, the incorporation of the DIA as part of the EIA should not be delayed given the urgent need of controlling the risk of flooding. Additionally, the Drain Impact Assessment Guideline should contain conditions that must be strictly followed.

For those morcellement projects not falling under the requirement of an EIA, the LDA, in collaboration with other stakeholders, should investigate on whether the possibility of flooding is real in that particular area. The promoter, though exempt from EIA, should then be required to submit a plan on how to reduce the likelihood of flood from surface water run-off as in Singapore where all new developments and re-developments of 0.2 hectares or more required the implementation of ‘source’ solutions to slow down storm water run-off entering the public drainage system.

4.2.8 Better Wetland Management

Wetlands and any other environmentally sensitive areas should be subject to close monitoring given that clearances are often given to development within or near wetlands. Ramsar Clearances should be closely monitored. This responsibility should be clearly determined and assigned to a Ministry/Department.

For both public and private wetlands found in areas which are critically prone to flood, after a thorough analysis on risk of flooding, Government should ensure that these are not subject to development.

Appendix

Vision and Mission of Stakeholders

1 Ministry of Social Security, National Solidarity and Environment and Sustainable Development

Vision

To achieve a 'cleaner, greener and safer Mauritius' in a sustainable manner, through protection and management of our environmental assets, mainstreaming sustainable development principles in different sectors of the economy, solid and hazardous waste management, enhanced resilience to disasters, and conservation and rehabilitation of beaches.

Mission

The Mission in connection with climate change and disaster risk reduction is as follows:

- To devise appropriate legal and policy framework regarding environment related issues, such as climate change, disaster risk reduction and beach management to effectively respond to emerging challenges;
- To incorporate climate change adaptation and mitigation measures to ensure sustainable development initiatives; and
- To ensure effective disaster preparedness and response to enhance the safety and security of the citizens.

2 National Development Unit

Vision

To have an informed society benefiting from efficient and continually upgraded infrastructures and Government programme.

Mission

To bring the benefits of socio-economic development to the doorstep of people and protect the population from flooding and natural disaster.

3 Ministry of Local Government and Outer Islands

The Ministry of Local Government and Outer Islands is responsible for local government matters in Mauritius. It has, amongst others, under its aegis the Local Authorities, the Mauritius Fire and Rescue Service, the Outer Islands Development Corporation and the Field Services Unit.

These Local Authorities aim at providing services and carry out infrastructural developments at regional level. These include the provision of street-lighting, construction and maintenance of roads, drains and public spaces, provision and maintenance of bus shelters and traffic centres, scavenging services, organisation of sports and cultural activities.

Vision

- To foster a vibrant local democracy; to promote effective, transparent and proactive delivery of services by Local Authorities and to bridge the development divide between rural and urban areas;
- To make the Republic of Mauritius a safe place to live in, work and visit anytime and anywhere free from the threats of fire and other calamities/emergencies; and
- To protect the ecosystem of the Outer Islands of Mauritius and improve the living conditions of the inhabitants of Agalega by providing basic infrastructure and social facilities to meet their needs.

Mission

- To ensure that Local Authorities adhere to the principles of good governance;
- To empower and provide appropriate support to Local Authorities so as to enable them to manage the affairs of the local communities effectively and efficiently;
- To engage all stakeholders in local community affairs;
- To protect and reduce losses of life and property and prevent damage to the environment due to fire and other threats; and
- To promote social, environment and human development in the Outer Islands.

Central Government grants are made available to the Local Authorities to enable them to provide services and amenities at regional level, including the provision of street-lighting, construction and maintenance of roads, drains and public spaces, provision and maintenance of bus shelters and traffic centres, organisation of sports and cultural activities, etc.

National Audit Office

Air Mauritius Centre, John Kennedy Street, Port Louis, Mauritius
Tel: (230) 212 2096 Fax: (230) 211 0880 Web: <http://nao.govmu.org>