



UNITED NATIONS ENVIRONMENT PROGRAMME



J. Pernetta and G. Sestini:
The Maldives and the
impact of expected climatic changes

UNEP Regional Seas Reports and Studies No. 104

Preface

The environmental problems associated with the potential impact of expected climate changes may prove to be among the major environmental problems facing the marine environment and adjacent coastal areas in the near future. Therefore, the Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) of UNEP launched, co-ordinated and financially supported a number of activities designed to assess the potential impact of climate changes and to assist Governments in the identification and implementation of suitable policy options and response measures which may mitigate the negative consequences of the impact.

In 1987, Task Teams on Implications of Climatic Changes were established for six regions covered by the UNEP Regional Seas Programme (Mediterranean, Wider Caribbean, South Pacific, East Asian Seas, South Asian Seas and South-East Pacific regions) with the initial objective to prepare regional overviews and case studies on the possible impact of expected climate changes on the coastal and marine ecological systems, as well as on the socio-economic structures and activities of their respective regions. Two additional Task Teams (for the West and Central African region and for the Eastern African region) were established in 1989, and the establishment of Task Teams for the Black Sea and the Kuwait Action Plan region is under consideration. The original terms of reference for all Task Teams and their composition are shown in appendix 1 and 2 of this annex.

The regional overviews and case studies were planned to be presented to the intergovernmental meetings convened in the framework of the relevant Regional Seas Action Plans in order to draw the countries' attention to the problems associated with expected climate change and to prompt their involvement in the development of policy options and response measures suitable for their region. The site-specific case studies were planned to be presented to national seminars.

The preliminary results of the regional overviews of the Task Teams were already considered by meetings convened under the Mediterranean, Caribbean, South Pacific, South-East Pacific and East Asian Seas Action Plans. One site-specific case study (the Nile Delta) was presented at a national seminar (December 1988). Two additional seminars are planned for mid-1989 (Delta of Po and Thermaikos Gulf).

A special intergovernmental meeting will be convened in the Marshall Islands (Majuro, 16-20 July 1989) for the island States and territories of the South Pacific to consider their policy options, suitable response measures and additional site-specific case studies to be developed.

Once the initial objective of the Task Teams (impact studies) is achieved, they will concentrate on providing assistance to national authorities in defining and implementing specific policy options and suitable response measures.

The development of climate scenarios for the Mediterranean region has been initiated. They are planned to be completed in 1990 and to be used in connection with the revision of the Mediterranean regional study.

On a global scale a review on the interaction of the oceans and greenhouse gases and atmospheric aerosols was completed and published, a bibliography on effects of climate change and related topics was prepared by the Mediterranean Task Team, and the launching of a globally co-ordinated programme for monitoring of climate related changes relevant to the marine and coastal environment is being negotiated with IOC and WMO.

(ii)

The second meeting of national focal points on development of an action plan for the protection and management of the South Asian Seas, convened by the Executive Director of UNEP in Bangkok, 7-11 December 1987, considered the progress made in the work of the Task Team established to examine the implications of climatic changes in the South Asian Seas region and recommended "that Maldives should be considered for a specific in-depth case study analyzing the full ecological and socio-economic implications of expected climate changes as well as the management and policy options available to mitigate or avoid the negative effects of these implications."

Subsequently, a request from the Government of the Maldives was received by UNEP for the preparation of such a study. In response to that request, in consultation with the Government of the Maldives and with the assistance of UNDP, a mission was sent to the Maldives (4-10 December 1988) to prepare a report which may become the basis for the in-depth study.

The report of the mission was presented by UNEP to the Government of the Maldives in March 1989.

The Government of the Maldives endorsed in general the findings and recommendations of the report, and agreed that the report could be published, with the understanding that the implementation of the project proposed by the report will be further discussed between the interested parties and modified as deemed appropriate.

The present document is the reproduction of the report submitted to the Government of the Maldives in March 1989, with minor editorial modifications.

TABLE OF CONTENTS

	Page
1. BACKGROUND	1
2. FACTORS WHICH MAY BE RELEVANT TO OR AFFECTED BY THE POTENTIAL IMPACT OF EXPECTED CLIMATIC CHANGES	2
3. VULNERABLE COMPONENTS OF NATURAL ENVIRONMENT AND OR SOCIO-ECONOMIC STRUCTURES AND ACTIVITIES	3
4. CONCLUSIONS AND RECOMMENDATIONS	4
Appendix I - TERMS OF REFERENCE : PROJECT CO-ORDINATOR	9
Appendix II - TERMS OF REFERENCE : SCIENTIFIC ADVISOR	10
Appendix III - TERMS OF REFERENCE : PHYSICAL OCEANOGRAPHER	11
Appendix IV - TERMS OF REFERENCE : MARINE BIOLOGIST/REEF ECOLOGIST	12
Appendix V - TERMS OF REFERENCE : GEOLOGIST/COASTAL GEOMORPHOLOGIST/ SEDIMENTOLOGIST	13
Appendix VI - TERMS OF REFERENCE : METEOROLOGIST/CLIMATOLOGIST	14
Appendix VII - TERMS OF REFERENCE : HYDROLOGIST	15
Appendix VIII - TERMS OF REFERENCE : TERRESTRIAL ECOLOGIST	16
Appendix IX - TERMS OF REFERENCE : ECONOMIST/PLANNER	17
Appendix X - TERMS OF REFERENCE : SOCIOLOGIST	18
Appendix XI - WORKPLAN AND TIMETABLE FOR THE PROJECT TEAM	19
ANNEX 1: TERMS OF REFERENCE FOR THE MISSION TO THE REPUBLIC OF THE MALDIVES	21
ANNEX 2: ITINERARY AND SUMMARY OF DISCUSSIONS HELD DURING THE MISSION (MALDIVES, 4-10 DECEMBER 1988)	23
ANNEX 3: SUMMARY PRESENTED TO A MEETING OF THE NATIONAL ENVIRONMENT COMMISSION OF THE REPUBLIC OF THE MALDIVES (MALE, 8 DECEMBER 1988)	27
ANNEX 4: A PRELIMINARY REVIEW OF THE ENVIRONMENT, RESOURCES, CURRENT AND FUTURE ENVIRONMENTAL PROBLEMS OF THE REPUBLIC OF THE MALDIVES	31
REFERENCES	81
BIBLIOGRAPHY	84

1. BACKGROUND

- 1.1. The virtual certainty that predicted climatic changes, including the concomitant sea-level rise, will profoundly affect low-lying islands was considered at the second meeting of National Focal Points on the development of an action plan for the South Asian Seas region, held in Bangkok, 7-11 December 1987. Therefore the meeting recommended that "Maldives should be considered for a specific in-depth case study analyzing the full ecological and socio-economic implications of expected climatic changes as well as the management and policy options available to mitigate or avoid the negative effects of these implications" (UNEP(OCA)/SAS WG.1/7, para 46).
- 1.2. This recommendation was subsequently endorsed by the first planning meeting of the Regional Task Team on the implications of climatic changes in the South Asian Seas region (UNEP(OCA)/WG.2/23 para 32) held in Islamabad, 28-30 June 1988.
- 1.3. On 19 June 1988 the Ministry of Foreign Affairs of the Republic of the Maldives informed UNEP that "the Government of Maldives fully support this recommendation and will extend its support and co-operation to the team which will be charged with the preparation of such a study".
- 1.4. In order to respond to the recommendation of the Bangkok meeting and to the request received from the Republic of Maldives, proposals for carrying out the study were solicited by UNEP from competent organizations. Two specific proposals were received (from Delft Hydraulics and MARC) and were submitted on 9 May and 15 August 1988 respectively to the authorities of Maldives for comments. In the meantime UNDR0's report on "Special assistance to Maldives for disaster relief and strengthening of its coastal defences" (A/43/703) and the Commonwealth Secretariat's possible involvement in a study of climatic effects on the Maldives were brought to the attention of UNEP.
- 1.5. In view of the two parallel proposals on which no detailed substantive comments were received from the Maldives, as well as of UNDR0's study and the study which may be carried out by the Commonwealth Secretariat, UNEP felt that a more precise insight was needed of the real problems and requirements of the Maldives before a full scale study is launched. Therefore, on 21 October 1988, a suggestion was made by UNEP to the Ministry of Home Affairs and Social Services of the Maldives for "sending a two man preparatory mission to the Maldives to determine, in close co-operation with the relevant national authorities, the scope of a study highlighting the problems which may be faced by the Maldives due to expected climatic changes and identify response options suitable and applicable to the Maldives".
- 1.6. The reply to the suggestion was received at UNEP through UNDP on 25 October 1988, indicating that "His Excellency Mr. Maumoon Abdul Gayoom, President of the Maldives, has asked (UNDP) to convey the Government's agreement to proposal to field the two person mission to determine scope of the study to which the Government accords the highest priority".
- 1.7. The authorities of the Maldives and UNEP agreed in ensuing correspondence to the terms of reference of the mission (Annex 1 to this report) and the consultants participating in the mission (Prof. John C. Pernetta and Prof. Giuliano Sestini).
- 1.8. The mission to the Maldives took place between 4 and 10 December 1988. Details of the mission's itinerary and discussions are attached in Annex 2. In all a total of 16 Government Officials from 11 Government Departments were consulted; two meetings of the National Environment Commission were addressed and a public lecture (televised) on climatic change and sea-level rise was delivered.

- 1.9. In accordance with the terms of reference a summary of the major findings of the mission, together with the recommendations for proposed follow-up activities (Annex 3 to this report), were presented to a meeting of the National Environment Commission for their discussion and approval.
- 1.10. This report has been prepared as envisaged by the terms of reference of the mission, duly taking into account the comments and suggestions of the officials of the Maldives consulted during the mission.
- 1.11. The mission wishes to express its appreciation for the co-operation, assistance and hospitality extended to it by all officials of the Maldives met during the mission, as well as by the staff of the UNDP Office in Malé.
2. FACTORS WHICH MAY BE RELEVANT TO OR AFFECTED BY THE POTENTIAL IMPACT OF EXPECTED CLIMATIC CHANGES
 - 2.1. The current status of the marine environment and environmental problems of the Maldives are reviewed in several publications (UNEP/RSRS 13; UNEP/RSRS 82; UNEP/RSRS 76) and a detailed current account is provided in Annex 4 to this report.
 - 2.2. The current problems stem in large part from the high population density (650/Km²) which is aggregated onto relatively few islands within each atoll. The problems of Malé (the capital) have reached a critical level in terms of environmental management, in particular, management of freshwater resources; coastal infrastructure development; solid waste disposal; rainwater runoff; sewage disposal; and population pressure.
 - 2.3. In all areas and atolls environmental problems are locally severe and the consequences of environmentally unsound developments have been recently highlighted by the impacts of storm generated long distance swells which have caused widespread flooding of reclaimed areas and weakening and/or destruction of coastal structures.
 - 2.4. Live coral mining for construction and road surfacing is considerably reducing the wave energy absorption capacity of the reefs and altering local current and sediment patterns. It may adversely affect the capability of the reef system as a whole to respond to sea-level rise.
 - 2.5. Land reclamation, particularly on the oceanic sides of the islands, increases vulnerability and is frequently associated with harbour dredging and construction, activities which are presently undertaken without data on local currents and sediment movements.
 - 2.6. Construction of coastal infrastructure, including sea walls, breakwaters, jetties, piers, groynes and harbours, without prior investigation of local current patterns and patterns of sediment erosion and deposition, not only increases their vulnerability but also increases the total capital investment which is at risk.
 - 2.7. Aquifer depletion and saline intrusion are a problem for several islands, however the Malé situation is compounded by compaction of the road surface preventing rain from permeating and recharging the aquifer. In the case of Malé the aquifer will be depleted long before sea-level affects its volume unless remedial action is successfully implemented.
 - 2.8. High population growth and urban drift (3.2% per annum for the country; 7.0% per annum for Malé) increase vulnerability by straining already limited resources and result in aggregation of human and capital resources into a few locations, hence increasing the risk of catastrophic impacts through episodic events.

- 2.9. The current environmental problems are exacerbated by: a lack of mechanisms within government for taking environmental problems into consideration in the planning process; a lack of guidelines and procedures for the evaluation of environmental issues; a lack of an adequate in-country data base covering many physical and biological parameters; and a shortage of trained manpower at all levels.
 - 2.10. Economic impacts will be most intensely felt if the tourist industry is adversely affected. The present "resort-islands" represent a considerable investment in infrastructure on the land and coastline of very small islands which is at risk from increased sea-level and episodic events, such as storm generated wave surges.
 - 2.11. The current, environmentally unsound development practices will increase the susceptibility of the country to changes predicted to occur as a consequence of global climatic changes.
3. VULNERABLE COMPONENTS OF NATURAL ENVIRONMENTS AND OF SOCIO-ECONOMIC STRUCTURES AND ACTIVITIES
- 3.1. Assuming a mean global sea-level rise of 20 cm by the year 2025, those islands in the archipelago which have been structurally modified can expect increased rates of erosion and coastal alteration. The impacts of "high waves" will be greater with greater mean sea-level and continued land reclamation reducing the wave energy absorption capacity of the reef system.
 - 3.2. Changes to aquifer volume may be expected under higher sea levels with increased saline intrusion exacerbating the already critical situation in some islands with high density human populations.
 - 3.3. Increased temperatures may lead to increased demand for air conditioning and hence energy requirements, thus indirectly affecting the economy of the country.
 - 3.4. Coral growth may be adversely affected by increased temperature, particularly in the more enclosed lagoons and atolls. Recent evidence of coral bleaching and death under increased lagoon temperatures (2°C above normal) underlines the importance of this potential impact.
 - 3.5. Social impacts arising from inter-island migration resulting from changes to island stability and/or habitability are likely to be extensive given the nature of Maldivian society which is characterized by generally low mobility and strong attachment to individual atoll/islands.
 - 3.6. The present "resort-islands" represent a considerable capital investment which is highly vulnerable to increased sea-level and episodic events such as storm generated wave surges.
 - 3.7. Changes in reef growth and productivity combined with changes in local current patterns may adversely affect tuna production and the distribution of stocks with consequent implications for the siting of fish processing facilities.
 - 3.8. The aggregated distribution of human settlements (only 202 of the 1,300 islands are inhabited) increases their vulnerability since high density settlements inevitably result in extensive coastal modification, hence the overall vulnerability of the entire Republic is increased.

4. CONCLUSIONS AND RECOMMENDATIONS

- 4.1. It is the view of the mission that the Maldives represent a critical case where assistance in planning sustainable development and developing an in-country capability for coping with climate change, sea-level rise and environmental management is urgently required.
- 4.2. Any programme of activities designed to address the planning/policy issues related to climate change and sea-level rise must seek to strengthen the existing national mechanisms and structures concerned with environmental planning and assessment in the country.
- 4.3. The combination of present environmental problems in the Maldives together with the numerous reports of visiting experts which remain largely unimplemented might suggest, on superficial examination, that the Republic either lacks the capacity or the will to implement change. It is the opinion of the authors of this report, however, that neither of these reasons is correct. The authors were struck by the clearly articulated and frequently expressed concern of many Maldivians about current environmental problems. It seems clear that the problems of planning sustainable development in the Maldives stem mainly from the highly sectoralised approach to planning which appears to operate at present.
- 4.4. Individual advisors/consultants produce reports and recommendations on industrial development, on manpower planning, on agriculture, fisheries, water management, transport, conservation and disasters without consideration of an holistic approach to planning and management. A country as physically limited as the Maldives can only be treated as a single entity, since changes and developments in one area have automatic links and impacts with all other areas of the economy and environment. Sustainable development in the Maldives can only be achieved by a careful and simultaneous consideration of all aspects of these islands' fragile environment.
- 4.5. Given the clearly expressed desire of the Government of the Maldives to initiate the process of sustainable development, including an adequate consideration of environmental issues in development planning, it is imperative that UNEP respond promptly if the current enthusiasm and commitment is to be successfully harnessed.
- 4.6. The best way to achieve a lasting input into the planning process of the Maldives, which would take into account the potential effects of expected climatic changes, is not by preparing another study by foreign experts who, though well meaning and highly qualified, most frequently fail to perceive the socio-economic context and the national aspirations of the country seeking their assistance.

预览已结束，完整报告链接和二维码如下：

https://www.yunbaogao.cn/report/index/report?reportId=5_15489

