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UNITED NATIONS DEVELOPMENT PROGRAMME

Global Environment Facility

PROPOSAL FOR PDF BLOCK B

Country:	Republic of Maldives
GEF Operational Programme:	Biodiversity - Coastal, Marine and Freshwater Ecosystems-OP2
Project Title:	**Conservation and Sustainable Use of Biodiversity Associated with Coral Reefs in the Maldives**
Funding requested:	US$ 310,000
Co-funding:	Government of Maldives: $45,850 (18,850 in kind)
Country Eligibility:	Convention on Biological Diversity, ratified 9 November 1992
Requesting Agency:	UNDP
Executing Agency:	Environment Section
Project Type:	PDF Block B
Block A Grant awarded:	$25,000 (January – February 1999)
Duration:	Twelve months
Estimated Starting Date of PDF B:	June 2000
GEF Operational Focal Point:	Mohamed Khaleel, Environment Section, Ministry of Home Affairs, Housing and Environment
Estimated Project Size:	US$ 2-3 million (GEF)

1 PROJECT SUMMARY

In the Maldives coral reefs are an essential backbone of the economy and culture, providing primary coastal sea defence, fisheries, tourism and a variety of biological diversity functions. Presently a wide range of human activities are responsible for the degradation of the marine and coastal environment, which in turn may lead to loss of biological diversity and the consequent fragmentation of marine and coastal ecosystems. Planning for conservation and sustainable use of marine and coastal resources requires the recognition of necessary limits of human use on those resources and, a holistic approach to planning, management and multiple use of the natural resource. At present, fishermen, coastal developers, shipping, sportsmen and tour operators all use the environmental goods and services provided by the coral reefs without adequate consideration of each others' needs, interests or plans.

The goal of the Conservation and Sustainable Use of Biodiversity Associated with Coral Reefs of the Maldives Project is to work with island communities to identify and sustainably remove threats to biodiversity in selected atolls representative of the Maldives, for replication throughout the Maldives and in coralline atoll environments elsewhere in the world.

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1.1 Context

1.1.1 Biological

The Republic of Maldives consists of a double chain of coral atolls, 80-120 km wide stretching 86 km from 72° 32' N and 73° 45' E. This chain lies south west of India on the Laccadive-Chagos ridge in the central part of the Indian Ocean. There are 23 geographical atolls grouped into 20 administrative units with the capital island Malé forming a separate administration. The maritime area of the EEZ covers 90,000 km² but the land area is estimated to cover only 300 km². There are 1190 islands of which only 202 are inhabited and currently 77 developed as tourist islands. The very existence of the Maldives islands is entirely dependent upon the growth of scleractian corals and deposition of their calcium carbonate skeletons over millions of years. Coral reefs provide various functions and services including; essential coastal sea defence, fisheries, tourism and a variety of biological diversity functions. The socio-economic benefits of coral reefs are recognised, for example, a recent study has estimated the global socio-economic benefits of coral reefs as US$ 375 billion yr^{-1}.

Biodiversity

The coral reefs of the Maldives have the greatest coral diversity in the central Indian Ocean. The unique characteristic that make the Maldives so striking compared to other reef systems in the region is the sheer abundance of islands, reef formations and the associated reefs and fauna. An exceptional feature of Maldivian atolls is the large number of faros or ring shaped reefs they contain. These structures occur in abundance in the north and central atolls but not in the south. Such ring reefs are found in other regions but nowhere are they found in such abundance as in the Maldives. The reason for their formation is not fully understood but the term faro, used worldwide, originates from the Maldivian Dhivehi language.

Regional variations exist across the archipelago in oceanographic conditions and the structure of reef formations. The northern region atolls have more open structures with wider channels and contain some of the highest islands with large sand-dunes and fresh water lakes. The central region lies on the central Maldivian plateau which has a high level of productivity due to upwelling and contains diverse reef formations and extensive faros. The southern region marks the boundary of the central plateau and is characterised by deep (1800-2000m) atoll channels but reef formations are less diverse with few faros. Moreover the influence of seasonal monsoons is greater in the north and central atolls.

A detailed biodiversity inventory has not been undertaken but it is estimated that there are at least 250 species of scleractinian corals. A total of 55 genera of hermatypic corals have been recorded in the south and 41 genera from the north. Fish populations are both diverse and extremely abundant, over 1200 fish species have been recorded for the reefs and surrounding areas. The invertebrate fauna is largely undocumented but provisional estimates indicate that there are between 100-200 sponges, over 1000 crustacea, 500 molluscs and 100 echinoderms. Five species of turtle are found in the Maldives. It is likely that the Maldives is one of the most species rich marine areas within the region.

Four species of seagrass have been recorded in the Maldives but extensive beds are rare with the exception of the southern region. These areas have high value for turtles and support large numbers of invertebrates. Five species of mangroves are known to occur in the Maldives but their distribution is not even across the country and mangroves are generally regarded as being more abundant and diverse in the southern region. Terrestrial fauna is relatively depauperate. It is estimated that there are 500 plant species, including introductions, of these 5 are estimated to be endemic. The known endemic species belong to the genus *Pandanus*.

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Forests of *Psonia grandis* covered much of the land before clearing for cultivation and settlement

Threatened species

Endangered species include the hawksbill turtle *Chelonia mydas*, the green turtle *Eretmochelys ambricata*, the blue whale *Belaenoptera.* Species considered to be at risk include; the spinner dolphin *Stenella longirostris*, striped dolphin *Stenella coeruleoalba*, spotted dolphin *Stellella attenuata* and the whale shark *Rincidon typus*.

Around 180 bird species have been recorded in the Maldives. Most are seasonal visitors, migrants or introduced species. Over 40 species of sea bird are identified, of these 13-15 are known to rest and breed in the Maldives. Endemicity and the frequency of unique sub-species is high in the south.

Importance of islands

Islands comprise coralline cays with unstable bioclastic sand and rubble which are strongly influenced by seasonal monsoons. Over 80% of the islands are less than 1-1.5 m above mean sea level and coral reefs play a vital sea defence role, protecting the islands from storm damage and flooding. These islands are among the most vulnerable to the predicted rise in sea level as a result of global climate change.

Maldives has a strategic geographic position at the centre of the Indian Ocean. The fact that endemism is rare in the Maldives is indicative of the role it may play as a colonisation corridor, transferring genetic material between the eastern and western sides of the Indian Ocean. It is likely that a large component of the fauna originates from the Laccadives, Sri Lanka and India. However, the possibility of colonisation from the African sub continent cannot be discounted, especially in the south.

Value of Coral Reefs

Coral reefs contain significant genetic and biochemical resources. Pharmaceutical research and bioprospecting offers an opportunity for Maldives to harness market forces. Coral reefs also provide vital sea defense services. In Malé where reefs have been sacrificed for land reclamation, sea defense is now provided by a series of detached breakwaters (composed of concrete tetrapods) at a cost of US$ 14 million to protect 1.52 km of shore. This gives a value of £5,625 (US$ 9,000) per linear metre indicating the replacement costs for low lying islands that are dependent upon the adjacent coral reefs for protection from waves.

1.1.2 Socio-economic

The most recent population census (1995) records a total population of 244,600 with 63,000 being in the capital, Malé and 182,000 in the atolls. The people of Maldives have seen very large benefits from the expansion of tourism in recent years. The income to government from taxation on tourism contributes 30% of fiscal revenue. The tourist industry is based on diving and other recreational activities that depend on the high quality of the marine environment. The islands on which resorts are established are subject to erosion from degradation of the atoll ecosystem, therefore the industry is dependent on the future health of the environment on which it is based.

Most other economic activity that generates revenue is also based on tourism. Import duty accounts for 60% of tax revenue, much of which is to service tourism, the other principal activities being fisheries and construction. Tourism is a major contributor to GDP with direct contribution of 20% from land rent and bed tax. (See Annex 1)

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Tourism provides the income on which health and education services are based and is an increasing source of employment with 10,600 people working directly in the industry of which 5,800 are Maldivian.

Atoll populations are increasingly involved in commercial activities and have benefited from the developments in communications from motorization of boats and the spread of telecommunications. Remote islands that were only accessible in sailing boats up to 20 years ago can now be visited readily and their resources utilised. Communications to Malé are improving all the time and other economic centres are developing in the north and south of the country. The Atoll populations are largely dependent on the resources of the islands, reefs and the sea. Prior to tourism all fishing was pole and line tuna fishing using live bait from the reefs, demersal reef fishing was practised at a very low level. The increasing population, advent of tourism and improved communications has seen a rapid rise in coral and sand mining, reef fishing for tourism, live fish export and exploitation of remote reef areas previously inaccessible.

1.1.3 Institutional

In the Government of Maldives environmental management is entrusted to the Ministry of Home Affairs, Housing and Environment in which the Environment Section reports to the Minister. Organisation charts in Annex 6.

The Environment Protection and Preservation Act (EPPA) of 1993 empowers the Ministry of Home Affairs, Housing and Environment, Environment Section to regulate all forms of activity for the conservation of the environment. This gives the Environment Section and the Ministry a coordinating role with other national administrations, where their activities affect the environment, under the overall guidance of the Presidents office. The act also provides for the National Council for the Protection of the Environment, the council meets regularly and the membership comprises senior members of the Ministries of:

- Atoll Administration
- Construction and Public Works
- Defence and National Security
- Education
- Fisheries and Agriculture
- Health
- Information and Culture
- Planning and national Development
- Tourism
- Malé Municipality

Ministries with direct activities in the coral reef environment are:

1. Ministry of Fisheries Agriculture and Marine Resources,
2. Ministry of Atolls Administration
3. Ministry of Construction and Public Works ,
4. Ministry of Tourism
5. Ministry of Transport and Communications (ports).

Under the Environment Act all activities are referred to the Environment Section for an assessment as to its potential environmental effects. If the Environment Section decides there are issues to be investigated then a scoping exercise is carried out by the Section, to provide

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the concerned Ministry with guidelines for the appropriate environmental impact assessment (EIA) study. EIA studies are made available to the public for comment and are evaluated by the Environment Section to form a view on the advisability of the proposal and, if allowed, the environmental commitments to be followed by the proposer as well as the monitoring and auditing programme to be established.

The Environment Section has an environment research centre currently based on Vilingili (North Malé atoll adjacent to Malé) but this is not operational due to reorganisation of the Ministries and overseas training of its director. There is a perceived lack of clarity over the roles of the Environment Research Centre (ERC) and the Marine Research Centre (MRC) under the Ministry of Fisheries Agriculture and Marine Resources. In the past there was an understanding at technical levels between staff of the centres that living marine organisms would be included in MRC research activities and terrestrial activities would be the responsibility of ERC. MRC has conducted significant research into the fish, crustacean and cetacean resources of Maldives and has been the focal point for coral reef related research conducted by government and under foreign assistance projects in the past. ERC has a shorter period of experience but as a part of the Environment Section is a coordinating body. The director of ERC is completing an important study into origins and structures of islands in the Maldives[1] which is expected to be of value in the future.

The Ministry of Fisheries Agriculture and Marine Resources is the responsible government agency for the formulation of regulations on coral mining, as well as other living marine resources. Prior to 1992 there were few regulations concerning coral mining. The government is concerned about the environmental implications of coral mining and in 1992 regulations were introduced to control mining activities.

The atolls are administered through 20 atoll offices each responsible for an administrative area, usually whole atolls but some atolls or groups of atolls are too large for a single administration and are subdivided. Each island has an island chief and an island development committee; each administrative atoll has an atoll development committee. The Ministry of Atolls Administration is responsible for representing the requirements of the atoll offices in central government, though atoll offices do deal directly with line ministries.

In atolls the atoll chief is a government appointment, island chiefs are also appointed and have a pre-eminent position in island life, the island chief is the chairman of the island development committee, which decides on all aspects of management of island activities. The application of participatory techniques is in its infancy in the Maldives and will require innovative methods to bring about a change in behaviour and attitude from a more traditional top down approach. The environment is generally viewed as the responsibility of government, and government has reinforced this view through centrally managed administration from Malé. In the past the northern and southern regions had various levels of autonomy and direct trade with India and Sri Lanka, which helped to retain regional identity. The spread of communications by motorised boats and recently telecommunications has brought changes to this system. The centralisation of administration and trade, and recently tourism, on Malé has brought benefits to the central region, which has developed more rapidly than the north and south.

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[1] Financed under the UNDP Capacity Enhancement in Environmental Managing and Planning

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1.1.4 Complementary projects

GEF National Biodiversity Strategy and Action Plan and Country Report to the COP

The objective is to formulate the strategies and actions necessary for then protection and sustainable use of the Maldives biodiversity, the primary output will be the National Biodiversity Strategy and Action Plan.

The project tasks are the training of Environment Section staff as a biodiversity working group in participatory planning methods and biodiversity analysis. The conduct of a comprehensive assessment of the existing information on biodiversity in the Maldives and to carry out a participatory strategic planning process and develop priorities for action in protecting Maldives biodiversity. This would result in a Biodiversity strategy action plan (BSAP) and preparation of the first country report for submission to the COP.

Integrated Reef Resource Management (IRRM)

Since 1988 the Marine Research Centre (MRC) has conducted information gathering activities in the four central atolls of Faafu, Dhaalu, Meemu and Vaavu to work towards an integrated reef resource management system. The project has operated under an annual budget allocation from the national government funds, which has financed travel, educational material costs and subsistence costs. More recently the Bay of Bengal Programme has provided financial assistance for project activities including a workshop in 1996 to present a framework for IRRM.

The MRC has successfully documented a range of detailed parameters for the atolls including:

- Locations of reefs used for live bait fishing for the tuna pole and line fishery, by season
- Reef areas targeted by demersal reef fishermen by season
- Extent of reefs targeted for beche de mer fishing
- Turtle nesting beaches by island
- Islands with habitat for sea bird roosting and breeding
- Areas of atoll used for sand mining
- Reefs used for coral mining
- Areas of each atoll which the community would agree to set aside for marine protected areas
- Locations used by tourist safari boats for anchoring and tourist sites
- Regions of each atoll where conflicts between atoll populations on fisheries exploitation occur.

The programme has reached the point of installation of interactive educational centres in each atoll where data on activities can be entered and retrieved and to serve as environmental education centres.

ADB Establishment of Regional Economic Centres

The Asian Development Bank has financed a period of study to identify the potential for the establishment of centres of economic growth remote from Malé. The objective being to sponsor economic activity in the north and south of the country to reduce national dependence on Malé. The project identified the northern centre Kulhudufushi in Haa Dhaal and Hithadhoo in Addu atoll in the south and is financing port facilities and city infrastructure in both places.

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Australian Aid Protected Area Management

This project is completing its design phase and has the objective of establishing three grades of protected area for the future management of the environment. The project seeks to identify one site which is relatively pristine and uninhabited, which can be established as a totally protected area with no human interference; a second site which is protected from human interference and available for research and tourist viewing, and a third site at which all forms of human activity are managed to protect the environment. The project plans to establish these sites and train the Environment Section in their management as a demonstration.

GEF National Green House Gas (GHG) Inventory and Vulnerability Assessment for the Maldives

The project objectives are a general understanding of the science, impact and policy implications of global climate change in the context of UNFCCC and national communication requirements. Training and capacity building will focus on methods of conducting inventories of GHG and evaluating mitigation options, basic principles and methods of vulnerability and adaption assessment for ICZM planning and use of Geographic Information System equipment and software for vulnerability and adaptation assessments. **Outputs** will include the preparation of national implementation plans and national communications. Overseas training comprises six members of the national team in integrated coastal zone management, geographical information systems, environmental economics and environmental management. National training is targeted at 75 island residents in coastal management, beach surveying and data collection procedures.

Global Coral Reef Monitoring Network

The Global Coral Reef Monitoring Network (GCRMN) sponsored by IOC, UNEP, IUCN has a regional office for the South Asia node in Sri Lanka to co-ordinate activities and training. Events so far include; i) regional Co-ordinator visited Maldives to assess the reef monitoring capacity, ii) Maldivian representatives attended a regional workshop held in India to strengthen links within the region and iii) a regional workshop was held in Maldives in April 1998. A small grant was provided to Marine Research Centre to monitor coral reefs following bleaching in May/June 1998.

Further activities are planned for 4-5 pilot sites around the region for comprehensive socio-economic and bio-physical monitoring activity by local institutions. Potential linkages exist between GCRMN and the PDF B proposal in the context of a complementary monitoring at selected sites.

1.2 Threats to biodiversity

1.2.1 Environmental threats associated with resource use

Most threats to coral reef biodiversity in the Maldives derive from two underlying causes, namely, rapid population growth and urbanization, and technology development – including improved communications and more efficient transportation (both internationally and inter-atoll). Taken together, these have generated a suite of threats, described below.

Exploitation of reef fisheries

Historically the only reef fisheries in the Maldives were livebait for the pelagic tuna fishery and the money cowry for export to Asia and Africa. The introduction of tourism in the 1970's and the mechanisation of the fishing fleet and development of the export market for reef fishery products around the same time, together with the rapidly growing population,

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resulted in a rapid economic and social development to the country. The consequences of these developments include; overfishing of some reef resources, degradation to the coral reef environment and an increase in resource user conflicts.

Tourism created new demands for reef fisheries and this was expanded in the 1980's for export-orientated fisheries such as beche-de-mer, giant clams, shark fishing and aquarium fish. The livebait and money cowry fisheries have survived for centuries despite high levels of catch and effort. In contrast some of the newly developed export orientated fisheries such as beche-de-mer and giant clam have reduced resources within a few years. The relatively new grouper fishery that started in 1993 to supply live or chilled grouper to the East Asia market has expanded rapidly. There is evidence that individual atolls are being overfished as the activity spreads from atolls close to Malé to more remote areas. Therefore selective fishing on coral reefs for single species such as groupers and sharks as practised in recent years threatens the whole future of the two mainstays of the national economy, fishing and tourism.

Coral reef fisheries are based on long lived demersal species that cannot withstand unmanaged commercial fishing practises. The long tradition of pole and line fishing for pelagic tuna resources in Maldives has been sustained up to the present day due to the previous fishing strategies of using coral reefs for bait fish supply only. All other pole and line fisheries in the world have ceased due to the lack of bait fish from over exploitation of coral reefs. Maldives is unique in still retaining a coral reef habitat able to support bait fisheries. Pole and line caught tunas have a preferred status in international markets as the fishery is perceived to be sustainable and yield high quality product. Other forms of surface swimming tuna exploitation are industrial with high capital costs and low employment.

Coral mining

Coral mining is a major cause of reef degradation. Miners select massive corals which are the longest lived species and form an essential element of the reef structure This results in a loss of topographic complexity, diversity of corals and reef fish and leaves an unconsolidated substrate, which is subject to further erosion. Reef recovery from such physical disturbance is limited by the lack of suitable surfaces for new recruitment.

Coral mining has severe implications for the tourist industry, as the loss of healthy reefs will reduce the very resources that attract the visitors in the first place. The traditional pole-and-line tuna fishery, unique in the world and the major employer in the country will be directly affected as it is dependent on bait fish collected from shallow reef areas, in particular the faros which are the preferred areas for coral mining.

Inhabited and tourist islands have adopted short-term measures to protect islands from erosion, which is a normal process in small islands in atoll environments. However the extraction of coral and sand from reefs and beaches has resulted in acceleration and changes to the natural order. Continued current practises are not sustainable and will result in high costs without necessarily providing long term solutions.

Ecological interactions between corals reefs, seagrass beds, mangrove areas and marsh areas are vital for maintaining natural ecological balances. These ecosystems are currently under threat due to land reclamation for human settlements. In southern regions, such as Addu and Fuahmulah mangroves areas are removed for firewood, house building material and used for garbage disposal. Use of uninhabited islands to supply firewood and construction timber and for agricultural use has significantly altered the natural vegetation patterns on many islands. Degradation of the habitat has also reduced the number of nesting sites for birds. An important relationship exits between seabirds and Maldivians, as they are directly related to

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fishing activity. Seabird flocks are important indicators of tuna schools and up to 90% of tuna is located this way. Reduction in the number of seabirds is directly affecting the pole and line tuna fishery, and has lead to community designation of protected status for some species.

Tourism

Maldives has developed a form of tourism that is appropriate for small island developing states, based on the image of a lost paradise. Tourism is entirely dependent upon the environmental quality and initially facilities were basic with a low impact on the environment. Recent expansion has developed a diverse range of options within a more elaborate infrastructure required to support the facilities.

A number of critical environmental issues arise from construction of resorts, harbours and other infrastructures in the coastal zone. These include;

- the use of coral and sand in the construction industry,
- dredging plumes, construction debris and dust that is generated
- land reclamation and shoreline re-modelling, and
- disposal of solid waste and sewage.

Tourists come in large numbers with 365,500 arrivals in 1997; bed capacity in 77 resorts is 11,500 with an average of 77.5% capacity usage in 1997, this was a 7.5% increase on 1996 a rate of increase which has been steady for some years.

Following the introduction of the main law on tourism in 1979 various regulations and standards have been specified, including important regulatory measures for building standards, sanitation, disposal of garbage carrying capacity and tourism behaviour. Enforcement of these regulations through voluntary compliance is variable between resorts.

The regulations enforced on tourist islands are in general well received and respected and in many cases exceeded by responsible operators, realising that part of their market is dependant on an image of protection of the fragile environment. However conflict exists where inhabited islands are adjacent to tourist islands and no regulations are applied to inhabited islands.

The effects of various development pressures on coral reef environments has been assessed and some of the general findings are summarised in the table in Annex 3.

1.2.2 National Biodiversity Conservation

On 5 June 1995, the Government of Maldives announced the establishment of 15 Protected Marine Areas within major tourist atolls to coincide with World Environment Day. The 15 protected areas represent popular dive sites that are at risk from the detrimental effects of over-fishing, anchor damage and coral mining. The Ministry of Planning Human Resources and Environment manages these areas and they are protected under the Environment Protection and Preservation Act (Law No. 4/93) of Maldives. Only limited activities are allowed in these areas. Annex 4 shows details of existing protected areas.

2 PROJECT SITE SELECTION

This PDF B will develop a Full Project that will address complex environmental and management issues for the future sustainable use of coral reefs. For reasons described here it

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is proposed to promote reef resources management on an atoll scale, rather than a national or island scale as:.

- Most reef-based activities are not carried out uniformly across all islands thus high fishing effort or coral/sand the construction debris and dust that is generated extraction in one island or area may lead to local overexploitation, which is not representative of the "atoll" situation.
- Fishermen often transfer between fisheries to take advantage of more profitable fisheries, especially when tuna catches are low.
- Reef fisheries do not exist in isolation and there is a wide spectrum of interactions between reef resource use within a given area.
- Absence of a traditional tenure system means that resource users have open access to any atoll. Thus there is no incentive for communities to conserve their atoll.

The concept being that experience gained at atoll level can be replicated in all atolls of the country, the activity needs to represent groups of islands and utilise the existing atoll management structure.

Sustainable management of reef resources requires a holistic approach, which deals with all human activities and their associated threats. This is supported by sound biological criteria including larval dispersal patterns, coastal processes and ecosystem balance. For example, in the sea, habitats are rarely restricted and survival of a species cannot be linked to a specific site.

2.1.1 Site selection procedures

A site selection process was conducted under the PDF A grant to select candidate atolls for the planned activities under the PDF B project. Given the regional variation in biophysical processes, (see section 2.1.1.1.) demographic characteristics and socio-economic indicators (Annex 5) a matrix approach was adopted for the regional analysis study. Based upon extensive consultations with government, non-government representatives and the private sector, agreement was reached on four sites. Representative atolls within the three main sub-regions were identified as follows:

1. Baa atoll – northern region
2. Vaavu atoll - central region
3. Meemu atoll – central region
4. Seenu atoll – southern region

The two central atolls Vaavu and Meemu have been included as a "unit" to consider inter-atoll issues relating to reef resource utilisation and resource user conflicts. Confirmation of the candidate sites will be addressed in the PDF B project and island sites for more detailed surveys will be selected through community consultations within each atoll.

3 OBJECTIVES AND ACTIVITIES FOR THE PDF B

3.1 Approach

The PDF B is designed to generate the information needed for the design and implementation of a Full Project for GEF, government, private sector and other development assistance

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financing to sustainably remove all identified threats to conservation of biodiversity of the coral reef habitats of Maldives. The objectives of the PDF-B activities are:

- to confirm the preliminary site selection undertaken by the PDF-A
- to undertake stakeholder consultations (communities, fishery and tourism sectors, etc.)
- to conduct surveys related to the status of biodiversity, intensity of threats, etc.
- using information from the previous two objectives, to propose strategies to be pursued in the Full Project, and
- to produce a Full Project GEF brief.

To meet these objectives, specific PDF-B activities are described below. There is a substantial degree of overlap in these activities, as befits a system wherein threats to biodiversity are so inter-related. Each of the activities involves actions that can be grouped under one or more of the following project **components**.

Stakeholder consultations

The PDF B team will work with the island development and women's committees at inhabited island level and with the Atoll office and Atoll development committee at Atoll level to identify the current status of the marine and terrestrial environments of the selected atolls. The information will first be recorded manually onto island and atoll maps and then later transferred to the Environment Section GIS system to construct visual representations of each and all threats to coral reef biodiversity.

This information will then be shared with the communities at all levels and their confirmation sought, following this the next round of consultations will request and propose solutions to the various threats and conflicts of over exploitation, pollution and competitive common resource use.

In the 2 central atolls of Vaavu and Meemu much of the groundwork of identifying threats and solutions has been carried out under the IRRM project, in these atolls the PDF B will test solutions. In Vaavu and Meemu atolls these and other identified solutions will be tested on pilot scales to determine their feasibility. The implementation of these solutions, together with the surveys required to support them, would form the work plan for the main project.

Ecological and Planning Surveys

Early phases of the PDF B project will involve acquisition of data from existing sources, and from field surveys, which will serve as inputs into a baseline data report. Standardised protocols and pro-forma data sheets will be developed, using the experience of the IRRM project, for collection of marine resource and planning data from selected sites. This will allow good comparability between islands / atoll sites. Assessment and analysis can be done at high resolution (i.e. by island) or lower resolution level (i.e. by atoll). These results will be valuable for identifying 'biological hotspots', as well as areas of heavy resource use, impacts and conflicts. This approach also allows ranking of reefs or islands according to various criteria and attributes, to help determine priority areas for protected area management.

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Information Management and Dissemination

Databases and a GIS system will be important components of the full GEF project. In this PDF B project an incremental approach will be adopted to build up the information databases, as technical capabilities become available. In this way it will be possible to demonstrate whether the approach is effective, before investing large funds into the system.

The project will use a planning system to combine physical, ecological and socio-economic data for analysis and diagnostic purposes to help rationalise reef resource allocation. Based on this planning system, thematic maps, incorporating different types of overlaid data will be produced for use in community based reef resource management. For example, this technique will identify the potential for complementary protected area and tourism areas within candidate sites. This information, and the results obtained by the marine ecology surveys, will prepare a solid foundation for the application of short-term and long-term sustainable community based resource management within selected atolls.

Review of Institutional Arrangements for Coral Reef Management

Though the Environment Law and the Fisheries Act provide for the protection of the environment including coral reefs, coral reefs do not fall under the direct responsibility of any of the existing institutions, it is a common property resource on which all national activities take place. The Environment Section was established as the lead institution in environmental management and so is primarily responsible for coral reef conservation and management. The Section needs the assistance and cooperation of:

- Ministry of Fisheries Agriculture and Marine Resources. This ministry has the Marine Research Centre responsible for research into all living marine organisms, is responsible for fisheries (a major player in degradation of the reefs), existing regulations on coral mining and has management arrangements in the atolls.
- Ministry of Atolls Administration on the basis that degradation is taking place due to human activities in the atolls, which come under the management of the atoll offices.
- Ministry of Construction and Public Works as coral mining for construction purposes, dredging for harbour construction and reclamation activities poses the biggest single threat to the biodiversity of the coral reefs

The project will focus attention on the institutional and capacity issues in the consultative process and identify training and support needs so that the GEF full project activities have the institutional support required to achieve the objective.

3.2 PDF B project activities

A series of targeted management measures are set out below as principal project components of the PDF B project. These aim at maintaining the sustainability of human uses that depend on a range of functions and services provided by coral reefs. They will also help resolve specific conflicts, problems and management issues. Two components, namely community consultation and environmental education are identified as separate project activities however, it is recognised that they are critical elements that underlie all project activities.

Linkages will also be made with a range of management measures identified as sub-projects in section 4.7. These include biodiversity assessments, applied research and protected areas management.

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3.2.1 Develop strategies for a reduction in coral and sand mining

Objectives: This issue has several components, it is clear that extraction from the environment must decrease for coral reef biodiversity conservation, therefore the use to which mined coral and sand is put must eventually be replaced by alternatives. However, it is not sustainable to simply terminate a whole section of economic activity without offering a replacement. The PDF B will work in the selected atolls to define the social implications of the required management of extraction, conduct pilot studies with alternative building materials and identify alternative income strategies. The consultative process will work with communities and government to identify the true economic costs of coral and sand mining and therefore the future strategies for importation of replacements. It will also explore financing options for partnerships between the public and private sectors to support demonstration projects.

Community consultations and atoll/island surveys

Activities:

- Conduct community workshops to acquire information on the status of coral and sand mining within selected areas. Acquire information on mining locations, current demand for coral rock and socio-economic issues.
- Use educational campaigns to demonstrate the destructive power of coral mining and promote public acceptance of alternative building materials and the need for management of sand and coral mining activities.
- In collaboration with the Island Development Committees review existing regulations for coral and sand mining to identify improved management measures. This will address: i) the allocation of specific zones for coral and sand mining, ii) existing procedures for island records on coral/sand mining and iii) the projected demand for coral and sand within project areas.
- Preliminary field studies will collect information on the impacts of coral and sand mining, particularly the use of coral in the construction of jetties, breakwaters and for large-scale development projects within selected sites.

Outputs: Situation profile on coral mining activities in each of the selected project areas, including an assessment of the threats, costs to and the willingness of the communities to adopt alternative materials. Community participation in pilot projects for sustainable coral and sand mining practices. Guidelines to improve existing data collection with recommendations for coral/sand collection permits and "hotspots" that require protection. A report on the environmental implications of coral use in coastal protection measures.

Develop options for replacement materials

Activities:

- Facilitate partnerships with investors, government partners, chamber of commerce and local construction companies to design practical, least cost solutions for the building industry thereby effectively reducing damage to coral reefs and protecting coastal integrity. Development solutions will include, but not be limited to the following: use of waste materials from large scale construction projects in Malé, new designs for stronger concrete blocks and alternative materials such as wooden constructions.

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- Conduct pilot studies in selected atolls with local manufacturers of hollow cement blocks to trial a range of alternatives and develop a management system for quality control that can be supported by government legislation and enforced by an appropriate government agency, in this case MCPW.
- Collaborate with MCPW and the private sector to prepare guidelines (code of practice) for building standards in the hollow concrete block building industry using coral sand.

Outputs: Formulation of guidelines for the construction industry to standardise hollow concrete block production and provide a reliable product to replace the use of coral rock. Report outlining options for alternative building materials, a cost benefit analysis and mitigating actions that will reduce threats to coral reefs where mining is still permitted.

Definition of employment alternatives

Activities:

- Review opportunities for alternative employment opportunities for the present work force engaged in coral and sand mining activities.
- Conduct an economic analysis of the cost of substituting local materials with imported materials, identifying economic benefits and losses to all sectors involved in the present industry.
- In collaboration with government authorities assess the use of soft loans for construction projects using alternative materials.

Outputs: Identification of options for employment identified and discussed with local communities. Economic analysis of substituting coral rock with imported materials and potential funding sources identified for new technologies.

3.2.2 Design of an Integrated Environmental Education Campaign

Objective: The true nature of coral reefs, their value to the nation and the world and their vulnerability to human activities are clearly not known to significant proportions of the population. Others may have knowledge but are driven by the short term gains from exploitation of fish resources, coral mining, construction of harbours and tourist resorts and lack of investment in sewage treatment and garbage disposal in population centres. These issues and practical solutions for conservation need to be disseminated to all parts of the national population and visitors to the country. Integrated environmental educational campaigns will be designed to promote understanding and support for the PDF B project activities.

Consultations with local communities, NGOs, education sector and other government officials

Activities:

- Orientation workshops with local communities, government and non-government representatives to introduce the PDF B project objectives, activities, outputs and evaluate target audience needs.
- Conduct an assessment of the current environmental education (EE) situation in selected sites with respect to coastal and marine environmental management at all levels. Review in an interdisciplinary manner; ecological reports, urban surveys, existing laws and regulations and both existing and previous institutional capacity building and its relevance to EE.

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- Design training workshops for trainers of communities/stakeholders at risk if environment is damaged. Focus of training will be on innovative methods and techniques for effective environmental education.

Outputs: Information on community groups, their understanding of environmental management and an outline of their specific needs. Action plan for an integrated environmental education campaign developed. This will build awareness of the biodiversity and value of reef resources within the Maldives targeted at different levels (i.e. national and economic programmes, private sector, community groups, school groups and tourists).

Design and costing of programme

Activities:

- Collaborate with the educational sector and environmental NGOs and educational sector to plan an integrated environmental education campaign (IEEC) and determine priority materials required for various stakeholders (i.e. targeted community groups). For instance, use EE tools and methods to make the scientific data more appropriate and accessible to beneficiaries, government and non-government stakeholders and to local communities of all age groups.
- Design public awareness programmes to build support for management strategies by explaining why particular activities (i.e. coral mining) damage the environment. Inform communities of changes in behaviour patterns and actions that individuals can adopt to help protect the environment and promote voluntary compliance of existing laws and regulatory mechanisms.
- Cost an incremental programme of IEEC activities based on the findings of the **Outputs** of the activities described above.

Outputs: Work plan and budget for the IEEC activities.

3.2.3 Environmental management options for inhabited islands.

Objective: Current environmental practices lag behind those established for the tourism industry. This component will evaluate the underlying causes of threats at different sites including the socio-economic significance and possible management solutions to address such threats.

Community consultations

Activities:

- Consultations with local communities to establish understanding of the links between coastal development practices (i.e. land reclamation) and beach erosion. Use local knowledge to identify those islands and reef areas most at risk from the consequences of rapid urbanisation, such as sewage and solid waste.
- Determine local knowledge of characteristics of the receiving waters (i.e. the currents, winds and wave climate) to predict fate of pollutants and help prepare mitigation measures.

Outputs: Assessment of local attitude towards existing or potential reef degradation and willingness to take action to address conservation and biodiversity issues. Report on current status, particularly the quality of the marine environment within selected areas.

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Atoll/island mapping and survey

Activities:

- Conduct baseline surveys using refined survey protocols and GPS to produce baseline maps of the islands, associated reefs and reef resources within selected project areas.

Outputs: Production of baseline maps for selected areas for use in planning and management of reef resource use.

Develop low cost environmental management solutions

Activities:

- Facilitate partnerships with the private sector to introduce specific targeted measures to alleviate negative impacts on biodiversity such as low cost sewage treatment, including composting options and small incinerators for solid waste management.
- Investigate costs of new technologies and funding sources for demonstration projects.
- Promote small demonstration projects in selected project sites to test and refine specific management solutions identified above.

Outputs: Preparation of guidelines for inhabited island management agreed and mitigation measures for environmental management defined and tested at all levels.

3.2.4 Review of environmental guidelines for tourism resort island management

Objectives: Tourist resort management guidelines include requirements for practises for environmental protection. These guidelines need to be reviewed and updated and where necessary given the strength of legislative support. In addition these regulations need phased application to all inhabited islands. The consultative process will investigate with communities and tourist resorts in the selected atolls the needs for sewage treatment and disposal, garbage collection and disposal, new building regulations for housing and coastal structures.

Consultations with owners, operators, dive centres and Ministry of Tourism

Activities:

- Conduct a workshop to elicit support for improved environmental to maintain the quality of the environment on which tourism is based.
- Facilitate the development of new operational guidelines and practical measures to reduce long term hazards associated with resort development and operation. For example the practice of dredging lagoons which alters physical and biological processes.
- Collect information on space requirements for recreational activities and assess ecological carrying capacity for each activity in the context of ecological and physical constraints within new tourism sector e.g. Baa atoll.
- Evaluate opportunities for ecotourism including low cost environmental technologies

Outputs: Willingness of stakeholders to participate in activities that reduce impact on biodiversity. Prepare an action plan to determine optimum level of recreational use, including dive management plans in emerging tourism sectors and recommendations for codes of

practise for tourism island management and assessment of quality of marine and terrestrial environment.

Activities:

- Conduct field surveys to assess environmental quality associated with tourism resorts and recreational areas within the selected project areas.
- Identify areas of major tourist recreational activities and ascertain current recreational "hotspots" within selected atolls using information collected from community workshops above.

Outputs: Report on the priority threats associated with resort development and recreational use within selected areas.

3.2.5 Review biodiversity significance in selected sites

Objectives: To determine areas of special need where biodiversity is high and subject to stress:

Activities:

- Review the desk study conducted by the GEF EA NBSAP project to compile, review and synthesise existing information on marine biodiversity relevant to the selected sites.

Field assessments of biodiversity status at selected sites

- Refine ecological survey protocols in relation to: i) the main purpose of the investigation; ii) the type of natural (or human) system being assessed; iii) physical, human & economic resources available, and related to this; iv) the time available. Prepare guidelines for the use of different surveys on the basis of the findings.
- Conduct pilot field programmes to assess the status and health of coral reefs and management requirements at different intensities and scales, using methodologies ranging from rapid/semi-quantitative to detailed/quantitative ones.

Training needs assessment

- Carryout training needs assessment to determine existing capacity and technical skills for ecological inventories and monitoring reef resources. Prepare guidelines for training programmes to transfer skills and techniques in assessment of ecological and economic impacts of coastal resource use practices.

Outputs: Production of a situation profile including knowledge of the distribution and abundance of marine and coastal biodiversity within the selected sites. Complimentary guidelines developed for ecological survey protocols to address marine and coastal biological diversity on the basis of an ecosystem approach. Report on training requirements for biodiversity assessments and monitoring of reef resources.

3.2.6 Identification of Research Needs for biodiversity conservation

Objective: To develop a programme of targeted research to identify gaps in information on ecosystem processes and determine the most cost effective means of obtaining detailed information for management of reef resources.

Activities:

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- Conduct pilot studies to collect preliminary data and evaluate the applicability of 3 research themes that focus on ecosystem processes (i.e. intra-demographic) and interdependence of reefs including:

  1. The effect of disturbance on reef ecosystem processes including; aspects of coral community structure relating to biogeomorphology that may modify the reef recovery processes (i.e. sediment balances) and the synergism of climatic events (i.e. coral bleaching) and environmental stress (e.g. sediment loading from dredging).
  2. Capacity of coral reefs to recolonise areas denuded by various interacting factors including; coral mining, storms and bleaching events associated with increased sea surface temperatures.
  3. The effects of marine protected areas on population size and dynamics, within the protected areas and in surrounding areas.

Output: Recommendations for specific management-orientated research to improve knowledge and information on ecosystem functions and processes that will contribute to the overall conservation and sustainable use of marine and coastal resources.

3.2.7 Develop management options and approaches to support a system of marine protected areas.

Objective: The most immediate possibility for the conservation of coral reef biodiversity is the establishment of protected areas in selected atolls. The possibility of recovery then exists and can be monitored, lessons learnt can be used to modify practises in other areas. The government has established protected areas for dive sites particularly requested by the tourism industry, for biodiversity conservation this initiative will need to be extended.

Establish a planning framework for protected areas management through community consultations

Activities:

- Adopt a consultative process to identify areas of the selected atolls suitable for protected area status and the level of protection needed to achieve conservation. Evaluate options for the following: i) total protection with no form of human intervention, ii) protection from all utilisation but controlled access by tourists under the guidance of community managers and iii) protection from normal activities but some utilisation allowed with application of site specific management measures.
- Evaluate biological, socio-economic and planning data in the context of zoning within selected areas to pro-actively to guide reef resource use, tourism and other coastal developments.
- Conduct workshops to secure local support and voluntary compliance where possible, including the provision of continued welfare of people affected by MPA.
- Develop clear management responsibilities between agencies and stakeholders to avoid duplication and develop mechanisms to ensure there is a process of ongoing consultation among them.
- Conduct a desk study to assess how MPAs can contribute to conservation and sustainable use in the Maldives building linkages between protected areas with tourism and environmental financing options.

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Outputs: Recommendations for sites for Protected Areas within selected atolls developed through community consultation. Report on the planning framework upon which the full GEF project and complementary initiatives can build.

Survey of potential sites

Activities

- Conduct field surveys within areas proposed for protection and review baseline information on sensitive and special habitats in the selected areas that will contribute to Maldives' natural heritage through targeted conservation actions. This will focus on areas that protect natural processes, critical ecosystems, and natural areas adjacent to tourism development zones.

Output: Confirmation of community site selection for protected areas within selected project areas.

3.2.8 Review reef fisheries management regulations and enforcement

Objectives: Establish community management of the reef fisheries resources to conserve the biodiversity of fish species on the reefs, this conservation will assist in the preservation of the bait fishery for the pole and line tuna fishery and in maintaining the attraction of the reefs for tourism.

Community consultations and socio-economic studies

Activities:

- By community discussion determine traditional and existing community fisheries management systems for each community within the atoll and the areas of each atoll in which they used to be or are still effective.
- In consultation with fishermen and community leaders establish the reasons for the reduced effectiveness of management systems in recent times and the actions needed to re-establish them. Training of island and atoll administrators in the importance, collection and primary analysis of fish catch statistics.
- The consultative process will investigate the links in the selected atolls and work with fishermen and tourist operators to define the need for management and their future respective roles and opportunities in a managed system.

Outputs: A fisheries management action plan for each target atoll to establish community management and contribute to protected area management. An improved fish catch information system analysed by island and atoll, at atoll level, for use by the community and transmission to Malé. Identification of options for livelihood strategies, including: community management of demersal fish resources, a return to tuna fishing, a role for communities as guides to tourists of protected sites, education of tourists into pelagic fish consumption and ceased night fishing activities by tourist resorts.

3.2.9 Finalization of GEF Project components

Objective: Participatory appraisals will be used to address the current status of knowledge on biodiversity, identify the underlying causes of impacts on coral reefs and attain consensus on selected sites for project activities in the full GEF project.

Formal and non formal consultations

Activities:

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- Acquire confirmation of site selection and project components for the full GEF project based upon participatory appraisals
- Use **Outputs** of the PDF B project components described above to provide information to refine the work plan

Output: Development of overall strategy and refinement of the work plan for the full GEF project proposal.

3.3 Preparation of a full GEF project proposal

Outputs of the activities conducted under specific components of the PDF B project will provide the information and the framework for the full GEF proposal.

3.4 Institutional structure and Training Needs

The Ministry of Home Affairs, Housing and Environment, Environment Section is the implementation agency and will draw assistance from its own research section, the Ministry of Fisheries Agriculture and Marine Resources, Marine Research Centre and the Ministry of Atolls Administration. This will be arranged through the National Council for the Protection of the Environment.

The Environment Section is a relatively new agency in government and has limited skilled management and technical specialists with a very active programme plan. The GEF project is central to the Environment Sections role, but a lot of time is taken up with routine work of supervising activities of other ministries in fisheries, public works, tourism and transport as well as the private sector. Therefore human resources are a limiting factor and training of staff in the Ministry and the Atolls as well coordination of community, NGO and private sector resources are essential elements of the PDF B activity.

3.5 Co financing

There are two ongoing activities which form contributions to the objectives of the GEF project and whose activities will be coordinated with the PDF B and the main GEF project through the Environment Section of the Ministry of Home Affairs, Housing and Environment. These are:

1. Australian Aid project for the establishment of protected areas, this project plans the community consultation process covering the same issues as the GEF, targeting particular areas within atolls. By coordinating the consultative process through the Environment section the projects will achieve efficiencies and the long-term support of the protected areas within atolls can be monitored b y the longer term GEF activity.
2. Integrated Reef Resource Management financed by Government of Maldives and Bay of Bengal Project, the continuation of some activities may be financed by the Joint Programme to Investigate Coral Reef Degradation in the Indian Ocean (CORDIO).

The principal co financier of the PDF B project is the Government of Maldives through the Environment Section of the Ministry of Home Affairs, Housing and Environment. The Environment Section plans to devote approximately one third of its activities to the support of the PDF B, representing an investment of Mrf 4.1 million over the period.

3.6 Global significance

1. In that Maldives' coastal and marine resources are an integral part of the central Indian Ocean, support for marine conservation will be a valuable contribution, with influence far beyond the nation's territorial shores.

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2. Conservation of global coral reef biodiversity including a range of threatened marine species.

3. Establishment of protected areas within selected project areas will make a significant contribution to that will contribute to the global system of protected areas.

3.7 Special considerations

1. Capacity for implementation

The Environment Section of the Ministry of Home Affairs, Housing and Environment has a total staff of 22 persons with an annual work plan utilising all staff resources. The Environment Section will need to coordinate the proposed project activities between its own staff, supporting ministries and the use of private sector, community and NGO resources. This coordination and management role has been reviewed at project design stage (see workplan) and is achievable.

2. Socio-cultural background

The application of participatory approaches for community based reef management represents a new approach to environmental management in Maldives. Standard techniques and protocols will require refinement to suite the traditional and socio-cultural traditions as well as existing management structures within the atolls.

4. PDF-B COSTS

Tasks	National PM	National staff	International specialists	Environment Section
Community consultations in Baa, Vaavu, Meemu, Seenu atolls	5	15	5	1
Review of biodiversity significance in Vaavu and Meemu		3		
Applied research for conservation of biodiversity		2	1	
Atoll/island mapping and GIS	1	3		4
Consultations with NGO's/Ministry of Education	0.5		0.5	2
Design and costing of education programme	0.5		0.5	1
Definition of employment alternatives	0.5	2	0.5	1
Conduct pilot programmes Vaavu and Meemu	1.5	4		4
Evaluate pilot programmes Vaavu and Meemu	0.5		0.5	0.5
Development of regulations for building standards		1	0.5	1
Fisheries resource assesments		2	0.5	
Development of management systems		1	0.5	2
Assessment of quality of marine and terrestrial environment	1	2	1	3
Preparation of GEF main project	1		1	2
Total man months	11.5	35	11.5	21.5

GEF PDF B Costs	MM	US $ Rate/month	Estimated Cost	11.72 MRF

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National project manager	11.5	1000	11500	134780
National staff	35	500	17500	205100
National staff travel allowances	35	600	21000	246120
International specialists	11.5	15000	172500	2021700
Workshop, Inception/orientation,			2000	23440
Workshop, Reporting on consultations			3500	41020
Workshop for GEF project design			3500	41020
Equipment, laptop computers for survey data	4	1000	4000	46880
Printers, consumables			3500	41020
Publications			5000	58600
National travel consultations, boat months	3	5000	15000	175800
Flights to Addu Gan	10	200	2000	23440
Travel costs in Addu	1	2500	2500	29300
Travel costs pilot activities Vaavu and Meemu, boat months	2	3000	6000	70320
International flights specialists	4	1500	6000	70320
Accomodation and subsistence international specialists	11.5	3000	34500	404340
Sub Total			310,000	3,633,200
Government of Maldives Contributions				
Staff Time	21.5	500	10750	125990
Dhoni for field trips	3	5000	15000	175800
Communications and office consumables	12	1000	12000	140640
Workshop venues and support facilities	3	2700	8100	94932
Sub Total			45,850	537,362
Total PDF B project cost			355,850	4,170,562

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ANNEX 1: GOVERNMENT REVENUE 1996-1998.

GOVERNMENT REVENUE,
1996 - 1998

(In million Rufiyaa)

Particulars	1996	1997 (Provisional)	1998 (Budget Est.)
Revenue and grants	**1,594.4**	**1,752.0**	**1,985.5**
Revenue	**1,351.5**	**1,620.9**	**1,805.8**
Tax Revenue	**733.2**	**872.8**	**951.4**
Import Duty	450.6	549.1	576.6
Export Duty	0.1	-	-
Tourism Tax	215.8	237.4	273.4
Bank Profit Tax	23.8	27.3	30.0
Others 1_/	42.9	59.0	71.4
Nontax Revenue	**618.3**	**748.1**	**854.4**
State Trading Organization	26.0	35.0	37.0
MIFCO	0.0	5.0	5.0
Air Maldives	-	-	-
MTCC	1.8	2.5	2.1
State Electric Company	8.0	17.0	27.0

Source: Ministry of Planning, Human Resources & Environment.

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ANNEX 2. ESTIMATES OF GROSS DOMESTIC PRODUCT FOR 1994-1996

GROSS DOMESTIC PRODUCT, ESTIMATES, 1994 - 1996

(In Million Rufiyaa, at 1985 constant prices)

Sector	1994	Growth Rate Over Previous Year (in %)	1995	Growth Rate Over Previous Year (in %)	1996	Growth Rate Over Previous Year (in %)
GDP (at 1985 constant prices)	**1,268.6**	**6.6**	**1,359.4**	**7.2**	**1,448.0**	**6.5**
Primary sector	**273.0**	**2.6**	**277.4**	**1.6**	**287.7**	**3.7**
Agriculture	101.2	3.8	104.5	3.3	-	-
Fisheries	149.5	1.5	149.5	0.0	155.5	4.0
Coral and sand mining	22.3	4.5	23.4	4.9	-	-
Secondary sector	**194.5**	**6.3**	**211.3**	**8.6**	**230.0**	**9.0**
Construction	115.9	5.2	126.7	9.3	140.6	11.0
Manufacturing (including Electricity)	78.6	8.0	84.6	7.6	-	-
Tertiary sector	**801.1**	**8.1**	**870.7**	**8.7**	**930.0**	**6.8**
Distribution	242.7	7.0	262.1	8.0	280.4	7.0
Transport	84.1	8.5	91.4	8.7	-	-
Tourism	225.5	10.5	249.5	10.6	276.9	11.0
Real Estate	54.0	8.0	58.4	8.1	-	-
Services	80.0	9.0	88.1	10.1	-	-
Government Administration	114.8	5.0	121.2	5.6	-	-

Source: Ministry of Planning, Human Resources & Environment.

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ANNEX 3

Major threats, consequences and mitigation options for management of coral reefs.

Source	Impacts	Consequences	Mitigation	Project activities
		Functions/Services		
Coral & Sand mining: • Coral for building material • Sand for building industry • Akiri for aggregate • Coral for lime production	Destruction of the habitat (i.e. direct removal of live coral and reef framework). Causes deepening of lagoons and alteration in hydrology.	Reduced capacity for sea defence and reef fisheries. Lack of sediment for beach accretion. Alteration of natural current movements.	National legislation exists (EIA/EPPA); designate areas for coral &sand mining and protection of vulnerable sites, promote use of alternative building materials with appropriate building standards.	4.6.2. and 4.6.3.
Construction: • Dredging • Coastal alteration • Sea walls, breakwaters, groynes etc.	Sediment loading-physical smothering & chemical toxicity[1]. Landfills can leach, especially on porous limestone.	Adversely affects on coastal processes (beach erosion and beach accretion patterns). Diminishes the role of reefs in fisheries.	National legislation exists. Minimise suspended material by use of silt screens; conduct land-based operations before seaward works;	4.6.4./4.6.5. and 4.6.3.
Solid waste management: • domestic • industrial • potential hazardous materials	Increase in suspended materials, leaching of phosphates and nitrogen. Contamination of ground water. Waste material blown into sea.	Associated with human health problems. Long term alteration in physical coastal processes.	National legislation exists; prepare guidelines for selection and operation of disposal sites in Atoll islands.	4.6.4./4.6.5. and 4.6.3.
Desalination plants: • hypersaline water • heated water	Large volumes of hypersaline effluent discharged; temperature acts synergistically	Habitat destruction; negative impact on aesthetic value of reef for tourism.	Re-use of waste water for non-domestic purposes; treatment of waste water before release.	4.6.4. and 4.6.5.
Tourist resorts: • Waste water –kitchen & laundry • Groundwater run-off • Sewage[2] • *Swimming pools*[3]	Increase in suspended materials, leaching of phosphates and nitrogen. Increase of contaminants in effluent (Chlorine, Algicides & fresh water)	Reduced productivity, reduces tourism value of reef resources.	High dilution rates to control phosphates entering sea water; correct placing of septic tanks; locate outfalls in deeper, well flushed coastal waters. Recycling and treatment of effluent	4.6.5 and 4.6.3.

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Annex 3 continued.....

Source	Impacts	Consequences Functions/Services	Mitigation	Project activities
Diving & snorkeller impacts: • Direct damage • Boat activities	Breakage and tissue damage to corals. Trampling in shallow reef flats.	Habitat destruction; negative impact on aesthetic value of reef for tourism.	Diver briefings Dive management plans Use of mooring buoys Carrying capacity	4.6.5. and 4.6.3.
Exploitation of reef resources: • Reef fisheries • Shark • Aquarium fish	Reduction in catch, increase in resource user conflicts particularly with tourism sector.	Decline or collapse in fishery. Value of exports decrease and difficulties in supplying the tourism demand.	Increase research & monitoring, develop management plans for sustainable rates of exploitation, provide sanctuaries for breeding and refugia. Establish a network of MPAs	4.7.4 and 4.6.3.

[1] – Dredging may result in re-suspension of chemicals and heavy metals buried in sediments, especially close to shipping lanes
[2] – Land disposal of sewage sludge must consider potential of leachates entering ground water. This also applies to use of grey water for gardens and golf courses

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ANNEX 4: List of protected areas established in the Maldives.

	Atoll	Reef name	Location	Special features	Area
1	Lhaviya-ni	Fushivaru Thila	Fushivaru Kandu south of Lh. Fushivaru	Excellent coral formations, abundant reef fish and pelagics - sharks, manta rays	100m radius
2	North Malé	Makunudhoo Kandu	Kandu - west of Makunudhoo. (>2km with several dive sites	Various caves, overhangs, coral gardens, reef fish and sharks	100m x 2000m
3	North Malé	Rasfari	Outer reef of Rasfari island	Interesting topography, grey reef sharks, manta rays.	5000m x 1700m
4	North Malé	H.P. Reef	Thila in channel between Girifushi and Himmafushi	Spectacular reef formations with soft corals & gorgonians; reef & pelagic fishes; sharks	100 m radius
5	North Malé	Banana Reef	West of Club Med - northern of 2 reefs	Outcrops, caves & overhangs; reef & predatory fish abundant	100 m radius
6	North Malé	Giraavaru Kuda Haa	North of Giraavaru (SW Malé Atoll)	Reef fish prolific; table corals on reef top.	100m radius
7	North Malé	Lions Head	Thila Fushi (west) facing Vadhoo Kandu	Caves and overhangs with abundant invertebrate life, Grey reef sharks patrol reef	500 m radius
8	North Malé	Hans Hass Place (Kikki Reef)	Western end of Gulhi Falhu facing Vadhoo Kandu	Wall dive in reef cavity with overhangs; prolific reef fish, spectacular corals & invertebrates	500 m radius
9	South Malé	Embudu channel (whole channel)	First channel south of Embudu island	Sharks & pelagic fish	Entire channel
10	South Malé	Guraidhoo channel (between Guraidhoo Faru & Maadhoo Falhu.	Entire Guraidhoo channel	Wide range of reef features; pelagic fishes & sharks	Entire channel
11	Ari	Maaya Thila	Thila 4 km NW of Maayafushi	Caves & overhangs; abundant fish life, sharks & manta rays	500 m radius
12	Ari	Fish Head	Thila 3 km south Mushimasmingili	Abundant fish life, grey reef sharks	500 m radius
13	Ari	Orimas Thila	Thila in channel south of Orimas Faru	Caves & canyons; spectacular corals, reef fish & sharks	100 m radius
14	Ari	Kuda Rah Thila		Outcrops & canyons; large sea-fans, corals; reef & pelagic fishes.	100 m radius
15	Vaavu	Devana Kandu	Second channel south of Alimathaa	Caves & overhangs; soft corals, pelagic fish; sharks	Entire channel

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ANNEX 5. Matrix of Demographic and Geographic Parameters for Atoll Selection

Atoll	1995 Census Population	Island Land area Hectares	Reef Area Km^2	Fish catch Tonnes	Coconut Production	Tourist Resorts 1999
Male	62973	187		7,662.73		
Haa Alif	13657	1348	125	5,281.26	1091019	
Haa Dhaal	14769	1667	250	2,402.23	905625	
Shaviyani	10462	827	100	6,469.79	904785	
Noonu	10096	747	26	3,501.70	918328	
Raa	12528	492	183	8,542.64	841029	1
Baa	8727	371	215	5,316.10	787342	5
Lhaviyani	8847	110	90	4,139.22	133099	4
Kaafu	11650	424	410	7,953.02	181991	42
Alifu	11744	536	407	9,885.00	622090	27
Vaavu	1779	42	314	437.85	130827	2
Meemu	4810	245	213	3,799.79	451599	2
Faafu	3167	147	188	213.45	190331	1
Dhaal	4825	159	175	1,771.02	731763	2
Thaa	9651	344	220	4,875.76	900071	
Laamu	10192	1405	180	6,617.70	1867552	
Gaaf Alif	8164	436	160	8,874.65	934274	
Gaaf Dhaal	11984	554	205	7,446.04	2429909	
Gnaviyani	6971	420	5	536.54	1478704	
Seenu	17648	805	50	9,686.57	1265468	1
Total	244,644	11266	3516	105,413.06		87

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ANNEX 6: Organizational chart