ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF

THE POST-TSUNAMI RECONSTRUCTION OF VILUFUSHI ISLAND IN THAA ATOLL

PROJECT SUMMARY
OCTOBER 2005

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1 Introduction and key features of the project

Background

On the 26th of December 2004, the Tsunami struck the Maldives. The tsunami was the worst natural disaster experienced by the Maldives in recent history, resulting in major economic, social and environmental impacts. Of the 200 inhabited islands, 13 were totally destroyed, 56 suffered major damage and 121 experienced moderate damage. Figures 1 and 2 show the devastation after the Tsunami

Figure 1: Destruction on Vilufushi island

Thaa atoll was one of the worst hit areas; the island Vilufushi, on the East rim of Thaa atoll, was completely flooded and damages to the island and its infrastructure were extensive. The housing sector suffered the most direct damages, but water- and sanitation-facilities also suffered, as well as the infrastructure for fishery, the main occupation of the inhabitants of Vilufushi. Due to the resulting situation all Vilufushi residents were temporary moved to the island Buruni, south of Vilufushi.

Figure 2: Picture of damaged buildings on Vilufushi island

Safe islands programme

To restore the island and to create a safer and larger island for the local population, a reconstruction plan has been developed by the National Disaster Management Centre.

Even before the Tsunami struck, the Ministry of Planning and National Development had developed a plan to construct so-called safe islands in each of the 20 atolls under the "Safe Islands Program" also called the "Focus Island Program". These safe islands will have a much higher protection from natural and other disasters, through seawalls, vegetation enclosure surrounding the island, and drains to clear away floods should there be high waves. Vilufushi has been selected as safe-island location in Thaa Atoll.

In order to cater for future population growth the new safe islands will be generally (much) larger then the present islands; this would lead to more efficient use of social-economic infrastructure such as health and education-infrastructure and provision of energy.

Project features

The present plan for post-Tsunami reconstruction of the island of Vilufushi is in line with the Safe Island Program. The design includes a (higher) land level of 1.4 meter above sea level and a protecting bundwall on the East side of the island of 2.4 meter above sea level and areas of high ground. The bundwall is part of the EPZ (Environmental Protection Zone) which has palm trees on the island side (figure 4). The island would be enlarged from 16 hectare at present to 60 hectares. Due to the enlargement of the island also a new and larger port area needs to be created, as *fishing is one of the main activities of the island's population and also general* transport will increase.

The main land-use categories are the following:

– Existing island – housing-social infrastructure	11 ha
– Existing island – green zones	5 ha
– Reclamation – housing-social infrastructure	36 ha
– Existing island – Environmental Protections Zone (EPZ)	9 ha
Total	**61 ha**

The island will provide in future space for housing and social infrastructure for up to 5000 inhabitants. It is noted that the Pre-Tsunami number of inhabitants was approximately 1800.

The project would include the following construction activities (see also figure 3)

- Debris removal from old Vilufushi and surrounding seabed
- Dredging and reclamation of 1 million m^3 of coral sand
- Finish original island to new (safe) levels
- Construction of revetments, 2000 meters (see figure 4)
- Dredging of new harbour (see figure 5)
- Construction of quay wall, 350 meters (see figure 5)
- Construction of harbour breakwaters, 350 meters
- Mitigating measures for environment

Total costs of the project, excluding costs of financing, would be between 15 and 16 million Euros. Duration of construction is estimated to be between 5 to 8 months.

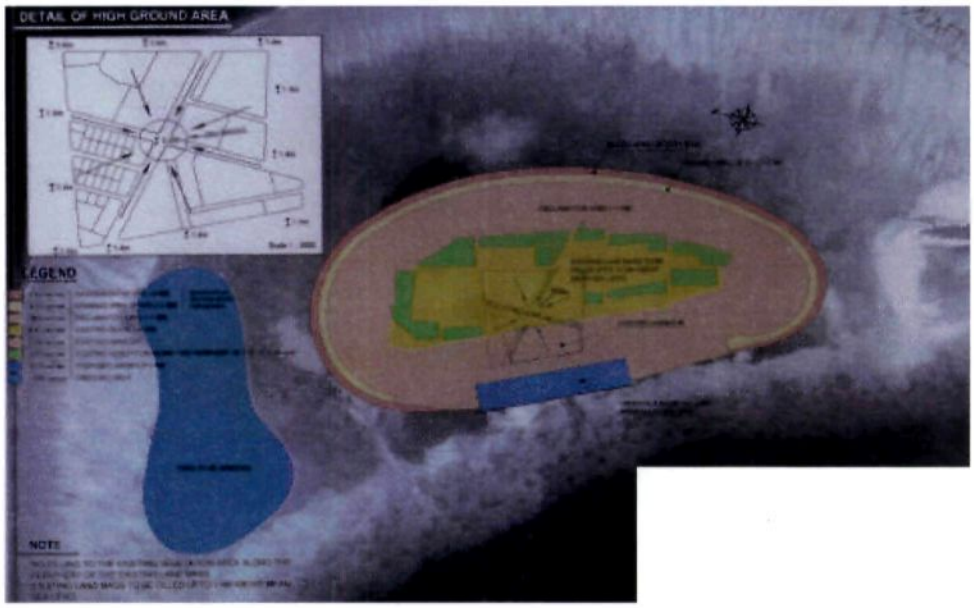

Figure 3: Project Layout

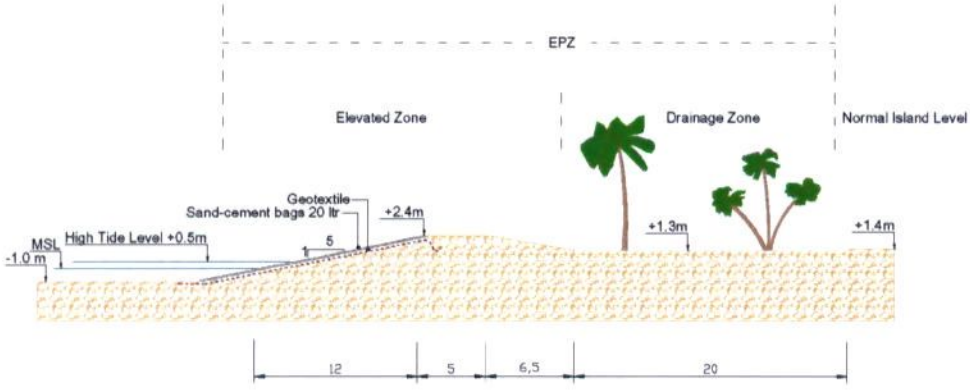

Figure 4: Cross section of the EPZ

Figure 5: Harbour layout

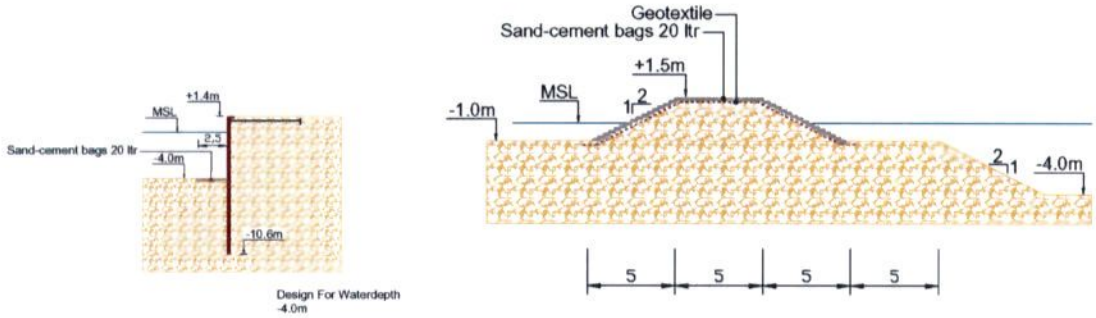

Figure 6: Harbour details (cross section of quay wall and breakwater)

Figure 7 shows the proposed land-use plan for the new, enlarged (60 hectare) and safe Vilufushi island.

Figure 7 – proposed land-use plan (NDMC)

The Environment Impact Assessment (EIA)

The EIA for the Vilufushi Island Reconstruction project has been prepared by Environmental & Dredging Consultancy (EDC) from Zoetermeer in the Netherlands. Field surveys were executed during September and October 2005 by EDC and by Boskalis International from Papendrecht in the Netherlands, the contractor selected to execute the project.

The scope of the EIA has been prepared by the Commission for the Environmental Impact Assessment of the Netherlands and has been approved by the Ministry of Environment and Construction of the Maldives (MEC) in June 2005; it follows the Standard Guidelines for EIA (MEC, 2004).

In the EIA the current situation of the socio-economic environment is described; it includes the pre-Tsunami situation and the present situation. The present EIA also describes for the proposed project (Island Reconstruction) the direct socio-economic impacts of the execution of the works including increased safety for the inhabitants. It is noted that the follow-up activities of the proposed project will also have socio-economic impacts, which are beyond the scope of this EIA, but which require attention in the follow-up phase. It has been agreed that these impacts would be described in an addendum to the EIA, to be submitted later.

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position of Maldives authorities?

2 Justification of the project, Design Considerations

The first and main justification of the present project is the reconstruction of the Vilufushi Island, in such a way that the pre-Tsunami inhabitants can return to their island and start rebuilding their lives and their community. The reconstructed Vilufushi should offer them at least the same environment and opportunities as the old Vilufushi, before the Tsunami.
However, the old Vilufushi had its clear disadvantages, the main ones being high vulnerability to future natural disasters in particular related to sea-level rise and not enough space for development or growth, resulting in migration towards places with more opportunities, notably to Male.

The Tsunami disaster has yet again underlined the critical importance of providing environmentally safe zones for isolated communities living on distant islands. For this and other reasons the Government of the Maldives had already, prior to December 2004, developed the so-called "Safe Islands Programme" (see Chapter 1).

So in addition to reconstruction of the old Vilufushi, the project will also "improve" and enlarge it. The increase of the surface area of the island is necessary, because the island as-it-was was already completely full with houses. The increase offers space for safe zones, possibilities for population growth and also does allow for people from some other smaller islands nearby, which were totally destroyed, to be resettled in Vilufushi. The extension of the island also allows space for extra social infrastructure such as schools, sport facilities, medical facilities, etc.

The choice to start the post-Tsunami reconstruction with the islands of Vilufushi and Meemu Muli (and some other islands) is clear: they are in the category of the ten worst-affected by the Tsunami, they qualify under the "safe-islands" program and have a population of over 500 -800.

Design Considerations

As the Safe-Island / Focus-Island policy had already been developed and approved by the GOM prior to the tsunami-disaster and as Vilufushi had already been selected as the Focus island for Thaa Atoll, the present EIA has not considered any alternatives for the overall layout and design of Vilufushi-Safe-Island, with its EPZ, its new harbour, and other design features, which were developed over a period of some 5 years by the various GOM ministries concerned.

verwijzen naar documentatie argumentatie

Taking into account the pre-tsunami surface levels, but also the future sea level rise, the area for housing and social (and commercial) activities will be raised to MSL+ 1.4m. This applies both to the restoration of the existing island, and to the new, reclaimed areas. In addition, based on the 'safe island' concept, some areas of high ground will be created, to be used for emergency evacuation. Their level will be MSL+ 2.5m. The Environmental Protections Zone, surrounding the island on its East, North and South side, consists of an embankment with slope protection raised to MSL + 2.4m, a drainage area and a green zone.

The new island, just as the old island, is located centrally on the wide reef-area, and has a similar oval shape. The N-S length of the new island will be approximately 1230m (old: 750m), and the W-E width of the island will be approximately 650m (old: 250m). The harbour will again be located on the relatively sheltered lagoon side (West) of the island. For the design of the reclamation, the revetments and the harbour, generally techniques are proposed which have already been applied in the past elsewhere in the Maldives. The borrow area for the 1 million m3 of sand for the reclamation has been designed centrally within the large North side of the reef; *its depth will be up to 6-7m below sea level.* location alternatives?

Level of protection

In the past the island has experienced little damage through waves, storms, or even tsunami's, partly due to its location centrally on a large reef. As on most other islands of the Maldives, the margin against sea-level rise and freak storm-surges does not exist. The Tsunami of 26th December 2004, for which a frequency of between 1:200 (years) has been mentioned, resulted in waves of a magnitude not seen before on Vilufushi (up to MSL + 3m - almost 2m above the island surface) and resulted in almost total destruction of the islands houses and infrastructure and even damage to the island itself; 20 people died.

The impact of physical measures proposed under the safe-island concept, results for Vilufushi in a very much diminished risk of loss of human life and same for damage to infrastructure and property for a period of at least some 50 years from now. Even a tsunami of the December 2004 magnitude would result in much less loss of life and smaller damage.

In addition there will be a huge psychological (and consequently economic) impact, due to the increased safety. The impacts of enlarging the island have already been explained above.

3 Alternatives considered, project impacts and mitigating measures

As the Safe-Island / Focus-Island policy had already been developed and approved by the GOM prior to the tsunami-disaster and as Vilufushi had already been selected as the Focus island for Thaa Atoll, the present EIA has not considered any alternatives for the overall layout and design of Vilufushi-Safe-Island, with its EPZ, its new harbour, and other design features, which were developed over a period of some 5 years by the various GOM ministries concerned.

There are however a certain number of alternatives for the construction-methods to be employed, which may have large environmental impacts. They are summarily described here below, and their impacts.
The most important are the alternatives for winning over 1 million m^3 of sand; the other ones concern structural elements of shore protections and harbour.

Dredging alternatives
The project requires between 1.0 and 1.5 million m3 of suitable fill sand.
The possible sources of fill material are the following:

1. Sand from the shallow reef flat area next to the island to be dredged by a CSD (cutter suction dredger) with a pipeline system, as planned;
2. Sand from the bed of the lagoon in the Thaa atoll to be dredged by the TSHD (trailing suction hopper dredger) with a pipeline system;
3. Sand and coral material from a coral reef (faro) elsewhere in the Thaa lagoon to be dredged by a CSD;
4. Sand imported from overseas by a Jumbo trailer (very large trailer).

Dredging alternative	Technically Feasible	economic ranking	environmental ranking
1. CSD/ reef	Yes	1	1
2. TSHD/ Lagoon	Yes	2	3
3. CSD/ reef other	Yes	3	unacceptable
4. Jumbo/ overseas	Yes	4	2

Table 1: Comparison of dredging options.

From the point of view of the impact in the borrow area and of impact through resuspension of material, the alternative (1) of dredging by CSD at the shallow reef, appears to have less impact and permits also mitigating measures, such as an embankment around part of the borrow area and extra settling basins to minimise the effects. This alternative appears to be acceptable from the point of view of the

environment and has been chosen for the project; the necessary mitigating measures have been included in the project scope.

For the reclamation area there are the four alternatives; they are compared in the table below.

Reclamation alternative	Technically Feasible	economic ranking	environmental ranking
Open reclamation area	yes	1	unacceptable
Closed recl. Area	yes	2	3
Closed recl+ settling basin	yes	3	2
Closed recl+ more settling basin	yes	4	1

Table 2: Comparison of reclamation options.

From an environmental point of view the alternatives with settling basins are acceptable; careful monitoring of turbidity will show how many settling basins will be required, and what size they should ~~have.~~ is dit dus onderdeel van projectactiviteit? (budget)

There are two alternatives for the dredging of the entrance channel to the borrow area on the reef. They are compared in the table below

Entrance channel alternative	Technically Feasible	economic ranking	environmental ranking
From old harbour	yes	2	2
Direct from lagoon	yes	1	1

Table 3: Comparison of entrance channels.

The entrance channel from the lagoon side has been chosen; its environmental impacts are limited. It should be partly closed after completion of the dredging works.

There are various alternatives for some of the main structural elements of the project; they are summarily compared in the tables below.

Revetment alternative	Technically Feasible	economic ranking	environmental ranking
Sand cement bags	2*	1	0
Rock slope	1*	2	0

Remarks: * Both alternatives have been used elsewhere in the Maldives

Table 4: Comparison of revetment options.

Quay wall alternative	Technically Feasible	economic ranking	environmental ranking
Concrete L-wall	1	1	0
Sheet pile wall	2*	2	0

Remarks: *depends on soil survey

Table 5: Comparison of quay wall options.

From an environmental point of view concrete might be the preferred material versus steel; however steel sheet piles have often been used in the Maldives for quay wall structures.

Breakwater alternative	Technically Feasible	economic ranking	environmental ranking
Sand cement bags	2	1	0
Rock slope	1*	2	0

Remarks: * Solution has been used elsewhere in the Maldives

Table 6: Comparison of breakwater options.

In fact all alternatives considered are acceptable from an environmental point of view; economic considerations will determine which will be adopted for construction. There are hardly any mitigating measures, other than careful construction using appropriate quality standards.

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4 Monitoring Plan

The monitoring program is based on the information needs for the project, the equipment, the monitoring locations and the frequencies and the monitoring reports. The monitoring program includes three items being:

- Information needs
- The monitoring program including the equipment and the locations and frequencies
- The monitoring reports

In this monitoring plan, which includes both the construction phase and the long term, the most relevant information needs are described, being:

1. Water quality aspects, including suspended sediments and sedimentation
2. Ecological aspects related to corals and seagrasses.
3. Soil salinity
4. Groundwater quality
5. The re-colonization of the borrow area at the flat reef
6. Erosion around the borrow area

The monitoring reports will be submitted to the Engineer, the Employer and the Contractor.

5 Project Risks

There are relatively few risks associated with the project. Three of them are worth mentioning here:

The release of suspended sediments during construction into the marine environment would constitute the main project risks. However the execution of the project by an experienced contractor in this field, careful monitoring of suspension levels during dredging and reclamation, and applying mitigating measures when necessary, would reduce this risk to virtually nil.

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There are potential risks that debris originating from the Tsunami will pollute the environment on or around the new island. Therefore the Contractor should plan and execute a debris-removal activity along well established guidelines; this should include careful sorting, destroying and/or removal of all debris, including his own construction-related wastes. It is worthwhile to separate the debris that can be used in new-construction i.e. as core material for the new breakwater.

Given the relatively short construction period - 6 months or so, the GOM should not loose any time to plan and prepare the construction activities which follow after the island construction.

hebben wij ook al gezegd

6 Conclusions

1. The reconstruction of Vilufushi island in Thaa Atoll is extremely urgent for social and economic reasons. It is acceptable form an environmental point of view and project risks are relatively small.

2. In view of future developments (technical: sea level rise / social: population pressure / economical: efficiency of services) it would appear to be logical to adopt the "safe-island" concept for both reconstruction and the enlargement of the island.

3. No alternatives have been considered for the layout of the future island and/or for the safe-island design criteria, as these had already been adopted by the GOM prior to the 2004 Tsunami.

4. From various alternatives to dredge 1 million m^3 of sand fill required for the reconstruction, the alternative of dredging coral sand from an area of the northern reef-flat of Vilufushi by medium sized Cutter Suction Dredge and pumping directly into the area to-be-filled, is by far the most attractive.

5. During the dredging and reclamation activities, good care should be taken to allow only a pre-determined minimum of suspended sediments to escape *from the working areas. Mitigating measures such as protection bunds on* the reef and/or suspension basin(s) in the reclamation area should be employed when the necessity arises. is het hoofd dan al niet geschied?

6. Monitoring should concentrate upon the aspects mentioned in conclusion 5 here above.

7. Debris removal from areas to-be-filled should be carefully planned and executed prior to start of filling in the area concerned. Debris should be sorted in reusable and not-reusable material.

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