Terms of Reference for the Study on the Vulnerability of the Republic of Mauritius to Seismic Hazards and Tsunami

OBJECTIVE

To carry out a study on the vulnerability of the Republic of Mauritius to Seismic Hazards and Tsunami.

BACKGROUND

1.1. Earthquakes

Earthquakes are common in the South-West Indian Ocean (SWIO) region, but the major seismic sources are far from Mauritius. The two major sources of seismic activity in the SWIO region are the Central-Indian Ridge (CIR) and the East-African Rift system, located along East Africa. Earthquakes in these regions are frequent but usually of low to moderate magnitude (World Bank Group, GFDRR, 2016). The newly collected seismic data from Mauritius and Rodrigues have shown low magnitude seismic activities around the islands. Figures 1 and 2 show earthquakes recorded by temporary networks on Mauritius and Rodrigues. These earthquakes were not reported by any global network. Long-term seismological data for the Republic of Mauritius are required.

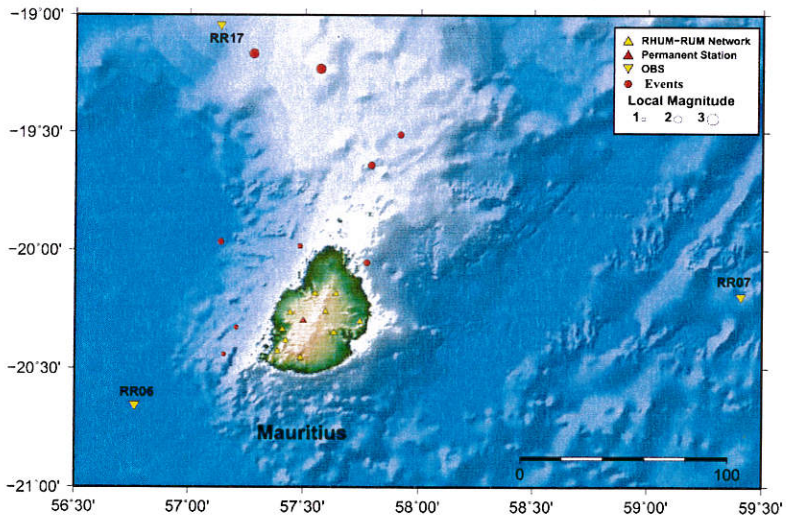

Figure 1. Earthquake locations (red circles) for the events around Mauritius, between 2012 and 2014, not detected by any global network. The yellow triangle and the inverted yellow triangle represents the location of land stations (duration 2012–2014) and OBS (duration 2012–2013) deployed under the RHUM–RUM project, respectively. The red triangle denotes the permanent station MRIV. The magnitude of the events ranged between 1.2 and 2.5 as shown by the size of the circles.*(Source: MOI)*

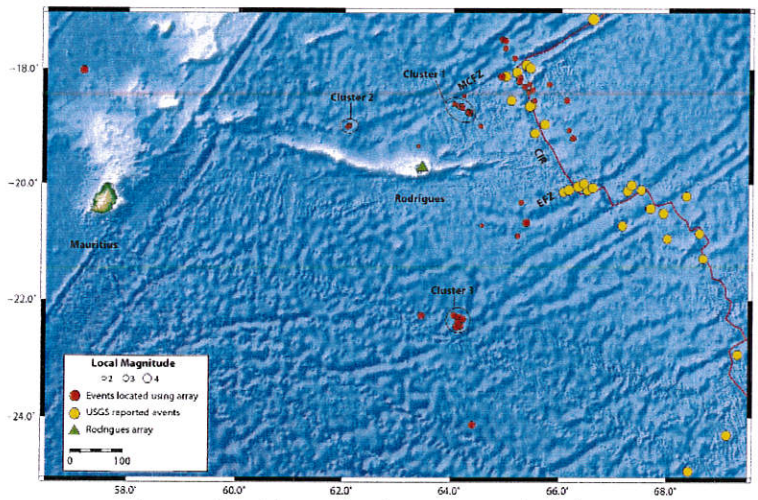

Figure 2. Locations of new events detected and located using array methods (September 2014–June 016) are shown by red circles whereas yellow circles denote events from USGS catalog for the same duration as the deployment of Rodrigues array. MCFZ, Marie-Celeste fracture zone and EFZ, Egeria fracture zone.*(Source: MOI)*

1.2. <u>Earthquake Events</u>

The earthquakes mentioned in this term of reference are of low magnitude as shown below:

I. An earthquake of magnitude 6.7 took place on 26 July 2012 around 600 miles North East of Mauritius at CIR, as shown in Figure 3 below.

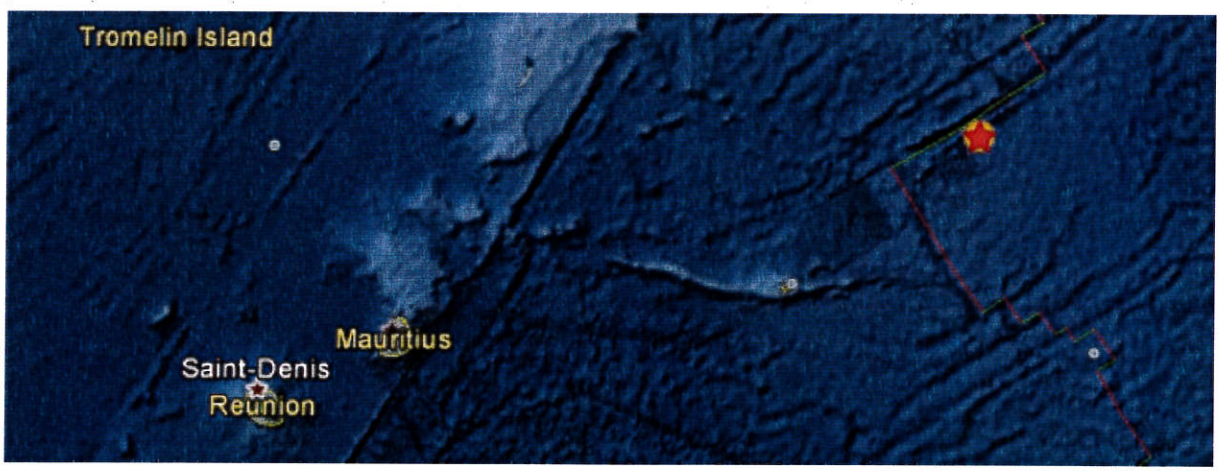

Figure 3. Location of earthquake that occurred on 26 July 2012 at CIR (*Source: https://watchers.news/2012/07/26/shallow-6-7-magnitude-earthquake-hit-offshore-mauritius-reunion-region/*).

II. A recent earthquake event occurred in the proximity of the island of Mauritius on the 27 February 2018 at 19hr25 UTC (Figure 4). It was an intraplate earthquake of magnitude 4.1 at about 70 miles to the South West of Tamarin, and people across the island felt the shaking for a few seconds.

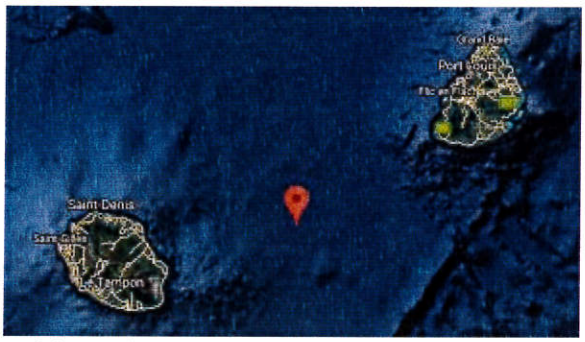

Figure 4. Location of the Earthquake around Mauritius (*Source: Earthquake-Report.com*).

1.3. **Tsunami**

The most destructive tsunamis are generated from large, shallow earthquakes with an epicenter or fault line near or on the ocean floor. These usually occur in regions of the earth characterised by tectonic subduction along tectonic plate boundaries. It should be noted that not all earthquakes generate tsunamis. Usually, it takes an earthquake with magnitude ≥7.5 on the Richter Scale, to produce a destructive tsunami (International Tsunami Information Centre). The SWIO region does not experience high-magnitude subduction-zone earthquakes, since there are no known subduction-zone in this region. However, the entire region may however be at risk of tsunamis generated by subduction zones located elsewhere in the Indian Ocean (World Bank Group, GFDRR, 2016:9).

Potential tsunami sources have been subjected to various studies and based on assessment carried out on their occurrences, seismicity and convergence rates; only areas along subduction and compression zones have been identified as potential sources of tsunamigenic earthquakes in the Indian Ocean (Jaiswal et al., Okal et al., 2008, Satake, 2014). These areas have already been characterised and represent namely the Sunda Arc, Makran Subduction Zone, Davie Ridge and the CIR (Aaronand Raizman, Air Worlwide, 2017), as shown in Figure 5. There is no known subduction zone in regions C and D. The plate movement is horizontal. Moreover, regions C and D have not reported any earthquake of magnitude 7.5 or greater. It is understood that earthquakes occurring outside these zones are not in subduction or compression zones and therefore the risk for tsunami wave occurrence is estimated to be minimal. Hence, modelling of tsunamigenic waves outside these subduction zones would not result in substantial vertical displacement of the ocean floor and therefore comprise low risk.

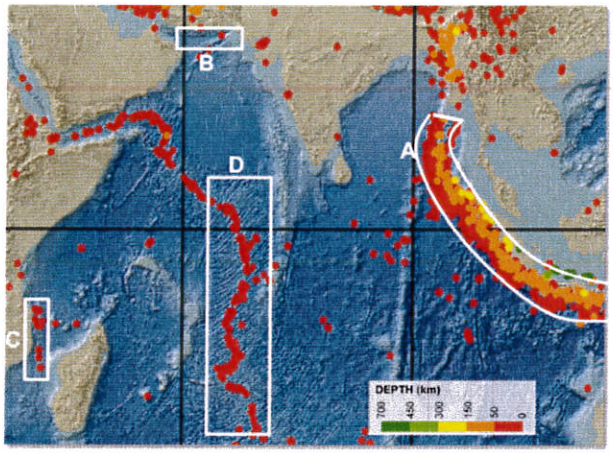

Figure 5. Potential sources of tsunami in the Indian Ocean. A, Sunda Arc; B, Makran Subduction Zone; C, Davie Ridge; and D, Central-Indian Ridge (World Bank Group, GFDRR, 2016:9).

1.4. Report of Professor Prof. Dr Montagner

Taking into consideration the populations' concern about the dangers associated with earthquakes and tsunamis, the Mauritian Government launched a study in 2012 on the 'Risks of Earthquakes and Tsunami for Mauritius and Rodrigues', whereby the team of experts under the lead of Prof. Dr Montagner made major recommendations as mentioned hereunder:

The earthquakes occurring on the Mid-Oceanic ridge are of 2 types; those occurring in the normal faults and the other in the transform faults. In both cases, the magnitudes of the earthquakes are much weaker than the ones in subduction zones and the probability of having an earthquake of magnitude 7.0 is very low. Only earthquakes occurring in normal faults that correspond to a vertical movement could give rise to a tsunami. Also, the gravitational collapse of the sides of the volcano, Piton de la Fournaise, can equally create a tsunami influencing Mauritius, but the masses displaced would probably be too weak to have a regional effect.

1.5. Bathymetric Survey

The Mauritius Hydrographic Services has been carrying out various bathymetric surveys in our waters including the survey of passes for which bathymetric data are available for the Western and Northern part of Mauritius. There is also an ongoing project at MHS to survey all the passes around mainland Mauritius. In addition to the above, Indian survey ships have also carried out numerous bathymetric surveys over the years around mainland Mauritius, Rodrigues, Agalega and Saint Brandon. These data would be useful towards the preparation of inundation maps, which could be utilised in the prediction of the effects of Tsunamis in the Republic of Mauritius.

1.6. Tsunami Warning System for the Indian Ocean

In the aftermath of the Great Sumatra Earthquake and Indian Ocean Tsunami of 26 December 2004, countries of the Indian Ocean basin formed an Intergovernmental Coordination Group (ICG) for the development of an Indian Ocean Tsunami Warning System (IOTWS) to promote the exchange of seismic and sea level data for rapid tsunami detection and analysis, to provide warnings for such events, and to coordinate mitigation efforts among its Member States. An efficient and effective end-to-end warning system was needed, ready to react 24 hours a day to any potential tsunami threat, alert those coastal communities at risk, and motivate them to take immediate and appropriate steps to save their lives.

The IOTWMS is a System of Systems with each National Tsunami Warning Centre (NTWC) of the 28 Member States issuing tsunami warnings to their respective communities based on the tsunami threat information provided by three Tsunami Service Providers (TSPs) of Australia, India and Indonesia. They will then issue regular bulletins informing about wave progression, time of impact and beach wave height so that the countries under threat can update their level of vigilance and take appropriate mitigation measures. The Mauritius Meteorological Services is the National Tsunami Warning Centre (NTWC) for the Republic of Mauritius.

The 2004 tsunami caused much damage and casualties across the entire Indian Ocean basin—even as far away as South Africa. Fortunately, Mauritius experienced only minor inundation, with greater impacts on Rodrigues, as the existence of coral reefs around Mauritius and Rodrigues are unfavorable to strong amplification of the tsunami waves.

PURPOSE OF THE STUDY

The purpose of this term of reference is to retain the services of a consultancy firm to:

- Carry out a desktop study to identify potential seismic hazards and tsunamic activities in the SWIO region and their potential impacts on the Republic of Mauritius.
- Submit a full report on the desktop study.
- Recommend measures to strengthen the resilience of the country to such potential disasters

SCOPE OF THE STUDY

The scope of this desktop study will cover the Republic of Mauritius and will consist of 2 phases:

Phase 1

a. A synthesis of the available data, past studies, reports and logistics with respect to seismic and tsunamic activities in the region.
b. Assess the state of preparedness and response against these natural hazards.
c. Evaluate the risks of seismic and tsunami activities in the region for the Republic of Mauritius.
d. Submission of a report adapted to the National context based on the findings of the above which should include:
    1. Gap analysis;
    2. Policies and legal framework;
    3. Setting up of a national seismic network including the institutional setup;
    4. Develop inundation maps for tsunamis for the republic of mauritius;
    5. Capacity needs assessment;
    6. Inter-institutional collaboration at national level;
    7. Regional/international collaboration;
    8. Road map for the implementation of the above-mentioned recommendations (3–6);
    9. Financial resources for the implementation of these recommendations.

Phase 2

a. Recommend measures to strengthen the resilience of the population;
b. Provide operational and technical support for the setting up of a national seismic network.

STAKEHOLDERS OF THE STUDY

The stakeholders of the study shall be the NDRRMC, MOI, Department for Continental Shelf, Maritime Zones Administration & Exploration (CSMZAE), National Coast Guard, Mauritius Hydrographic Service and Mauritius Meteorological Services (MMS) and any other co-opted organisations.

DURATION OF THE STUDY

The study should be completed within 2 months from contract signing. It should include of a total of 30-person days, comprising of 2 missions of 10 Working Days (10 WD) each and 10 home-based working days (However, the bidder may propose alternative durations for consideration).

Expected contract start and end dates: as specified in RFP document

EXPECTED OUTPUTS AND DELIVERABLES

S No	Deliverables/ Outputs	Estimated Duration to Complete	Target Due Dates	Review and Approvals Required
1	A work plan for the desktop study with proposed methodology	1 week	19 June 2019	Approved work plan*
2	Gap Analysis Report	2 weeks	24 June 2019	Approved Gap Analysis Report*
3	A draft report of the desktop study which should include para d (2)-d (9) of phase 1 and para(a) of phase 2	3 weeks	04 July 2019	Approved report on desktop study*
4	Validation Workshop	1 day	22 July 2019	Approved Workshop Report*
5	Submission of the final report of the desktop study	2 weeks	01 August 2019	Approved final report of the desktop study*
6	Provide operational and technical support for the setting up of a National Seismic Network		14 August 2019	Submission of short report on various advice tendered to UNDP & NDRRMC*

****all approvals shall be made by UNDP & NDRRMC***

COMPOSITION AND PROFILE OF THE CONSULTANCY FIRM

The technical expertise to be provided by the Consultant will consist of a main consultant, the "Team Leader" who will be responsible for the desktop study.

Experts	Qualifications	General Experience	Specific Experience &Knowledge
Expert in Seismology (Team Leader)	PhD	8 to 10 years	Proven experience in setting up real time seismic monitoring networks.
Expert in Tsunami	PhD	Minimum 5 years	Experience in Tsunami Modelling and Capacity Development for Tsunami Preparedness.

INSTITUTIONAL ARRANGEMENT

1. A steering committee shall be set up at the level of the NDRRMC to monitor the evolution of the desktop study as well as provide any technical assistance required.
2. The team leader should be in constant liaison with the steering committee pertaining to the technical progress of the works.

SUBMISSION OF OFFERS

Offer should include the following elements:

1. Company profile
2. Proven experience in working on similar tasks
3. CVs of experts that will potentially be assigned to this task
4. References/contacts
5. Technical and Financial proposals for the consultancy services

EVALUATION CRITERIA

Criteria	Weight	Max. Point
• Technical score	70%	70
• Financial score	30%	30

Technical Proposal Evaluation - Section 1

SN	Description	Max Pts
Expertise of the Firm/Organization		
1	***General Experience of the firm in the area of Seismic Hazards and Tsunami***	**50**
	5 - 10 years (40 points)	50
	More than 10 years (50 points)	
2	***Specific Experience:***	**150**
	Experience in SIDS:	50
	1 - 5 projects (30 points)	
	More than 5 projects (50 points)	
	Experience in Mauritius:	50
	1 - 5 projects (30 points)	
	More than 5 projects (50 points)	
	Previous work for UNDP:	50
	1 - 5 projects (30 points)	
	More than 5 projects (50 points)	
Total part 1		**200**

Technical Proposal Evaluation - Section 2

SN	Description	Max Pts
Methodology, Its Appropriateness to the Condition and Timeliness of the implementation Plan		
1	***Technical approach and methodology***	***150***
	Understanding of the objectives of the assignment	50

	Interpretation of scope of tasks in line with the Terms of Reference	50
	Methodology for carrying out the activities and obtaining the expected output/Degree of detail of output	50
2	***Workplan***	***150***
	Main activities of the assignment and its logical sequences	75
	Efficient implementation plan, milestones and delivery dates of the project	75
Total part 2		**300**

Technical Proposal Evaluation - Section 3

SN	Description	Max Pts
Management Structure and Qualification of Key Personnel		
Management structure and key personnel		
1	***Management structure***	***50***
	Composition of team - all relevant consultants are as requested in the TOR	25
	Organisational structure of the consultants	25
2	***Key expert qualifications and competence for assignment***	***150***
2.1	***Key Expert 1 (Expert in Seismology - Team Leader) – 75 points***	
A	**General Academic Qualification: Advanced degree and other related areas**	
	Masters (20 points)	25
	Phd (25 points)	
B	**Experience and language:**	
	Previous experience within the field of Seismology	20
	8 – 10 years (10 points)	
	More than 10 years (20 points)	
	Proven experience in setting up real time seismic monitoring networks	10
	5 - 10 years (7 points)	
	More than 10 years (10 points)	
	Previous experience in working with UN agencies	10
	1 - 5 projects (7 points)	
	More than 5 projects (10 points)	
	Excellent communication skills - written and oral (English and French)	10
	English only (7 points)	
	English and French (10 points)	
2.2	***Key Expert 2 – Expert in Tsunami (75 Points)***	
A	**General Academic Qualification: Advanced degree and other related areas**	
	Masters (20 points)	25
	Phd (25 points)	

B	**Experience and language:**	
	Previous experience within the field of Tsunami	20
	5 - 8 years (10 points)	
	More than 8 years (20 points)	
	Proven experience in tsunami modelling and capacity development for Tsunami preparedness	10
	5 - 10 years (7 points)	
	More than 10 years (10 points)	
	Previous experience in working with UN agencies	10
	1 - 5 projects (7 points)	
	More than 5 projects (10 points)	
	Excellent communication skills - written and oral (English and French)	10
	English only (7 points)	
	English and French (10 points)	

Any Technical Proposal falling below 70% points will be disqualified, and their financial proposal will be disregarded.

The financial offers will be evaluated giving the lowest price proposal 30 marks and marking the other more expensive proposals reverse proportionally to the cheapest offer.

REFERENCES

1. Aaron, M., and Raizman, D. (2017), Air Worlwide, Regional Platform Meeting of the ISLANDS Financial Protection Programme - Risk Modeling.

2. Blašković, T.(2012), The Watchers, available online at https://watchers.news/2012/07/26/shallow-6-7-magnitude-earthquake-hit-offshore-mauritius-reunion-region/

3. Earthquake-Report.com, available online at https://earthquake-report.com/

4. International Tsunami Information Centre, available online at :http://itic.iocunesco.org/index.php?option=com_content&view=article&id=1158&Itemid=2026.
5. Report from Prof. Dr Montagner in 2012 on the risks of seismic and tsunami for Mauritius and Rodrigues.

6. World Bank, GFDRR, Disaster Risk Profile, Mauritius, 2016.

NDRRMC ***08 March 2019***