

STATE OF THE ART DR3 IN MAURITIUS



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1.0 ABSTRACT

Mauritius being a developed island, situated in the Indian Ocean having a tropical climate, is often subjected to disasters, namely; Cyclones, flash floods, torrential rains, increase in temperature extreme during the summer period, mini tornadoes, storm surges, mini tornadoes, coastal erosion, coral bleaching and sealevel rise. The concerned authorities have been taking many measures, both mitigation and adaption, to address the impacts of climate change. For flood management, climate resilient flood measures are being constructed, drains with larger carrying capacity, flood walls along flood prone river banks, softer measures such as flood impact assessment for new development are required, social vulnerability mapping to floods has been mapped, zones with relative vulnerability to floods have been mapped and in many vulnerable areas, community engagement schemes have been set up. With regards to droughts, the general public is regularly being made aware of the need to use water in a more sustainable way, water harnessing and storage are being increased and rainwater harvesting encouraged for secondary uses. With regards to heat waves, this tend to occur during the summer periods and the Ministry of Health and Quality of Life provides much advice to the general public, in particular the vulnerable groups for them to keep safe during these days. A lot is being done to adapt to the growing impacts of climate change but much still remains to be done, specially with regards to reaching the most vulnerable groups of people who are at risk to disasters. So far, family support is the strongest support and next comes the first responders who have since long been going out of their way to help communities.

Much still remains to be done to fully appreciate the dynamic characteristics of the vulnerability of the communities to different types of disasters, as such an information is needed both for resource allocation and for strategies that will enhance community awareness and involvement, in order to build resilience to climate change impacts. The use of information technology in disaster risk reduction and resilience at community level has strong potential and is still not fully exploited. The NDRRMC has come up with several policies to enhance disaster risk reduction at national level, the most recent one being the launching of the National Disaster Risk Reduction and Management Policy, Strategic Framework and Action Plan 2020-2030. As per this national action plan, each concerned institution has defined an action plan to mainstream DRR at their level and each has also identified relevant indicators. The NDRRMC will be responsible to monitor the progress at national level.

2.0 INTRODUCTION

The Republic of Mauritius lies in the southern hemisphere of the Indian Ocean. It is a small tropical island of 1864 km² situated at Latitudes 20°20' South and Longitudes 57°30' East of Greenwich, and located off the east coast of the Republic of Malagasy (Figure 1). It consists of a main island, Mauritius, a smaller island Rodrigues and other small islets. The relief of the island is roughly a main hill with a central plateau (PMO, 2020). The climate is sub-tropical, in general it can be characterized as a pleasant mild maritime climate with average temperature over the island during summer is 24.7°C and 21.0°C during winter, normal annual rainfall of about 2010 mm and a mean annual duration of sunshine per day varying between 7 and 8 hours. Two seasons are observed

summer from November to April - warm and wet, and winter from May to October - cool and dry (Mauritius Meteorological Services, 2019).

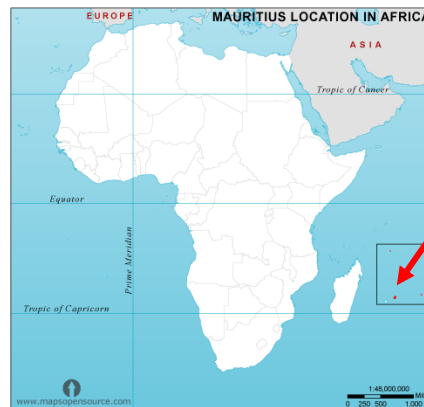


Figure 1: Location Map of Mauritius

Volcanic activities have carved the existence of water bodies such as reservoirs, rivers (streams), open valley, waterfalls and deep gorges. Many of these rivers (streams) enable the flow down of heavy rainfall towards an open sea. The shoreline of Mauritius is covered by sandy beaches and partly by cliffs; as such the lagoon is protected by a vast natural coral reef barrier (PMO, 2019).

For many years Mauritius has been exposed to tropical storms/ cyclones. However with the alarming effect of global warming the island is being hit recurrently by extreme weather events which are more intensive than ever experienced. Mauritius has had a history of natural disasters in form of cyclones. The country has experienced major natural calamities that result to major negative impacts on the livelihood of a common man (Desai, 2018, p. 4). In 1975, Mauritius experienced the “Gervaise”, “Holland” in 1994 and “Carol” in 1960s. All these cyclones resulted to major destructions in the nation (UNDP, 2019). On 30th March, 2013, the country experienced a massive flood in the capital that shook the population (Desai, 2019, p. 12). The country has geographical isolation, sensitive ecosystems and it’s susceptible to natural calamities. Mauritius experiences intensified climatic changes due to small land areas and anthropogenic pressure like pollution, deforestation, and over-harvesting. Additionally, the country struggle with fragile economies, high importation acts, and heavy dependence on external aids. There have been mitigations to assist the country overcome the climatic changes challenges such as development of Small Grants Programme (SGP).

The climatic changes are resulting to a number of superfluous conditions in the country. There has been an increment in the mean annual temperature. According to Desai (2018), it has been predicted that that by 2100, the country will experience an increase in heat level by 1.1 to 6.4 degree Celsius. This will depend on the trend of total annual rainfall and increase in the intense frequency of the rainfall episodes. The sea level is also predicted to rise from 18 to 59 cm by 2100. There is the danger of increasing the intensity of tropical cyclones (typhoons and hurricanes) could these predictions become a reality. It could also result to acidic oceans, heavy precipitation, and speedy wind. All these predictions were made by IPCC (Intergovernmental Panel on Climatic

Change) and were determined based on the already occurring cyclone evidence in the country (Desai, 2018, p. 4).



Figure 2: Major and deadly flood event in Mauritius (March, 2013)

In March 2013, 11 people were killed by flash floods in Port Louis. The passage of Tropical Cyclone Fantala, with 280 km/hr gusts, threatened the low-lying islands of Agalega and St Brandon. In March 2017, the passage of Tropical Cyclone Enawo at 250 km/hr gusts in the Southern Indian Ocean region posed a threat to the main island of Mauritius. More recently, in February 2019, Cyclone Gelena with 165 km/hr gusts crossed approximately 50 km southwest of Rodrigues Island leading to flash floods that caused the displacement of 259 people as well as damage to infrastructure, private residences and farms, and severely affected the electricity network. Mauritius' disaster risk profile by the Global Facility for Disaster Reduction and Recovery highlights that flooding is the second largest risk after cyclones, causing 20 per cent of the direct economic losses associated with disasters. Most of these costs arise from damage to people's homes. But climate change is not the only risk driver. Rapid urbanization on formerly agricultural land has strained the national drainage system and increased the occurrence of flash floods, destruction of housing, infrastructure and crops, and putting the population at risk of vector and water borne diseases.

The major hazards to which Mauritius is exposed are mostly climatic and geological as illustrated in the table 1.

Table1: Major hazards influencing Mauritius

Climate Related hazards	Geological Related hazards
Tropical Storms/Cyclones	Earthquake
Heavy Rainfall ; Flash Floods	Tsunamis
High waves	Coastal Erosion; Sea level rise
8Thunderstorm and Lightning	Landslide; Rock fall

Disasters such as such as increase in the level of the sea, in temperature , aggravated beach erosion, and increase in the occurrence of events such as flash floods normally affects SIDS but Mauritius is mostly affected by the following climate change related disaster:

Mauritius is exposed to a set of complex risks, particularly derived from climate change impacts (Figure 3). Another notably impact is the sea level rise and changes in wave patterns which have been constantly increasing costal erosion, an environmental impact in itself. This erosion also threatens numerous hotels and resorts that have built too close to the high water mark for today's expected climate change impacts.

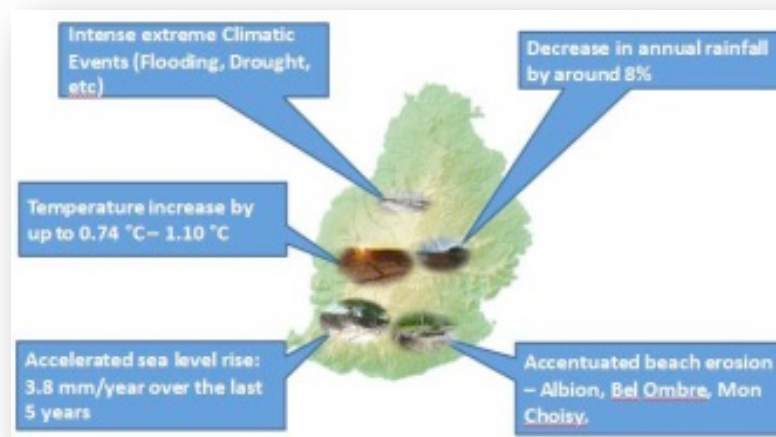


Figure 3: Climate Change Impact (Ministry of Environment,2015)

In addition, climate change impacts on the oceans, including water temperature increase, changed wave action, increased run-off, sedimentation, sea-level rise and coral bleaching are impacting coral reefs. These reefs are a major asset to Mauritius; an ecological attraction, a natural barrier from predators of the oceans and prevent coastal erosion. Marine Spatial Planning is an ocean management tool which is actually being implemented to cater for the different activities being carried out offshore in order to avoid conflict with each other in a sustainable approach (UNDESA, 2012).

Over the last decade, a series of disasters have occurred affecting different localities. Regions affected by flash floods are Port Louis, Camp Chapelon, Piton, Gokhoola, Fond du Sac, Flacq, Curepipe, Quatre Bornes, St Aubin, and Mahebourg. Landslide reoccurrence in Chitrakoot, Quatre Soeurs and La Butte, rock fall at Macondé, Baie du Cap (Mosaheb, 2015). Storm waves are more recurrent along the coastal zone of South, South-East and West regions of Mauritius this is due to reefs close to the coastline (L'Express, 2014).

2.1 VULNERABILITY OF THE REPUBLIC OF MAURITIUS TO CLIMATE CHANGE IMPACTS

The Intergovernmental Panel on Climate Change (IPCC) has predicted, in its 4th Assessment Report, that global warming is bound to impact SIDS. In Mauritius, the impacts of global warming are already being observed with accelerating sea level rise, beach erosion and the increase in the frequency and intensity of extreme climatic events, such as floods and droughts. Climate change is indeed a serious threat to our hard-won development.

According to the Mauritius Meteorological Services, some observed impacts of climate change are:

- From 1998 to 2007, the local mean sea level rose by 2.1mm per year.
- Over the past five years, the sea level has been rising by around 3.8 mm/year.
- There is a decreasing trend in annual rainfall of around 8% over Mauritius since the 1950s.
- The average temperature has risen by 0.74^o Celsius since 1990.
- The yearly amount of hot days and warm nights are increasing There were death casualties due to the Flash floods in 2008 and 2013.
- Mauritius experienced its worst dry period in 1999 and 2011.
- The frequency of extreme climatic events, torrential rains and storms is increasing.

In an endeavor to adapt to the climate changes and to enhance the country towards resilience in Mauritius, the Government has set up in March 2010 a Climate Change Division which has authority for the development, coordination and implementation of climate change adaptation and mitigation policies, programs and initiatives. Table 2 clearly shows the difference in the indicators for a period of ten years. It can be observed that (i) there is a decrease in the mean of rainfall (ii) an increase in sea surface temperature and (iii) a significant increase in the emission of greenhouse gas.

As an evidence to the above the World Risk Report 2018 (Figure 4) published by the United Nations University, Mauritius is positioned 16th in the list of countries ranked by disaster risk and as the 7th most exposed to hazards impacts, with particularly high levels of vulnerability and particularly low levels of coping and adaptive capacity (World Risk Report, 2018). The World Risk Report 2019 now ranks Mauritius 47th in the list of countries with the highest risk index and 27th in the most vulnerable countries of the world.

Table 2: Climate Indicators in Mauritius

Year	Mean Rainfall	Total GHG emissions (Gg or '000 tons CO ₂ eq)	Mean Sea Surface Temperature
2004	2271	3844.5	25.8
2005	2374	4024.8	25.8
2006	1936	4428.6	25.9
2007	1954	4600.2	25.7
2008	2381	4611.4	25.8
2009	2390	4124.9	25.8
2010	1806	4835.87	26.6
2011	1945	4784.26	26.7
2012	1609	4834	26.4
2013	2050	5010	26.2

WorldRiskIndex 2018 Overview

Classification	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
very low	0.36 - 3.15	1.02 - 9.53	20.97 - 32.01	8.26 - 17.05	35.36 - 53.90	13.33 - 23.60
low	3.16 - 5.45	9.54 - 11.70	32.02 - 40.77	17.06 - 20.81	53.91 - 67.73	23.61 - 33.84
medium	5.46 - 7.13	11.71 - 14.50	40.78 - 48.60	20.82 - 28.80	67.74 - 76.73	33.85 - 41.82
high	7.14 - 10.43	14.51 - 17.73	48.61 - 63.00	28.81 - 46.48	76.74 - 84.10	41.83 - 54.77
very high	10.44 - 50.28	17.74 - 86.46	63.01 - 76.47	46.49 - 70.00	84.10 - 92.28	54.78 - 72.52

Risk > 100%, Classification according to the quintile method.

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
1.	Vanuatu	50.28	86.46	58.75	36.07	84.27	52.80
2.	Tonga	29.42	35.82	52.61	28.93	80.04	48.82
3.	Philippines	25.94	49.94	50.33	29.58	81.52	39.83
4.	Solomon Islands	23.29	37.00	61.59	47.28	82.30	39.11
5.	Guyana	23.25	40.54	58.98	27.33	77.36	48.25
6.	Papua New Guinea	20.68	37.88	40.28	36.58	83.80	54.86
7.	Guatemala	20.48	38.36	53.58	33.98	83.35	46.52
8.	Brunei Darussalam	18.82	52.78	35.71	34.90	47.50	30.83
9.	Bangladesh	17.38	29.94	58.03	33.72	84.94	36.42
10.	Fiji	16.58	30.55	46.68	22.33	75.48	42.24
11.	Costa Rica	16.54	44.23	37.41	20.42	62.98	29.63
12.	Cambodia	16.07	23.13	50.23	40.97	84.03	50.62
13.	Timor-Leste	16.05	26.96	58.56	45.22	78.69	54.76
14.	El Salvador	15.95	33.46	47.65	25.63	75.86	41.46
15.	Kiribati	15.40	26.37	58.67	45.64	82.63	51.35
16.	Mozambique	14.20	30.00	38.35	17.69	59.26	38.89
17.	Nicaragua	13.89	26.27	53.25	31.45	80.21	40.11

Figure 4: World Risk Index 2018

3.0 LEGISLATION, GOVERNANCE AND FUNDING MECHANISMS

In August 2013, the National Disaster Risk Reduction and Management Centre (NDRRMC) was set up. It is an operational and correlating corporate for implementation of DRR and DRM policies such as development for disaster resilience is possible in Mauritius. This body ensures guides response to disasters and ascertains that risk-informed development plans are available.

The National Emergency Operations Command (NEOC), another key body, was established within NDRRMC is activated whenever a disaster or any other major crisis becomes imminent. It is the main coordinating body during the preparedness, response and recovery phases of any disaster. At the level of Local Authority, a Local Emergency Operations Command (LEOC) has also been established. Both the NEOC and LEOC base their actions on the National Disasters Scheme (NDS) which also defines the roles of all stakeholders involved in the operations(Figure 5).

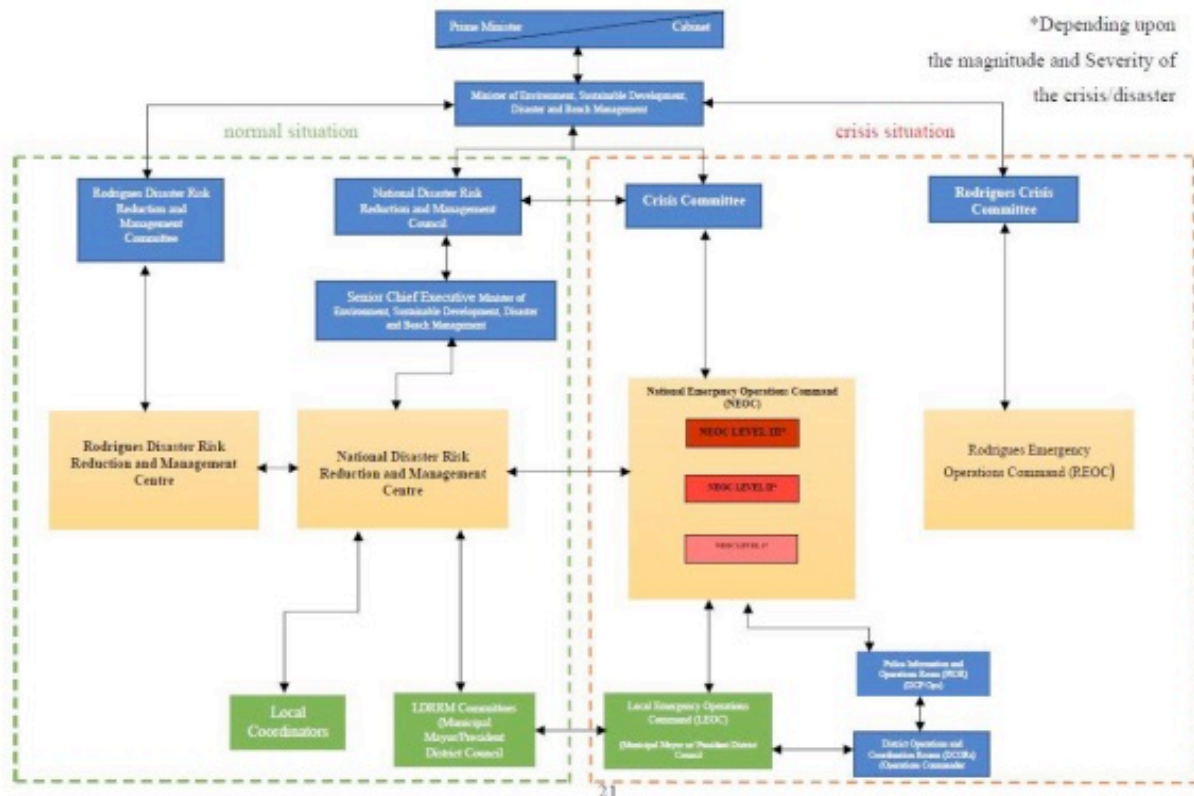


Figure 5: Stakeholders' Involvement during a Disaster

In the year of 2015, Mauritius has developed the National Disaster Scheme to further improve disaster risk reduction and management. The National Disasters Outline (NDS) have principally been used as the main source of information for institutions and individuals preparing and reacting to known threats (NDS, 2015). The use of NDS in crisis situations as well as in simulated catastrophe, information and documents are always accessible and user-friendly (NDS, 2015). This program covers the whole spectrum of disaster management cycle and includes information about all the Ministries concerned with particular events. The key stakeholders in Mauritius's DRR committee are listed in the National Disaster Scheme 2015 and National Disaster Risk Reduction and Management Act of 2016.

The accepted DRR framework in Mauritius is the "National Disaster Risk Reduction and Management Act 2016" (No. 2 of 2016); it includes provisions for a National Disasters Scheme, the Flood Response Plan for Port Louis, and the development of a national strategy including enhanced early warning and emergency systems (UNISDR, 2017).

In order to make the country resilient to the impacts of extreme events and climate change, the Disaster Risk Reduction and Management (NDRRM) Act 2016 and the National Disaster Scheme (NDS) 2015 Edition, the two important legislations which has been recently adopted by the Government of Mauritius for the management of disaster is being enforced. The NDRRM is a comprehensive legislative framework that focuses on various issues in disaster risk reduction and

provides a well-organized structure, authority, line of reporting and advice, and a properly defined scope of work for effective response and humanitarian aid.

The NEOC is the emergency cell that is activated whenever a disaster crisis is striking the island. Its major task is to coordinate activities using the Police Command, control and communication system. Hitherto the main issue with this policy, it is more orientated towards response activities and planning, thus compromising on the mitigation and recovery factor as laid down in the Sendai framework.

On the other hand the NDS contains a comprehensive list of agencies that accentuates the roles and responsibilities in disaster preparedness and response with a series of protocols to be followed in the event of a disaster. The NDS has under its purview a wide range of schemes for DRR arrangement for various hazards. These are Cyclone Emergency Response; Tsunami Emergency Response; Water Crisis Emergency Scheme; Landslide Emergency Scheme; Heavy Rainfall, Torrential Rain and Flooding; High Waves Emergency Scheme; Earthquake Emergency Scheme and Port Louis Flood Response Plan. The major issue of this policy is that it does not have a proper organizational process and there are inter-agency constraints as in the event of different disaster occurrence with duplication in the arrangements which causes chaos all around the island.

In addition to disaster response management, disaster risk reduction and risk management into a broader context of resilience whereby a system that allows a community exposed to the different hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard, in line with climate change adaptation, is being given due consideration. Resilience in its global state of art includes several elements such as self-reliance, effective upwards and downwards communication, local resourcing, local understanding of risk, effective training and resourcing of local government. Mauritius is working towards the implementation of this broader approach and to align DRR more closely with climate change adaptation, social and economic development. Resilience programmes must be explicitly emphasized and as such develop strategies and advising on coordination of mitigation policies and programmes.

As an aid to the implementation of DRR policies, support documents are available at national level. In 2013, various risk assessments were carried out for regions affected by landslides, flooding and coastal inundation which was undertaken by JICA a Japanese agency expert in DRR. National Risk Profiles (Risks and Hazards Maps), Strategy Framework and Action Plan for disaster risk management have been developed.

There is currently an ongoing flood risk map and a master plan being prepared under the Land Drainage Authority (LDA) in collaboration with different stakeholders.

3.1 Floods

Flood Management in Mauritius involves several organisations and flood related events come from cyclones, torrential rainfall, flood rainfall, heavy rainfall or storm surge along the coastlines.

The Mauritius Meteorological Services (MMS) is the organisation which provides climatic information to the general public. The MSS provides information about rainfall intensity and if there is the potential of flood this information is communicated to the general public by the NDRRMC. Depending on the severity of the problem, the NEOC (for Mauritius) and the REOC (Rodrigues) are activated, should both Mauritius and Rodrigues be concerned.

In order to ensure that flood related events do not cause much harm, a number of activities have been put in place. At the level of the Local Government, the District Councils and the Municipal Councils monitor the drainage network, to ensure that the existing drains are well maintained. The Land Drainage Authority (LDA), an institution, recently set up, nowadays are involved at the proposal stage of major developments. Clients are expected to conduct Flood Impact Assessments to ensure that the new development plans have very minor to no impacts of floods downstream of the project, subject to which the client will be given the development permit.

Seventy percent (70%) of natural disasters each year is related to flooding caused by heavy or torrential rains. The most traumatizing flood event that occurred was on the among the 30th of March 2013 where 11 people died. Damages to buildings and infrastructures worth \$ 2billion was estimated by the DRR Report 2013.

3.2 Heatwaves

Heat waves are not so common in Mauritius, though the temperature can go above the long term average during the summer period. Whenever this happens, the MMS inform the general public and the Ministry of Health and Quality of Life advises the general public on the precautions to be taken during such periods, in terms of types of clothes to be worn, advise on drinking water to keep hydrated and to stay in shaded areas, and avoid the bright sunlight.

Each decade, a temperature rise of about .015 degree has been noticed when compared to the long term mean (LTM). December 2019 has been the warmest year on record since 1960 and average temperature over the island exceeded the LTM 1981-2010 normal by 1.5 °C. (MMS, 2020).

3.3 Droughts

Mauritius experienced its worst drought in 1999 and 2011. In 1998, Mauritius experienced a severe dry spell which was characterized by a high deficit in rainfall from July 1998 up to May 1999 provoking serious drought conditions in the country and affecting all sectors in the island. (A. Saiboo, 2009). In 2011, severe scheme of water rationing was unavoidable as all reservoirs and underground water reserves were drying up fast due to the terrible situation brought about by drought as the rainfall activity from May to August was very low. (245mm compared to the 515mm average for the same period). However, in Mauritius, we experience long dry periods at times, and if this long dry period extends above one year, then it becomes difficult to keep the normal activities. The MMS keeps a record of monthly rainfall and compares this with long term average on a regular basis, hence the coming of a dry period is noted through this practice.

With regards to the remedial actions, the local water authorities manage the water resources to ensure that water is available for the basic needs. The Water Resources Unit monitors the water resources, both surface water flows and groundwater levels. This institution is also in charge of the development of the water resources of the country and this concerns the exploitation of both surface and groundwater resources. So if the dry period go longer, then deep boreholes are set, water rationing is conducted and legislation are set up which prevent people from utilizing treated potable water for secondary uses. The Central Water Authority which is the institution responsible for the distribution of potable water, control the provision of water, by providing water for a given period during the day. The CWA also send water advisories to the general public to create awareness on then need to use water wisely.

3.4 Others

Mauritius is subject to many other types of climate change impacts:

Tropical Cyclones

Though we have been spared by a direct hit from cyclones recently, the Mauritius Meteorological Services states that the number of storms reaching cyclone strength have increased since the last 32 years. Any direct hit will invariably cause flooding in these flood prone areas. Tropical Cyclones are the most recurrent hazard that Mauritius experience yearly. Tropical cyclones: including storms and hurricanes bring along high gusts, abundance of rain consequently disrupting inhabitants' infrastructure in Mauritius. Warm-hearted atmosphere in the tropical oceans encourage the development of cyclones. Knowledge of how and why those occur are of much interests to scientists and allow understanding of the evolution of cyclones with respect to frequency and intensity. The number of depression or tropical cyclones; with the annual average of 10 and these developing into full gusted cyclones are shown in the graph below in the Indian Ocean (Rughooputh, 2013). Figure below also illustrates cyclones are more common in the months of January and February in the Indian Ocean/

Gusts and torrential rain generated by tropical cyclones can cause floods, storm surges and even landslides. Road and communication networks, agriculture, infrastructure and building are affected. As a consequence, injurious sanitary issue, social and economic imbalances arises. But having dealt with this hazard very often, the community at large is prepared to face it both in terms of infrastructure and capacity to cope with it. Nonetheless, it still remains that the island will still remain exposed to this kind of hazard and their frequency keeps on increasing.

Heavy Rain / Torrential Rain

In 2016, 9 locations in Mauritius received more than 100mm in 12 hours. 300 people were displaced. Many infrastructures and property were damaged. The capital city and its neighboring areas were severely touched. Government institutions as well as some private ones had to close their businesses and staffs and student had to be sent home. Cases of landslide and blocked road were reported.

Sea level Rise

A noticeable increase in the level of the sea has been noted from 1950 to 2001. The rise was by 7.8 cm in Mauritius and 6.7 cm in Rodrigues (MMS, 2014). Loss of beaches of approximately 20m, loss of bays and serious harms to built-up areas around the coast were observed as a result of beach erosion.

Storm Surges

Most particularly, storm surges occur during summer, i.e., during the cyclonic periods. The primary causal factor of storm surge is the strong winds in a storm/cyclone. Storm surges are likely to increase the risk of flooding and landslides in coastal regions.

Landslides

The rate of settlement beyond high risk zone on the sloppy sections of mountains have increased the vulnerability of the inhabitants to landslide hazard. An example is what happened in 1987 along the 30° - 35° slopes of the Signal Mountain at La Butte. (L'Express)

3.5 Resource distribution

All public organisations keep a budget for contingencies and when a disaster strikes each organisation pulls funds from this fund to cater for damage and rehabilitation needs. The Ministry of Social Security and National Solidarity provides financial support to all those who have been directly affected by natural disasters, to meet basic needs only.

3.6 Strengths and Weaknesses

Mauritius has adapted different systems to assist with disaster risk reduction and resilience. However, these frameworks are not adequate and lack the capacity to effectively eradicate the disasters and the impacts they have in the community (United States Framework Convention of Climatic Change, 2015). The following are measures at national level that could help to decrease the vulnerability of Mauritius to climate related disasters such as heat waves, droughts, and flood:

The national platform for DRR should be implemented to assist in coordination of risks prevention, emergency response and recovery, and preparedness. The national government should come up with a strategy to form different response groups in the prone areas (Desai, 2019). These groups will be equipped with skills to handle a disaster and reduce the impacts to human lives (United States Framework Convention of Climatic Change, 2015). If the nation experiences droughts due to climatic changes, the national platform groups should represent the affected members of the society at national level to provide reliefs (UNDP, 2014).

The government should invest in providing civic education to the society on the importance of embracing risks as a culture and ensure that all the hazards and their impacts are fully understood. The measure will help to ensure that the citizens work in collaboration with the government to

assist in risks reduction (United States Framework Convention of Climatic Change, 2015). The communities will also help one another to reduce trauma and resilience to the survivors as a result of droughts, flood, and waves (French Development Agency, 2018).

Creating awareness to people will also induce thorough preparation and ensure that people stay alert. For example, in the communities prone to flood, people will make dredges and terraces to reduce soil erosion and impacts of floods. The emergency response departments should be further developed to make sure that there is seamless coordination during the disaster strikes (Oxfam, 2019). Early signs systems for cyclones and tsunami should be used to cover other hazards like the droughts and floods. The response departments should also set programmes and policies to coordinate in disaster risks reduction and resilience before, during, and after the disaster.

The following gaps have been noted:

- Rescue drills require to be increased and should be good publicity (broadcasted on number of times)
- Not enough emphasis is laid on the “Build Back Better”
- Fire Services to proactively enlist the services of local volunteers whom they can train so that they may assist them in times of need
- At least 37 sites have been found to be prone to landslide and their monitoring devolves on the technicians of MPI which is unrealistic because of limited staff, thus here also delegation is necessitated
- The different alert system in place are not fully understood by the general public and they need to be sensitized on these and also to be inculcated about the predictive nature of information
- Encouraging community involvement for provision of foods to persons evacuated to emergency shelters
- Aggressive awareness program is required on the effects of climate change and on the hazards existing in the community
- Psychological support as well as financial schemes should also be made available to affected communities

4.0 POLICY MEASURES FOR DR3 DECISION MAKING IN MAURITIUS

The NDRRMC promotes the concepts of Disaster Risk Reduction and Resilience at national level. Training workshops are regularly organised in this area and a DRR Strategy and Action Plan is currently under development and this will engage the public institutions in adopting the concepts of DRR. Several training workshops have been organised in this context and each organisation has already identified its key indicators that will help monitor the progress while mainstreaming concepts of DRR at their level.

4.1 Disasters Management

Protocols for disaster management has already been finalized with relevant concerned public and private institutions and each institution is fully aware of the procedure to be adopted during a

disaster, with regards to the safety of its people, its infrastructures and with regards to regularly communication of the event to all those concerned at their level.

4.2 Mitigation

There are several schemes which fall under mitigation to climate change impacts. In the DRR sector, the local Government is the organisation, under which the District Councils and the Municipal Councils fall. They have set up a number of measures such as:

1. Ensuring proper maintenance of drains
2. Setting up of a database of flood prone areas
3. Setting up of a database of high vulnerable groups within their management boundaries
4. Regular meetings with the communities to create awareness specially during the wet period, where the risk of flood events are high.

The second institutions which is fully engaged in mitigation is the Land Drainage Authority. They overlook proposed developments and ensure that these do not add to the vulnerability of low lying downstream areas to flood problems.

4.3 Response

The response to disaster events is well managed by organisations which fall under the group of first responders, and this includes the Police Force, the Mauritius Fire Services, the Mauritius Red Cross Society, and the emergency department of the Health Sector amongst others.

4.4 Stakeholder Engagement

The main normative institution responsible to promote disaster risk reduction and to coordinate disasters during crisis, is the National Disaster Risk Reduction and Management Council. This Council is represented by top officials of all the Governmental Bodies and key Parastatal bodies as indicated in the National Disaster Risk Reduction and Management Act 2016. Some of the prime institutions represented at the council are: the Meteorological Services, the Police Department, the Mauritius Ports Authority, the Mauritius Red Cross Society, the Fire and Rescue Services Department and the Ministries concerned with Infrastructures, Utilities, Agriculture, amongst others.

The objects of the National Council are to –

- (a) promote a culture of safety and resilience to disasters, through the use of knowledge, innovation and education;
- (b) promote and strengthen scientific research and technical capacity in multi-hazard risk assessments and disaster risk reduction and management; and

- (c) promote the implementation of the obligations of Mauritius under disaster management treaties to which Mauritius is a party.

Operating directly under the National Disaster Risk Reduction Council, is the National Disaster Risk Reduction and Management Centre (NDRRMC). As per the National Disaster Risk Reduction and Management Act 2016, this Centre is the main institution in Mauritius for coordinating and monitoring the implementation of disaster risk reduction and management activities as per the National Strategic Framework and National Plan. The NDRRMC is to overlook all issues related to disaster risk reduction and management at national level and work in close collaboration with all relevant organisations to develop the knowledge and capacity needed for building disaster readiness.

In addition to the NDRRMC, the next most important organisation is the Mauritius Meteorological Services (MMS). The vision of the MSS is to support the country and build a weather resilient and climate smart nation. The MMS is the official organisation mandated to issue climate related warnings, for cyclones, droughts, torrential rains, flood rainfall events, heavy swells, storm surges and tsunamis. They work closely with NDRRMC to during disaster events.

The third organisation which is also important during crisis situation is the Mauritius Red Cross Society. The Mauritius Red Cross Society (MRCS) is a member of the Prime Minister's 'National Disaster and Other Calamities Committee' (NDOCC). It has 6 branch disaster response teams (BDRT), and a national team (NDRT). The National Society regularly participates in simulations organised in coordination with the local authorities. Four team members are also RDRT-trained to intervene throughout the Indian Ocean region.

The fourth organisation is the media in particular the Mauritius Broadcasting Corporation (MBC TV). The media plays a very important role during natural calamities, working in close collaboration with the NDRRMC, the MMS, and the Police Force in order to inform the general public about the evolution and impacts of the calamities in the country.

In addition, organisations such as the Central Water Authority, the Central Electricity Board, the Wastewater Management Authority, FAREI, all the Government Bodies (the Ministries) are involved through the collaboration with the NDRRMC, in promoting DRR at the level of their own organisations and some in supporting the Ministry of Local Government to manage climate related crisis situation in the country.

With regards to equity, firstly the whole population is informed about crisis situations via MMS through the media, and also via a multi hazards early warning systems through the NDRRMC. The Mauritius Telecoms Services have set up a weather application to add to the communication mechanism. In addition, the local police branch work with the local communities to create awareness, to carry out simulations and to keep them informed of any crisis situation.

STAKEHOLDERS' ENGAGEMENT

In order to ensure strong stakeholders' engagement in this study we have already officially got permission from the Ministry of Local Government and Disaster Management to work with the NDRRMC. The NDRRMC in turn works with all concerned institutions which are directly involved with ensuring effective disaster management during crisis situations and in promoting Disaster Risk Reduction at the level of their institutions.

The planning is as follows:

- (a) Conducting face to face meetings to complete formal surveys (questionnaires) with institutions directly linked to climate related disasters: NDRRMC, MMS, Mauritius Red Cross Society, Mauritius Police Force, and the Ministry of Local Government (Municipalities and District Councils)
- (b) New stakeholders will be identified following this first set of meetings.
- (c) We plan to conduct online surveys with staff and students from the University of Mauritius, and other local universities (both Government and Private) – to capture on the status of DRR in Mauritius and the way forward, the perception of those who have reached up to tertiary education level.
- (d) Workshops with Disaster Officers working at the various District Councils and Municipalities to discuss DRR issues and to test proposed measures – to discuss in depth DRR issues and to identify new indicators, mostly as you have highlighted additional social indicators.
- (e) The balance score card for testing the proposed indicators during the workshops.
- (f) Following a first set of online survey and the workshops, we plan to conduct additional online surveys using the Delphi Survey Method in order to come to an agreement on the gaps and the proposals for social indicators.
- (g) The multi actor and criteria multi can be investigated as the project shapes up but we ourselves will need additional training.

LIST OF STAKEHOLDERS

The following is a list of the stakeholders whom we plan to contact in the first stage of the study. We plan to start with all those who are directly involved with disaster management first:

- Ministry of Local Government and Disaster Risk Management
- District Councils (6)
- Municipal Councils (4)
- Mauritius Red Cross Society
- Mauritius Meteorological Services
- Central Statistical office
- Mauritius Police Service
- Ministry of Environment, Solid Waste Management and Climate Change
- Ministry of Energy and Public Utilities
- The Central Water Authority

- The Central Electricity Board
- Ministry of Housing and Land Use Planning
- Ministry of Rodrigues, Outer Islands and Territorial Integrity
- Ministry of Land Transport and Light Rail
- Ministry of Education, Tertiary Education, Science and Technology
- Ministry of Tourism
- Ministry of Financial Services and Good Governance
- Ministry of Health and Wellness

4.5 Budget allocation

As discussed earlier, each organisation has a budget line to manage during crisis situation, other than the budget allocated for mitigation measures, such as construction of drains with regards to floods, or investment in major water resource projects such as dams and deep boreholes, or concrete drains to reduce losses during conveyance from one reservoir to another.

4.6 Evidence for Effectiveness of Interventions

Interventions are often in the form of:

1. Removal of obstacles blocking flow of traffic along roads – similar obstacles are common during cyclonic events.
2. Helping to move vulnerable people to shelters.
3. Helping to remove water accumulated in houses during flood events.
4. Provision of water during drought events.
5. Management of fires in sugar cane fields.
6. Restoring of services – water, telecommunications, electricity and wastewater networks.

Evidence for similar interventions are reported via media coverage during documentation of the damages incurred during events. The reports prepared following interventions are often at the level of the institutions concerned.

4.7 Strengths and weaknesses

There is a lot of work being done at the level of institutions with regards to Disaster Risk Reduction, specially since the creation of the NDRRMC. Mainstreaming DRR at level of individual institutions will be coming up with the finalization of the DRR Strategy and Action Plan.

The weaknesses is that the process of design of infrastructures is still be undertaken in the same way as it used to in the past. The new approach to building resilient infrastructures is yet to be developed and adopted, through design guidelines and regulations.

4.8 Key Performance Indicators

At national level, the Statistics of Mauritius (Figure 6) undertakes census surveys every 10 years, the most recently one is the 2011 survey. The indicators that are included in this survey are as illustrated: Housing and Living Conditions; Demographic & Fertility Characteristics; Educational Characteristics; Disability Characteristics; and Household Characteristics. A number of indicators are collected under each of these groups.

Given the data available, we plan under a research study to conduct a statistical multivariate analysis to identify the indicators that are stronger in the local context. However, under the Sendai Framework, Mauritius also abides to the annual data collection based on indicators identified under the Sendai Framework. There is a strong tendency for Mauritius to report as per these particular indicators.

Volume I - Housing & Living Condition	PDF Report	Excel Tables
Volume II- Demographic & Fertility Characteristics	PDF Report	Excel Tables
Volume III - Educational Characteristics	PDF Report	Excel Tables
Volume IV - Disability Characteristics	PDF Report	Excel Tables
Volume V - Economic Characteristics	PDF Report	Excel Tables
Volume VI - Geographical and Migration	PDF Report	Excel Tables
Volume VII - Household Characteristics	PDF Report	Excel Tables

Figure 6: Data Collected by Statistics Mauritius at National level

Some of the indicators are:

1. No of people living in a housing unit (house/apartment)
2. Size of households and age group of people living in the same housing unit
3. Households with extended family and with nuclear family
4. No. of households having access to piped water supply.
5. No. of households having access to clean and safe sanitary facilities
6. No. of households having access to electrical supply
7. No. of people having a mean of communication; TV, Radio, Fixed phone or Mobile phone
8. No. of elderly people getting support from the surrounding community
9. No. of elderly people getting support from health care
10. No. of elderly people getting support from the National Security Council

Thus, Mauritius works with the UNDRR to implement the Sendai Framework, and follow the Sendai online reporting platform, the desinventar website to keep records of data during crisis situation. Concerned institutions provide information as per the template of the desinventar website and this is checked and uploaded on the desinventar website on an annual basis.

4.9 Data for Disaster Occurrence and Disaster Financing in Mauritius

The information about disaster occurrence is published in the UNDRR website Desinventar (Figure 7), and Mauritius regularly reports to this organisation.

DesInventar for Flash Floods in Mauritius

Islands	Code	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Directly affected	Indirectly Affected	Relocated	Evacuated	Losses \$USD	Losses \$Local	Education centers
MAURITIUS	571.0	28		2	8	1637	11	15478		6		1035850350	
TOTAL		571	28		2	8	1637	11	15478		6		1035850350

Figure 7: Flash Floods data for Mauritius from desinventar UNDRR website

An analysis of the Flood Risk Profile by the GFDRR World Bank Institute in 2016 noted that on average, Mauritius experiences over US\$110 million in combined direct losses from earthquakes, floods, and tropical cyclones each year. However, a specific event such as a severe tropical cyclone could produce significantly larger losses. For example, results suggested that a 100-year return period tropical cyclone event could produce direct losses of \$1.9 billion and require approximately \$430 million in emergency costs. Cyclones are the natural disasters which used to account for 80% of the disaster related economic losses. Nowadays, as at 2021, flood related events, such as flash floods or torrential rains, are also inducing significant economic losses, for those households living in flood prone areas.

4.10 Disaster Occurrence Data

As mentioned, published information about disaster occurrence can be noted from the UNDRR website. The Land Drainage Master Plan is being finalized currently and will include more detailed information about flood prone areas, with varying levels of vulnerability.

4.11 Data for Mapping Vulnerability

At the level of the Land Drainage Authority, a vulnerability map with respect to floods has been developed. A social vulnerability map to floods has been prepared by a team of researchers at the University of Mauritius, under a SADC funded project and this report is currently under review and will be published in the coming months.

Data for the development of the social vulnerability map to flood was taken from the published information by Statistics Mauritius as well as the flood vulnerability map produced by the Land Drainage Authority.

5.0 VULNERABILITY INDICATORS CONSIDERED IN MAURITIUS

5.1 Vulnerability data collected

Data at national level, census data, is collected by Statistics Mauritius. Here, we have data group at ward level and for census 2011, the latest published census data, there are 144 wards. For each ward much information is collected, and from these set of data, the vulnerability indicators can be constructed.

In addition there data which reflect the physical system, such as the variation in topography, the spread of residential building in flood prone area, the types of infrastructures in flood prone areas, or the types of support services in such area.

The NDRRMC has a sound database of such information, but these data are not published. The data can however be generated in detail for critical study areas. In Mauritius there are around 30 highly vulnerability flood prone areas, some falling under the category of residential zones located in flat plains at the foot of mountains, residential zones located in low lying areas and some mixed use, residential and commercial.

5.2 Overview of Vulnerability to Disasters

By its nature, a small isolated island located in the Indian ocean, the Republic of Mauritius, is highly vulnerable to natural hazards; sea level rise, warming of the ocean accompanies by coral bleaching, storm surges from the sea affecting the coastal areas, beach erosion, flash flood rainfall affecting developments in flat coastal plains, droughts affecting the whole island, earthquakes, tsunamis and mini tornadoes.

The level of vulnerability for each natural hazards vary, some affected selected areas, some affecting the whole island. The level of vulnerability also changes as more resilience measures are being implemented over time.

However, not enough studies have been undertaken to map vulnerability to disasters and there are not enough publications in this area. Understanding how the social conditions interact with the physical environment at different scales, need to be studied if we are to come up with climate resilience measures that will fully engage the communities taking into consideration their own social vulnerability levels. Often, the most vulnerable groups living in relatively weaker conditions, are the ones who suffer more economic losses. Though there is still a strong social support to help vulnerable people during climate related disasters, much still needs to be done to understand the dynamism of the situation.

5.3 Identification of Vulnerable Communities

Leaving no one behind, has been the priority of those managing disasters in Mauritius. All the local government organisations have a sound database of the vulnerable groups of people in their locality, and during disaster events, these areas are adequately monitored by the first responders.

However, such data are available at institutions level and may not be readily available for research studies. Part of the data can be made available subject to strong justifications, or the data needs to be generated through field surveys. People are most of the time willing to provide information, but given that authorities collect such information, field surveys are considered as duplications and this discourage the community from actively participating.

So for selected study area, local authorities concerned can be contacted for information.

5.4 Comparison to international guidelines

In Mauritius, much help is obtained from UNDRR and given that the area of DRR is relatively new, this organisation provides much support and guidance on the way forward. Mauritius reports to the UNDRR through the Desinventar website, and data collected helps international support organisation gauge the vulnerability as well as the progress of the country towards mainstreaming DRR in national policies and strategies.

5.5 Equitable Resource allocation

Resource allocation during disasters are at the level of institutions and concerned Ministries. In addition Mauritius social support schemes address the needs of the vulnerable groups directly mostly on a one to one basis. Family is still considered as the most important support during difficult situations, on which vulnerable groups rely. However with time the family size is reducing and the support that families were able to provide to the vulnerable people is being challenged.

There is still a need to study and understand how this situation is changing over time.

5.6 Financing and Equity

Financing of major infrastructure climate resilient projects is addressed at national level, be it directly from the Government's budget or from loans obtained from major financing institutions.

At the level of the local government, strategies and actions are put in place to consolidate resilience of vulnerable areas, within the allocated budget available. Local government work closely with the community groups to get the involvement of communities in several climate resilience activities.

However, financial support addressed directly to the most vulnerable groups is yet to be fully studied and addressed by concerned authorities.

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ANNEX 2

SITES WHERE FLOOD, DROUGHT AND HEAT WAVES HAVE HAD IMPACTS

