Ministry of Environment and Energy

Republic of Maldives

Consultancy Services for conducting detailed investigations for establishing flood mitigation measures in N. Holhudhoo

Terms of Reference

BACKGROUND

The Republic of Maldives is a low lying, atoll based, archipelagic nation in the central Indian Ocean. It comprises 1,190 islands grouped into 26 atolls that together occupy a land area of 298 km2 and form a chain over 820 km in length, spread over an area of around 90,000 sq km. With a total population of 341,256, it is the smallest Asian country in terms of area and population. It is also amongst the most susceptible to climate change. The country has an average elevation of 1.5 meters above sea- level. The two most important sectors of the economy are tourism and fisheries which contribute nearly 80% of the country's Gross Domestic Product (GDP).

Vulnerability of Maldives

The Maldivian islands are regularly exposed to multiple natural hazards and the disaster risk scenario for the country is described as "moderate" due to a low probability of hazard occurrence and high vulnerability from exposure to geographical, topographical and socio-economic factors. Its unique geography makes this archipelagic small-islands nation particularly vulnerable to projected adverse consequences of climate change, including sea-level rise, as well as increases in sea surface temperature, ocean acidification[i] and frequency/intensity of droughts and storms. For example, sea levels are projected to rise within the range of 10 to 100 centimeters by year 2100, threatening submergence of the entire country in the worst-case scenario. Extreme rainfall events are likely to occur at twice the current frequency by 2050. Higher ocean temperatures increase the rate of coral bleaching and increase the risk of massive coral die-off during the local ocean temperature spikes that occur during El Niño events. Within the archipelago some islands are more vulnerable to natural causes when compared to other islands. Moreover, various human intervention have had a compounded effect on accelerating this condition.

Vulnerability of Holhudhoo

The island of Holhudhoo is located on the southern half of Miladhunmadulu (Noonu Atoll at approximately 5°45'20.79" N and 73°15'46.12" E. Noonu Atoll forms the southern end of the largest natural atoll in the Maldives archipelago – Thiladhunmathi Atoll. Out of the thirteen inhabited islands in the atoll, Fohdhoo, Maafaru, Velidhoo, Magoodho, and Miladhoo lies within 10 km radius of Holhudhoo. According to 2014 census the island has a resident population of 1,638. It is the second most populous island in the atoll, behind Velidhoo.

According to UNDP Disaster Risk Profile study for Maldives, Holhudhoo has been identified amongst top 20 islands that have the highest windstorm risk in the Maldives, with a storm hazard and storm risk index of 5 (Figure 1). No marshy or wetland areas are observed in the island for absorbing the rain water. However, due to the topography of the island with the center being lower than the periphery, a "saucepan" effect occurs during the rainfall, as the surface runoff tends to accumulate at lower areas, ultimately causing severe flooding. This has caused numerous damages to property and belongings of the residents of the island. Previous topographic surveys done for the island suggests that the depression in certain central parts of the island is as low as, just 0.9 meters from Mean Sea Level (MSL).

In order to mitigate this problem, Ministry of Environment and Energy (hereinafter referred to as the Ministry) is seeking consultancy service to study the flooding issues of Holhudhoo by collecting historical data of such events, mapping of traditional flood events, impact on economic and social wellbeing of natives, and proposing an optimum design of a proper drainage system based on the analysis derived from this in-depth investigation.

Table 26: Top 20 islands with Windstorm Risk					
Sl. No.	Island	Atoll	Population (2000)	Storm Hazard	Storm Risk Index
1	Male	Kaafu	74,069	3	5
2	Kulhuduffushi	Haa Dhaalu	6,581	5	5
3	Dhidhdhoo	Haa Alifu	2,766	5	5
4	Huvarafushi	Haa Alifu	2,221	5	5
5	Alifushi	Raa	1,737	5	5
6	Kelaa	Haa Alifu	1,196	5	5
7	Nolhivaramu	Haa Dhaalu	1,556	5	5
8	Thoddoo	Alifu Alifu	1,071	3	5
9	Holhudhoo	Noonu	1,562	5	5
10	Komandhoo	Shaviyani	1,525	5	5
11	Ihavandhoo	Haa Alifu	2,062	5	5
12	Vaikaradhoo	Haa Dhaalu	1,210	5	4
13	Maakadoodhoo	Shaviyani	1,606	5	4
14	Foakaidhoo	Shaviyani	1,061	5	4
15	Baarah	Haa Alifu	1,270	5	4
16	Manadhoo	Noonu	1,239	5	4
17	Hulhudhuffaaru	Raa	939	5	4
18	Hanimaadhoo	Haa Dhaalu	1,009	5	4
19	Funadhoo	Shaviyani	799	5	4
20	Kedhikolhudhoo	Noonu	1,114	5	4

Figure 1: Storm Hazard Risk of N.Holhudhoo (source UNDP).

A. OBJECTIVES OF THE ASSIGNMENT

Given the context of is N.Holhudhoo as one of the most vulnerable islands in the whole country to the impacts of climate change, especially with respect to flooding due to increased rainfall, the main objective of the assignment is to propose effective storm water drainage options, based on the outcome of the detailed investigation. The specific tasks associated with this assignment include the following:

- Undertake literature review of existing information available on flood hazard risks of Holhudhoo.
- Undertake data collection relevant to the assignment.
- Undertake a feasibility study to determine the most appropriate drainage option for the island.
- Develop detailed engineering designs and drawings to the selected, most feasible drainage option for the island.

B. SCOPE OF WORKS

Under the guidance and coordination with the Ministry, the consultant will work to deliver the following sub-component activities in consultation with Holhudhoo council and the community. The specific tasks for the assignment include the following:

1. Undertake literature review of existing information available. When undertaking this task include existing studies undertaken for the island with respect to hazard vulnerability,

specifically flooding, attaining historical and current rainfall data for the region, any historical and current data on flooding associated with storm surges, any existing survey maps and data from Environmental Impact Assessment reports, and other relevant documents

2. Data collection to assess the state of the existing environment, fill information gaps and to get most up to date information. This shall include topographic survey, hydro-geological studies of the island (including but not limited to groundwater assessment including groundwater level and quality, soil profiles, and studies to determine soil percolation rate & infiltration rate), shoreline and vegetation line mapping and community consultation to attain information on flooding frequency and causes and to get their views on potential solutions. Based on the collected data, flood risk maps for the island need to be developed.

3. A feasibility study to determine best possible drainage option for the island. At least three options need to be presented excluding the no project option and each option needs to be compared taking into account financial, social and environmental context. A cost benefit analysis needs to be undertaken for each selected option. When undertaking the feasibility study, based on the base map created in task 2 above, maps need to be developed for various future climate scenarios and the robustness of the different proposed options in each of these climate scenarios needs to be investigated. In addition, the system needs to be tested for various extreme weather events, for example one in twenty five year, one in 50 year, flood events. The consultant shall recommend the best possible option based on this feasibility study.

4. Develop detailed engineering design and drawing for the most feasible option selected above through task 3. The detailed engineering design should include detailed accounting for the material required and estimate costing for material requirements and labor (BOQ). A rough schedule of implementation of the project needs be proposed with the detailed engineering design.

C. OUTPUTS/DELIVERABLES

Please note that the timings are approximate depending on the actual date of the commencement of the assignment. The deliverables stated below should include, but not be limited to, the corresponding items noted in the Scope of Works above.

(i). An Inception brief detailing out the specific tasks to be carried out, a time-based work plan, work methodology and other appropriate technicalities for conducting the assignment (to be submitted to the Ministry). The Inception brief shall be submitted no later than **02** weeks after the commencement of the assignment. The Inception brief shall also identify any constraints the consultant/firm foresees with delivering the services and propose actions to be implemented to overcome the constraints identified.

(ii). Report on existing environment. A report on existing environment needs to be prepared based on the literature review and field surveys undertaken. This report needs to be submitted no later than **06** weeks after the commencement of the assignment.

(iii). Feasibility Study report. A feasibility study report, exploring three different options proposed by the consultants, needs to be prepared and submitted, no later than **10** weeks from the commencement of the assignment.

(iv). Report, drawings and specifications of the detailed engineering design Upon approval of the most feasible option from above by the Ministry, the detailed engineering design and drawings, along with the BOQ need to be developed for this option. The report highlighting the detailed engineering design and drawings needs to be submitted no later than **14** weeks from the commencement of the assignment.

D. REPORTING OBLIGATIONS

All reports and documents needs to be submitted to the Ministry by the specified due date for each deliverable. All reports and documents needs to be first submitted in draft format as an electronic copy. The Client will review the reports and documents and provide comments to the consultant as soon as practicable. The consultant will address the comments of Client and submit as Final Reports within a week of receipt of comments. Following approval of the drafts, all final reports and documents should be submitted in English in 2 (two) hard copies and an electronic copy on CD. Designs shall be submitted in both AutoCAD and PDF format.

E. CONSULANT STAFFING REQUIREMENTS

Shortlisted consultants will have the opportunity to propose staff to support their technical proposal in the response to the Request of Proposals. The following table identifies the minimal staffing requirements and their qualification.

Professional Staff	Area of Expertise	Experience
Team leader	Minimum Master's degree in environmental science, geography, hydrology or earth science. Experience in undertaking hazard and risk assessment. Previous relevant experience working in the Maldives.	10 – 15 years
Environmental Economist	Minimum Bachelor's degree in Economics (with environmental economics taken as a module of study) or Environmental Economics. Experience in undertaking cost benefit analysis of infrastructure development projects. Experience working in the field of environmental economics. Previous relevant experience working in the Maldives.	5-10 years
Community Liaison Officer	Minimum Bachelor's degree in the social sciences, business administration or environmental science. Experience in undertaking community consultations and liaising with the community in undertaking development	5 - 10Years

	projects. Previous relevant experience working in the Maldives.	
Civil Engineer	Minimum Bachelor's degree in civil engineering, coastal engineering or water engineering. Previous experience in developing detailed designs for drainage in low lying coralline islands, including costing for such projects. Previous relevant experience working in the Maldives. Additional background of Hydrology course modules will be advantageous.	5-10 years

In addition, all experts in the consultant team should possess the following:

(i). Knowledge of issues around environmental sustainability and climate change adaptation in Maldives;
(ii). A degree of knowledge of Hydrology and ability to investigate through analysis of meteorological data.
(iii). Good organizational skills and ability to help deliver and report on delivery of indicators;
(iv). Computer literacy and good word processing skills;
(v). Excellent written and oral English communication skills;

The Consultant team will also be expected to include at least one person who is fluent in reading and writing Divehi to facilitate the work of the team.

F. SCHEDULE FOR THE ASSIGNMENT

Estimated duration of the assignment is **14** weeks from the commencement of the consultancy.

G. FACILITIES TO BE PROVIDED BY THE CLIENT

The Ministry will coordinate closely with the consultant during the process. The Ministry will assign a project specific counterpart to liaise with the consultant. This counterpart may also join some field visits and review progress from time to time. The Ministry will ensure that access to data and reports that are identified in the various tasks will be provided to the consultant in a timely manner. The Ministry will facilitate meetings with various ministries and government agencies, including the local government officials to enable productive field visits, workshops and consultations.