CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

CTCN Technical Assistance
Response Plan (RP)

Country:	Republic of Mauritius
Request Identification Number:	2016000004

Title:	*Identification and Characterization of potential Sand Resources for beach rehabilitation*

Summary of the CTCN Technical Assistance

The Ministry of Environment, Sustainable Development, and Disaster and Beach Management (MOESDDBM) of the Republic of Mauritius, has requested CTCN Technical Assistance for the "Identification, Characterization and exploitation of Potential Offshore Sand Banks/Deposits". This is because many of the sandy beaches along the Mauritius coastline are eroding and the erosion will be aggravated due to the impact of Climate Change. The beaches are of great importance for Mauritius, partly as an integrated part of the marine, coral and lagoon environment and partly as an important landscape resource of great importance for the tourism industry. Consequently, it is of great importance to identify sustainable ways of protecting the beaches against historical and future erosion. Initially a project request was submitted with 5 activities but in line with preliminary investigations carried out, and due to budget constraints, it has been suggested to prioritize the request to two activities. Consequently, the CTCN assistance will help identifying and initiating this development via the implementation of the following activities:

1) Identification and Characterization of potential Sand Resource areas.
2) Marine geophysical surveys at selected sites.

The objectives are to determine if marine sand resources are available in areas where sand mining is feasible and legal and to perform geophysical surveys in selected resource areas to ascertain the quantity and quality of the identified sand and to determine if the sand is suitable for beach nourishment activities.

1. Overview of the CTCN technical assistance

1.1 Technology aspects

Preliminary investigations by Mauritius Oceanography Institute (MOI) and under the JICA Project on Capacity Development on Costal Protection and Rehabilitation in the Republic of Mauritius have identified sand deposits at different location, namely Flic en Flac, Le Morne amongst others. A basic guideline for nourishment is that the borrow sand should be of similar grain size or coarser than the native sand in order to be stable. There is the possibility that the identified sand deposits are generally not suitable for nourishment; thus, this may lead to issues that sand of suitable quality in sufficient quantity is probably not available. Accordingly, there is a need for detailed granulometry and geophysical surveys to determine whether the quality and quantity of sand is appropriate for beach nourishment.

Consequently, it is essential to start first with the identification of potential mining sites (Activity 1) and performing marine geophysical survey of the selected sites to determine if sand of the needed quality is available (Activity 2). Based on the results, the Government of Mauritius (GOM) will have the necessary information on the existence or not of potential

sand deposits sites around Mauritius and consequently plan for any beach nourishment programme.

MOI and the Hydrographic Unit of the Ministry of Housing and Lands (MHL) have delivered a list of available survey equipment for the bathymetric surveys. Based on this list, it has been agreed that MHL and MOI would be responsible to conduct bathymetric surveys for the project, under the guidance of the Implementer. The surveys inside the lagoon is proposed using portable equipment installed (as per list submitted earlier) on suitable craft of opportunity (fishing vessel) arranged by MOESDDBM. Since the bathymetric data is also required off the reef in up to 20-25 m depth (as per earlier discussions), entire bathymetric data collection can be done using portable survey equipment mounted in a suitable rented craft. Alternatively, MHL would provide ISV Pathfinder boat for off-reef bathymetry (equipped with a single beam echosounder and DGPS) and the minimum depth where the vessel can operate is 3 m. Furthermore, the survey boat with crew will be available for the second component of the surveys, which consists of sub-bottom profiling and seabed sampling. DHI will perform this component and it has been anticipated to hire the services of an appropriate laboratory in Mauritius to do the granulometry analysis of the collected seabed samples. It has also been agreed that MOESDDBM, MOI, MHL will make the above mentioned equipment and services available for the project without expenses for the project. A detailed time schedule for the survey activities under Activity 2 will be prepared under Activity 1.

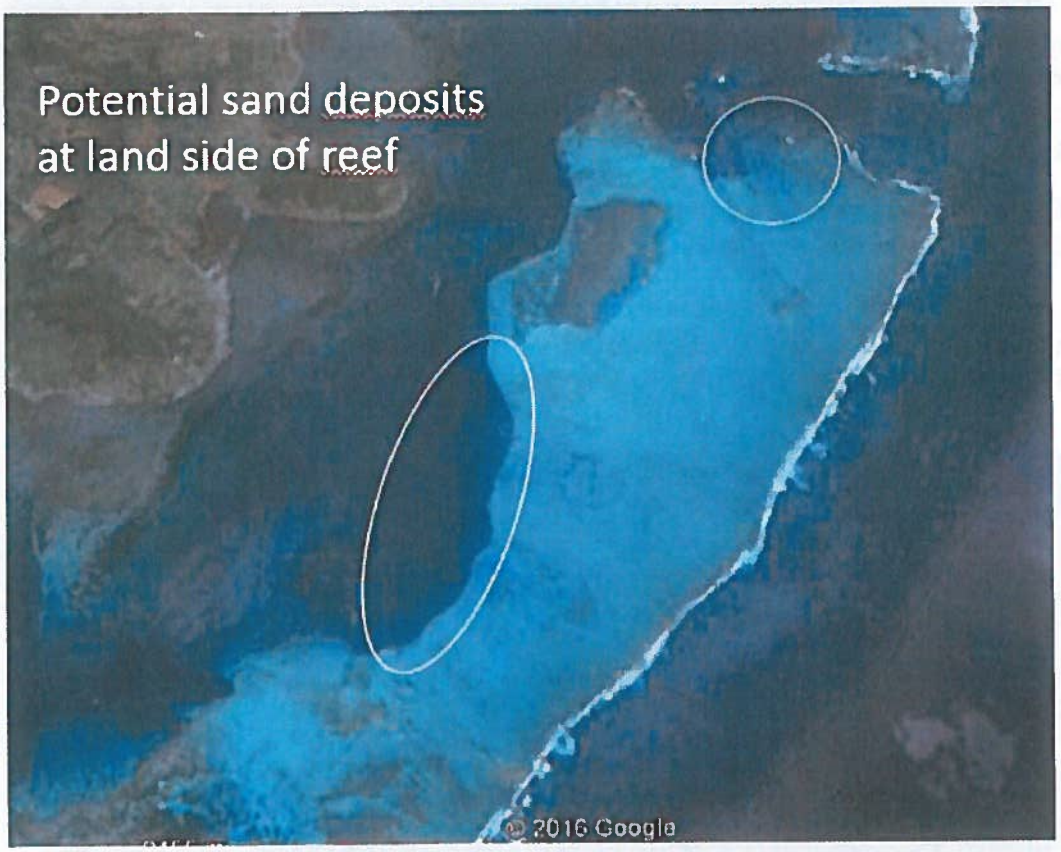
As the sites identified through preliminary investigations are found on the windward side (i.e. South East Trade Wind, mostly prevalent during the winter period from May to September), it would be appropriate to undertake the surveys from November to March.

Rationale for identifying all Sand Resource areas

There are two main types of reefs in Mauritius:

1. Fringing reefs closely connected with the associated beaches via a reef flat/coastal lagoon. These beaches are protected by the reefs and the beaches receive sand directly from the coastal lagoons. The ban for sand mining in the lagoon is well argued for location of this type.

2. Detached reefs are not connected to the mainland beaches because there is a relatively deep coastal lagoon between the landside of the reef and the mainland beach. The mainland beaches are in such cases protected by the detached reef but the mainland beach does not receive any sand from the detached reef. The sand transport mechanisms at these detached reefs are similar to those of the fringe reefs; sand is transported landwards but the transported sand is deposited at a slope on the landward side of the detached reef and this sand has no influence on the stability of the mainland beaches. The reef located east of Grand Sable/Bambou Virieux is an example of such a location, see photographs below.



Such locations would be potential sand resource areas and there is no connection between the stability of the mainland beaches and the sand transport mechanisms. Consequently, there is no professional reason for not allowing sand mining in such areas. The main question is if these areas are included in the ban or if controlled sand mining is allowed at such locations.

Other potential sand deposition areas are in the passes between the reefs, where a prevailing offshore directed current may lead to deposition of sand. However, at these locations one would expect the sand to be relatively fine.

According to this approach it is to be expected that there will be the best chances to locate suitable sand at locations with maximum wave exposure. The dominating waves come from SSW to SE, therefore locations on the SW, S and SE side of Mauritius will be the potential locations where sand can be located in the passes and at detached reefs. This is in agreement with the findings in the above mentioned JICA Project.

The main issue underlying this request for assistance is that Mauritius has a desperate need for good quality sand, not only for nourishment, but also for other society needs. The potentially best chances for locating suitable sand deposits around Mauritius are deposition areas associated with the reefs as explained above. However, due to unregulated and inappropriate sand mining in the past the general ban on sand mining in all coastal lagoons was issued in 2001. The present technical assistance is operating under these conditions and legislation. Therefore, during the technical assistance, the detailed coverage of the sand mining restrictions will be discussed; does the ban on sand mining cover all areas landwards

the reef edges or does the ban only cover areas where the mining potentially can harm the adjacent beaches because these are in direct connection with the reef flat/coastal lagoons? The consequences of the ban on sand mining in the different types of areas in terms of impact on the environment as well as in terms of sand resources available for sand extraction will be discussed.

It will, despite the ban on sand mining, be of interest, for national reasons, to locate all the potentially best sand resource areas as basis for future sound planning and decision making.

Four potential promising locations for sand resources have been identified at a very preliminary level; the areas are indicated in the figure below. However, there may also be other sand resource areas, which are relevant to investigate.

1.2 Objectives (outcomes)

The main outcomes of this CTCN technical assistance in the Republic of Mauritius are the following:

a) To identify potential sand deposits sites through discussions with relevant stakeholders and using tools such as satellite images, aerial photography, and coastal hydrodynamics considerations, amongst others.

b) To perform geophysical surveys in selected resource areas to determine the quantity and quality of the identified sand and to determine if the sand is suitable for beach nourishment activities.

1.3 Results (outputs expected from CTCN assistance)

Beach nourishment is generally identified as the optimal method for mitigation of on-going coastal erosion; this also applies for most of the eroding beaches in the Republic of Mauritius. This is in agreement with international up-to-date shore protection practice, which focusses on the "Working with Nature" concept. This is especially relevant in the case for the Mauritius coasts because preservation of the natural beaches is of paramount importance for the tourist industry and at the same time this methodology represents a sustainable way of shoreline management as it preserves the natural beach/dune landscapes and morphodynamics.

The main output of the present assistance is the possible documentation of sites where suitable volumes and quality of marine sand can be extracted for beach nourishment as well as a description of the recommended extraction and nourishment technology. The proposed assistance does acknowledge that there is a risk of a negative outcome of the proposed activities – resulting from findings that sand of suitable (coarse sand) quality and quantity is not available in the reef passes or other nearby sites at reasonable depths. However, these results will be fundamental for any future beach nourishment activities in Mauritius and will inform future strategies.

1.4 Expected use of outputs

The expected use of the outputs is guidance to the Government of Mauritius regarding availability of sand resources suitable for feasible extraction, including the quality, quantity and suitability for beach nourishment.

If the outcome of the two activities is positive, i.e. that sand of suitable quantity and quality for beach nourishment is identified in areas where extraction is legal and feasible, then the next activities towards implementation of beach nourishment will be:

- Identification of the immediate and the long-term quantity of sand required for beach nourishment
- Undertake an environmental impact assessment of sand mining and beach nourishment activities
- Produce a guideline for good practice for sand mining and beach nourishment

These three activities were part of the original request but they were taken out during the prioritizing process as explained in the Summary.

There is the risk that the results of some of the items under the two activities are negative. This can be divided in the following situations:

a. Marine sand resources are available, but they are located in areas covered by the ban on sand mining. In this case the next step could be to perform an assessment of the impact of the sand mining including remedial measures or restrictions required to compensate for possible impacts. Thereafter to make recommendations for policy decision making.
b. Marine sand resources are available in areas where it is legal to perform the mining, but it is not feasible to perform the mining with the type of equipment available at Mauritius. In this case the next step could be to describe the dredging methodology and make specifications for the required type of dredging equipment. On basis of this either to identify ways for purchasing the equipment and setting up of a dredging unit, or ways to contract the dredging to foreign contractors.
c. Marine sand resources are not available in the investigated areas, neither in sufficient quantity nor in the quality required for beach nourishment. The investigation areas were mainly in the immediate "offshore" areas, such as the reef passes and in the "offshore" part of coastal lagoons. In this case the next step could be to investigate if suitable marine sand resources are available in other areas, and what would be required for utilization of these resources in terms of dredging equipment and permissions. However, such investigations are not covered under the present technical assistance.
d. If all efforts for identifying suitable marine sand resources for beach nourishment are unsuccessful, the next step could be to investigate alternative protection measures than sand nourishment. Again, such investigations are not covered under the present technical assistance.

The main objective of this technical assistance is to document possible sites where suitable volumes and quality of marine sand can be extracted for beach nourishment, as well as to describe the recommended extraction and nourishment technology. It is important to note this technical assistance does not cover an environmental impact assessment of sand mining. Any subsequent decisions related to sand harvesting made by the Government of Mauritius after this technical assistance will closely analyse relevant environmental, social and economic impact considerations and undertake relevant assessments as per the rules and regulations of Mauritius.

2. Description of the Assistance

2.1 Activities

Activity 1 – Identify potential areas of sand resources suitable for extraction
This activity consists of the following sub activities:

Activity 1.1 Preparations
Prior to a site visit, preliminary studies need to be undertaken. The preparations will include:

- Preparation of discussions to be held with stakeholders to obtain a mutual understanding of coastal hydrodynamics and morphology with special emphasis on the conditions in Mauritius, i.e. generation and characteristics of coral sand beaches and sand deposition areas, equilibrium profile, chronic and acute erosion and requirements to nourishment sand
- Study of existing reports
- Study of satellite images and bathymetric maps (CMap)
- Together with the NDE (i.e the MOESDDBM), the identification of the relevant stakeholders to meet during the expert visit to Mauritius.
- Preliminary identification of potential sand resource sites

Activity 1.2 One-week visit to Mauritius by coastal expert

A series of meetings with national and local actors will be held. The local actors shall cover national authorities responsible for laws and regulations as well as sector institutions, such as MOI, MHL, amongst others. It has been agreed that the NDE is responsible for identifying relevant local actors to meet and for arranging the meetings.

Discussions to be held with stakeholders to obtain a mutual understanding of coastal hydrodynamics and morphology with special emphasis on the conditions in Mauritius, i.e. generation and characteristics of coral sand beaches and sand deposition areas, equilibrium profile, chronic and acute erosion and requirements to nourishment sand. The implementer (i.e CTCN/DHI) will prepare an introductory presentation for the discussions.

The main issue for this activity is to identify and select potential sites for sand mining in reef passes near the critical erosion sites, and in a few additional promising sites, which are located on the shoreward side of offshore detached reefs. These sites may not be in the immediate vicinity of critical erosion sites but these sites have a promising mining potential. The critical issue is if such sites are covered by the ban on sand mining in the coastal lagoons.

The potential sand resource sites will be identified on basis of the following topics and data:

- Reef hydrodynamics and morphology, which will describe the generation of sandy carbonate beaches and typical transport paths and deposition areas for coral sand at shore connected reefs and detached reefs
- Available satellite images and aerial photos
- Existing bathymetric surveys available at MOI and others
- Existing reports

The selection of the laboratory to conduct the Granulometric analyses will be also part of Activity 1.2

Activity 1.3 Desk-based analysis of the potential sand resource sites

Discussions will be held with MOI, MHL and other stakeholders as appropriate regarding specifications to the marine surveys and planning of the surveys. Logistical conditions for the two survey components will also be discussed and agreed upon. This information will be used as basis for a detailed description and planning of Activity 2. This activity will take into consideration gender aspects of the impact of coastal erosion and potential beach nourishment activities.

It is assumed that the NDE, in collaboration with other relevant stakeholders, will arrange the following activities:

- Provide all available relevant data, such as existing bathymetric surveys, aerial photographs and satellite images and previous assessments of seabed conditions etc.
- Meetings with relevant authorities and other stakeholders
- Site inspection to typical potential sand resource sites to be inspected from land or by boat, as relevant
- Site inspection to typical erosion sites.

Activity 1.4 Reporting, recommendations and deliverables

The outcome of this activity would be to identify the most promising sites in which to conduct additional bathymetric surveys as well as the geophysical marine survey.

The main findings during the site visit will be discussed with CTCN and the NDE in order to agree on the way forward. The outcome of discussion will be used as guidance to the site visit report and to the way forward, i.e. detailed performance of Activity 2.

A short report will be submitted with the following content:

- Overview of activities
- Conclusions from meetings and site visits
- Summary of legal aspects and clarification of areas covered by ban on sand mining in coastal lagoons
- Description of potential sand resource sites, both in "offshore" areas and in areas on the shoreward side of detached offshore reefs
- Recommendation of potential sites of sand resources
- Recommendations for survey activities at potential sand resource sites.

Activity 1.4 will be performed in the consultant's home office, however, it is anticipated that the reporting of the findings will be initiated during the visit to Mauritius.

Activity 1 – Deliverables

Deliverables	**Delivery**
1.1 Preparations	*Week 1*
1.2 Site visit of Mauritius	*Week 2*
1.3 Desk-based analysis of the potential sand resource sites including gender considerations	*Week 3 and 4*
1.4 Reporting, recommendations and deliverables *Draft Report* *Comments on report* *Final report for Activity 1*	 *Week 4* *Week 5 to 7* *Week 8*

Activity 2 – Geophysical Marine Surveys at selected sites, suitability for sand extraction and characterization of sand in terms of quality and quantity

Geophysical marine surveys in the most promising sites identified in Activity 1 will be executed. It is anticipated that four to six locations will be selected for surveys, most probably at the SW, S and SE side of the Island as explained above. Activity 2 will determine the suitability of the investigated sand resources and provide recommendations as per its use. Activity 2 is divided in two main components: Bathymetric surveys, which will be undertaken by MOI and MHL with guidance from the implementer, and sub-bottom profiling, and granulometric analysis which is the responsibility of implementer.

Data under activity 2

The tangible Results (data, report, information summary, analysis, calculation, assessment, survey, layout, drawing or the like) produced by DHI with funding from CTCN/UNEP in connection with performing the implementation of activity 2 and the Intellectual Property Rights required to utilise such Results, shall be the property of the NDE (Republic of Mauritius). Know-how, tools, scripts, methods, techniques and other intangible Intellectual Property Rights developed by DHI or ascertained by DHI in connection with performing the Services shall be the exclusive property of DHI.

Furthermore, DHI and CTCN/UNEP shall be entitled to use the tangible results in connection with publications, articles, speeches, conferences or similar events as well as for non-commercial research and educational activities. This license to use the tangible results shall be perpetual, worldwide, irrevocable and royalty-free.

Each party retain all rights to its intellectual property that the party owned, created or acquired prior to this agreement and/or the party created or acquired outside of this agreement.

Activity 2.1 Bathymetric surveys

The purposes of the bathymetric surveys are to:

- Provide detailed depth conditions in potential sand resource areas
- To characterize the seabed conditions. Even and level areas would indicate sandy seabed whereas uneven and steep slopes would indicate rocky or coral areas
- To extract areas where the seabed is covered with sand

The execution of the bathymetric surveys will be based on discussions during Activity 1 between the implementer and the MOESDDBM, MOI and MHL on how to perform the surveys. The bathymetric soundings will be performed by a single beam precision echo sounder mounted on a small survey boat equipped with DGPS positioning system. (Hemisphere V-131 DGPS receiver with differential corrections subscribed from Fugro's MarineSTAR service). Data will be collected using HYPACK 2012 and processed/analysed by implementer, MOI and MHL CARIS HIPS &GIS software suites. Tide correction will be done using mms data.

Survey line spacing of 25 m has been anticipated. Boat facilities covering complete survey spread (survey boat, echosounder and positioning equipment and associated software) incl. crew for both surveys in Activity 2 will be covered by MOI, MHL and MOE as their

contribution to the technical assistance. The CTCN implementer will cover the cost of rental and shipment of Sub-bottom profiler and grab including granulometric analysis.

The areas to be surveyed will be selected under Activity 1.

The outcome of the surveys will be bathymetric maps of the selected areas and seabed analysis pointing out potential sand covered areas.

It is estimated that survey of one area will take between 1 and 2 days. This corresponds to 4 to 12 survey days for Activity 2.1 assuming 4 to 6 locations.

Activity 2.2 Sub bottom profiling and seabed sampling
The purposes of the sub bottom profiling are to:

- Provide information on thickness of the sand layer in the sand covered areas of a reasonable size, say minimum size 10,000 - 20,000 m2.
- To compute the volume of sand in the sand covered areas

The purposes of the seabed sampling are to:

- Document the grain size distribution of the sand in the resource areas by taking sand samples and by performing sieve analysis. The typical size of a sand resource area has been set at 300 m x 500 m = 150.000 m^2
- To describe the suitability of the sand for beach nourishment

The sub bottom profiling will be performed by a light-weight sub bottom profiler equipment, which will be mounted on a small boat equipped with DGPS positioning system. Since probable locations are at considerable distance from Port Louis, it has been anticipated to arrange boats available nearby as this is the most cost effective and expeditious way to perform such surveys. The boat will be used for the bathymetric survey as well as for the sub bottom profiling. A SES-2000 light Parametric Sub-bottom Profiler or similar has been anticipated. Survey line spacing of 25 m has been anticipated. The seabed samples will be collected by a Van Veen Grab Sampler, a seabed sample for every about 5,000 m^2 (50 m x 100 m) has been anticipated. This gives typically about 30 samples per area for an anticipated area of 150.000 m^2.

The implementer will be responsible for the sub bottom surveys and for the seabed sampling. It has been anticipated to hire the services of a laboratory in Mauritius for the granulometic analyses. Since the local stakeholders have inadequate capacity to undertake sub bottom profiling and interpretation of data, a capacity building session will be held on this aspect for transfer of knowledge on SB profiling and discussion of results.

The capacity building session will be performed by the implementer for duration of three days to relevant participants identified by the GOM up to 15 participants.

It is estimated that the field activities can be performed as follows:

- One to two days for sub bottom profiling per site
- One day for sand sampling per site

However, it can also be considered to perform the echo sounding and the sub bottom profiling simultaneously, this may save time and expenses.

Estimated survey days for Activity 2.2: 8 to 16 days. 12 survey days have been anticipated for price estimate.

Note that only visit by the implementer's hydrographic surveyor has been anticipated during the survey activities in Activity 2. An additional travel for 2 experts is also included in this activity for the capacity building session.

Activity 2.3 Reporting, recommendations and deliverables
The volume of the potential sand resources will be computed by the implementer, the resources will be distributed in classes according to the mean grain size distribution.

Typical grain size distribution curves and sand characterization parameters from eroding beaches will be extracted from existing reports; this will be undertaken by the implementer in collaboration with NDE, MOI and MHL.

The implementer will be responsible for the final evaluation of the available sand resources suitable for extraction and their suitability for beach nourishment or other purposes.

The coastal expert will prepare a short report with the following content:

- Overview over activities
- Conclusions from survey activities
- Description of identified sand resource areas, sand volumes and sand characteristics
- Recommendation of potential sand resources suitable for beach nourishment
- A guide/protocol on use sub bottom profiling including interpretation of results will be prepared and included in the report.

Activity 2 – Deliverables
The outcome of this activity will be description of available sand resources in the reef passes and other locations at the selected about 4 to 6 sites. The possible resources shall be described in terms of location, extension, layer thickness, extractable sand volumes and sand characteristics (grain size distribution curves and composition of the sand). The suitability of the sand for nourishment of the eroding beaches shall be analysed by comparing specification for the nourishment sand with the characteristics of the identified sand resources.

Deliverables	Delivery
2.1 Bathymetric Surveys at 4 to 6 selected sites	*Weeks 9 and 10*
2.2 Sub-bottom profiling *2.2 Capacity building report*	*Weeks 11 and 12* *Week12*
2.3 Reporting, recommendations and deliverables *Draft report* *Comments on report* *Final Report, Activity 1 and 2*	 *Weeks 13 and 14* *Week 15 to 17* *Week 18*

2.2 Synergies and Baseline Setting

It is mentioned in the Request Submission that the local authorities, i.e. especially Ministry of Environment (MOESDDBM) and Mauritius Oceanography Institute (MOI), have already in the past organized comprehensive studies of coastal erosion and of coastal protection as well as assessment of sand resources etc. The "only" item missing before implementation of the recommended protection techniques, namely nourishment with sand from offshore deposits,

is the identification, characterization and exploitation of the offshore sand deposits. The core of the present technical assistance is consequently the physical surveys, characterization and exploitation of the offshore sand deposits whereas all other subjects are extracted from the earlier studies.

It is anticipated that the process will be guided by the MOESDDBM with participation from local and regional authorities according to local regulations and traditions. The capacity of private stakeholders in terms of available dredging and reclamation equipment shall be investigated.

The CTCN assistance will consequently draw on data from previous studies carried out for MOESDDBM and by MOI and available expertize in these organizations as well as available private stakeholders form the construction/dredging industry.

2.3 Timeline

The proposed timeline is presented in the below table. The time is given in weeks after work order.

The timeline lists the activities for the CTCN assistance for the response plan only including specific milestones for each activity.

Activity	Weeks after order																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.1 Preparations																				
1.2 Visit to Mauritius																				
1.3 Desk based analyses																				
1.4 Reporting, recommendations and deliverables																				
Draft report																				
Comments on report																				
Final report																				
2.1 Bathy. survey																				
2.2 Sub bottom profiling																				
2.3 Reporting, recommendations and deliverables																				
Draft report																				
Comments on																				

report																			
Final report																			

The actual time schedule will depend on availability of the involved consultants and other obligations of MOI and others, an actual time schedule will be developed at the start of the assignment.

2.4 Expertise required

The expertise and other resources required to implement the Activity 1 and 2 are listed in the below table.

Activity 1	Type of Expert	Approx. number of man-days
1.1 Preparations	Coastal expert	3 HO
1.2 Visit to Mauritius	Coastal expert, incl. travel	8 M
1.3 Desk based analyses	Coastal expert Gender specialist	4 HO 2HO
1.4 Reporting, recommendations and deliverables Draft Report *Clients Comments* Final Report	 Coastal Expert *Client* Coastal Expert	 1 HO All local stakeholders 2 HO
Events		Days/Amount
1 Int. travel, one travel	Coastal Expert	USD 1000
Hotel and per diem	Coastal Expert	6 days
Activity 2	Type of expert	Approx. number of man-days
2.1 Bathy. survey	MOI Coastal expert	BY MOI and MHL 2 HO
2.2 Sub bottom profiling and seabed sampling	Coastal expert Marine Surveyor, incl. two travels	1 HO 17 M
2.3 Reporting, recommendations, SBP session and deliverables Analyses and Draft report *Clients comments* Final report	 Coastal expert/surveyor Client Coastal expert	 7/5 HO All local stakeholders 2 HO
Events		Days/Amount
Int. travel, three travels (for performing the SBP surveys (14 days) and capacity building for transfer of knowledge on SB profiling	Coastal expert/surveyor	USD 7,500

and discussion of results) including DSA		
Rental and shipment of SB profiler and grab		USD 5500
Cost of granulometric analyses of 180 samples		USD 9000
Capacity building session	Coastal Expert	USD 3,000
Summary of man days		
Total man days	Coastal expert Marine surveyor	20 HO and 8 M 5 HO and 17 M

Note: HO: Home Office, M: Mauritius

2.5 Main partners

The role of in-country partners who will be involved in the implementation of the CTCN assistance is listed in below table.

Stakeholder	**Role to support the implementation of the CTCN assistance**
National Designated Entity/Ministry of Environment (NDE/MoESDDBM)	*Supply of local experience and of data and local liaison with other stakeholders* *Make arrangement for survey boats for bathymetric surveys and SBP* *Logistic support (office space, transport facilities, amongst others)*
Mauritius Oceanography Institute (MOI)	*Collaboration partner on marine geophysical surveys and data analyses* *Provide technical inputs on potential sand deposits sites.* *provide certain survey equipment for bathymetric surveys* *Undertake bathymetric surveys under the guidance of the implementer.*
Ministry of Housing and Land (MHL)	*Collaboration partner on marine geophysical surveys and data analyses* *Provide technical inputs on potential sand deposits sites.* *provide certain survey equipment for bathymetric surveys* *Will undertake bathymetric surveys under the guidance of the implementer.*
Local/regional authorities	*Contacts as appropriate and guided by MoESDDBM*

2.6 Indicative budget

The indicative budget has been based on the calculated man-days and the out or pocket expenses.

Activities	Estimated Budget (USD)
Activity 1 Identification of and resource areas	USD 26,000
Activity 2 Geophysical marine surveys	USD 78,000
Total	**USD 104,000**

Implementation of this Response Plan will be led by the Climate Technology Centre (including selection, contracting, supervision and monitoring of implementation partners) in close coordination with the corresponding National Designated Entity and relevant national actors.

2.7 Gender considerations

Given the purely technical nature of the outlined activities of the proposed technical assistance, the monitoring of gender related indicators is limited at this stage. However, special attention will be given to representation of women in activities requiring workshops or stakeholder consultations in the course of the technical assistance activities. The desk-based analysis of the potential sand resource sites undertaken under activity 1.3 will take into consideration gender aspects of the impact of coastal erosion and potential beach nourishment activities.

The benefits of the proposed activities are also expected to contribute to women employed in the tourism sector – particularly in the coastal areas, where tourism activities may be compromised in the absence of beach nourishment activities, and thus valuable jobs and income opportunities lost. This is particularly relevant for women employed in the service sector, and women self-employed in tourism and related sectors that heavily rely on continued inflow of tourists (such as garments and crafts).

2.8 Risk identification and risk mitigation

The risks that could jeopardize the realization of the CTCN assistance outcomes and any expected impact of such risks, their probability and how the CTCN assistance will mitigate these perceived risks, are described in the below table.

Risk	Consequence	Probability	Mitigation measure
Suitable amount/quality of marine sand not found in selected areas	Not sufficient sand for nourishment and other purposes	50%	This is the reason for only implementing Activities 1 and 2 in order to give sufficient information for the GOM to decide on future actions, under guidance of CTCN
Surveys take longer time that anticipated because areas are larger than assumed or	Budget overrun	30%	Request for increase of budget or limiting the number of survey areas

because sailing time between locations is underestimated			
Good sand resources identified in areas covered by ban on sand mining, but mining is deemed to be environmentally acceptable	Sand resources cannot be utilized under present legislation	70%	Recommendations from implementer will help the GOM for any policy decisions related the ban on sand mining

3 Long-term impacts of the assistance

3.1 Expected climate change-related benefits

	CTCN climate technology impact	Anticipated contribution from CTCN assistance
1	Climate technologies adapted to national context are identified and prioritized to enable their deployment and/or transfer in the requesting countries	Sand resources suitable for nourishment of eroding coasts identified. Nourishment is recognized as a feasible tool for adapting the sea level rise
2	New national Technology Needs Assessment (TNA) and Technology Action Plan (TAP) as a result of the response	Alternatives to beach nourishment may have to be formulated
3	Progress made against mitigation objectives (i.e. energy and carbon intensity reduction) as a result of the response	N/A
4	Progress made against adaptation or resilience objectives (e.g. climate vulnerability index improvement) as a result of the response	Nourishment as an adaptation measure against coastal erosion caused be SLR is made possible due to results of the CTCN assistance
5	New mitigation or adaptation technology projects/initiatives implemented as a result of the response	Subject to the outcome findings of the initial activities of the project, the implementation of this Response Plan may lead to implementation of beach nourishment activities in Mauritius, for increased climate resilience
6	New or strengthened policies/ laws developed, approved and enacted as a result of the response	Arguments for relaxation in ban on sand mining in certain areas delivered via the CTCN assistance
7	New policies/laws where climate change was mainstreamed as a result of the response	N/A
8	Country integrating climate change mitigation and/or adaptation issues into its	See point 6 for related possible outcomes of the Response Plan (in regard to planning and

	planning and policies as a result of the response	regulations in the coastal areas)
9	New or strengthened Public-Private Partnerships (PPP) created directly as a result of the response	N/A
10	New or strengthened twinning arrangement created as a result of the response	N/A
11	Capacities to access and attract public and private finance increase to enable financing of technology deployment	N/A
12	Post-response intervention funding attributable to the response.	N/A
13	Framework and analysis of local production developed to enable deployment of national production of climate technologies	Technological capacity Enhancement of stakeholders.

3.2 Co-benefits

The anticipated economic, social, and environmental co-benefits of the CTCN assistance is described in below table, which indicate how the CTCN assistance will contribute to one or more of the Sustainable Development Goals (SDG)[1].

	Sustainable Development Goal	**Contribution from CTCN assistance**
1	End poverty in all its forms everywhere	Proposed activities, given positive outcomes of the survey mission, will contribute to reduced risk of economic losses and losses of jobs in tourism and related sectors in the coastal areas.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	N/A
3	Ensure healthy lives and promote well-being for all at all ages	Beach erosion can contribute to increased severity of coastal storm and flooding impacts, as well as impacts of sea level rise. Properly planned and executed nourishment activities can mitigate these risks.
4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	N/A
5	Achieve gender equality and empower all women and girls	N/A
6	Ensure availability and sustainable management	N/A

[1] Please note that the SDGs as listed here reflect their current status and may be subject to change.

	of water and sanitation for all	
7	Ensure access to affordable, reliable, sustainable, and modern energy for all	N/A
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Proposed activities contribute to ensuring sustainability of the economic activities and growth reliant on the natural resources in the coastal areas of Mauritius
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Proposed activities aim at restoring the natural coastal infrastructure that is currently being lost to erosion
10	Reduce inequality within and among countries	N/A
11	Make cities and human settlements inclusive, safe, resilient and sustainable	Reduced beach erosion will contribute to reduced risks of damages caused by erosion, flooding and sea level rise to human settlements and economic activity in the coastal areas
12	Ensure sustainable consumption and production patterns	N/A
13	Take urgent action to combat climate change and its impacts	Prepares for sustainable protection of coasts which are exposed to excessive erosion due to SLR. Properly planned beach nourishment will increase the resiliency to these effects.
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Promotes sustainable use of marine resources for beach nourishment by ensuring that sands are mined in the most appropriate sites and with sustainable approaches
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	N/A
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	N/A
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	N/A

3.3. Post-assistance plans and actions

It might be recommended to supplement the present CTCN assistance with supplementary assistance for completing the marine geophysical surveys as the present assistance only

covers selected locations. Furthermore, future activities required before actual nourishment can be initiated, are the following:

- Identification of long-term quantity of sand likely to be required for beach replenishment
- To undertake an environmental impact assessment for potential exploitable sites
- Produce a good practice guide for the activities of sand mining and beach replenishment

This would maximize the in-country use of the outputs and outcomes produced by the CTCN assistance in achieving the expected climate change related and co-benefits as described above.

3.4 Monitoring and Reporting of technical assistance results and impacts

Performance indicators of CTCN Assistance				
Response output *(linking to sec 1.2)*	**How output will be used to ensure creation of result**	**Expected result**	**Expected outcome of result** *(linking to sec 1.1)*	**Anticipated impact that outcome will produce** *(linking to section 3)*
1. Identification of potential sites where suitable volumes and quality of marine sand can be extracted for beach nourishment	*Etc.*		Identification of marine sand borrow areas	Informed decision for undertaking (or halting) of further activities for beach nourishment relating to feasibility of the proposed approach and best sites for continued action
2. Performance of geophysical surveys at 4 to 6 selected sites suitable for sand extraction based on sea bed and sand characteristics			Information on the quality and suitability of the sands for beach nourishment in the surveyed potential extraction sites	
3. Description of the recommended extraction and nourishment technology (IF suitable sites identified)			Recommendations for further activities to be undertaken	

2. Signatures

Signatures of the requesting country

NDE

Name: Sin Lan NG YUN WING
Title: Director of Environment
Date: 30/11/16

Signature:

Signatures of the CTCN

CTCN Director

Name: JUKKA UOSUKAINEN
Title: DIRECTOR
Date: 01/12/2016

Signature:

Annex 1: Response Logframe

Activity *(link to sec 2)*	**Description of sub-activities conducted by the CTCN**	**Output/ Deliverable** *(link to sec 2.9)*	**Expected Outcome** *(link to sec 3)*	**Main national partners involved**	**Objectively Verifiable Indicator** *(see Annex 5 guidance)*	**Means of Verification** (data source, method of collection, responsibility and periodicity)
Activity 1 - Identify potential areas of sand resources suitable for extraction	1.1. Preparations for mission including desk study of reports and satellite images	1.1. Pre-identification of survey sites and preparation of survey logistics	1.1. Successfully planned in country mission	NDE (MOESDDBM), MOI,and MHL	1.1. Mission plan and programme	1.1. Clearance and acceptance by the CTCN and the NDE
	1.2. Coastal expert visit (site identification)	1.2. Stakeholder meetings and desk analysis of survey sites based on a number of variables	1.2. Information collection, stakeholder discussions and pre--selection of survey sites		1.2. Maps and analysis of relevant sites (incl. bathymetric maps (existing and new and map showing sand resource areas, quality and volume of sand).	1.2. Meeting reports + results of criteria analysis
	1.3. Reporting, analysis and recommendations (deliverables)	1.3. Identification of sites for bathymetric and geophysical marine surveys	1.3. Final selection of sites for geophysical marine surveys		1.3. 4-6 recommended sites for undertaking the survey	1.3. Final report with analysis results, meeting reports and recommendations
Activity 2 – Geophysical Marine Surveys at selected sites, suitability for sand extraction and characterization of sand in terms of quality and quantity	Activity 2.1 Bathymetric surveys	2.1. Bathymetric maps of the selected areas and seabed analysis pointing out potential sand covered areas	2.1. Information on the depth conditions and seabed conditions of sites	NDE (MOESDDBM) , MOI,, MHL	2.1. Maps and associated datasets	2.1. Acceptance of results by NDE and CTCN

	Activity 2.2 Sub bottom profiling and seabed sampling	2.2. Computation results on the thickness of sand layer and sand volumes	2.2. Information on the suitability of sand for beach nourishment		2.2. Computations and analysis for the selected sites	2.2. Acceptance of results by NDE and CTCN
	Activity 2.3 Reporting, recommendations and deliverables	2.3. Concluding results of the survey activities (description of identified sites and recommendations based on sand qualities)	2.3. Final recommendations for the usability of the selected sites		2.3. Final outcome report with analysis and recommendations	2.3. Acceptance of results by NDE and CTCN