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***Water quality studies on selected***

***South Pacific lagoons***

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## PREFACE

Nineteen years ago the United Nations Conference on the Human Environment (Stockholm 5-16 June 1972) adopted the Action Plan for the Human Environment, including the General principles for Assessment and Control of Marine Pollution. In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" [General Assembly resolution 2997 (XXVII) of 15 December 1972]. The organizations of the United Nations system were invited "to adopt the measures that may be required to undertake concerned and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organizations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination". Subsequently, the Governing Council of UNEP chose "oceans" as one of the priority areas in which it would focus efforts to fulfil its catalytic and co-ordinating role.

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans.

The Regional Seas Programme at present includes 12 regions<sup>1</sup> and has some 140 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities<sup>2</sup>.

The idea for a regional South Pacific Environment Management Programme came from the South Pacific Commission (SPC) in 1974. Consultations between SPC and UNEP led, in 1975, to the suggestion of organizing a South Pacific Conference on the Human Environment. The South Pacific Bureau for Economic Co-operation (SPEC) and the Economic and Social Commission for Asia and the Pacific (ESCAP) soon joined SPC's initiative and UNEP supported the development of what became known as the South Pacific Regional Environment Programme (SPREP) as part of its Regional Seas Programme.

The Conference on the Human Environment in the South Pacific was convened in Rarotonga, from 8 to 11 March 1982. It adopted: the South Pacific Declaration on Natural Resources and Environment; the Action Plan for Managing the Natural Resources and the Environment in the South Pacific Region; and agreed on the administrative and financial arrangements needed to support the implementation of the Action Plan and on the workplan for the next phase of SPREP<sup>3</sup>.

The legal framework of the Action Plan was developed through several meetings of legal and technical experts from the South Pacific Region. It was adopted by the plenipotentiary meeting of the High Level Conference on the Protection of the Natural Resources and Environment of the South Pacific Region convened by the Secretary-General of SPC in Noumea, New Caledonia, from 17 to 25 November 1986.

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<sup>1</sup> Mediterranean, Kuwait Action Plan Region, West and Central Africa, Wider Caribbean, East Asian Seas, South-East Pacific, South Pacific, Red Sea and Gulf of Aden, Eastern Africa, South Asian Seas, Black Sea and North-West Pacific.

<sup>2</sup> UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1, UNEP, 1982.

<sup>3</sup> SPC/SPEC/ESCAP/UNEP: Action Plan for managing the natural resources and environment in the South Pacific Region. UNEP Regional Seas Reports and Studies No. 29, UNEP, 1983.

The legal framework adopted by the Conference consists of the following instruments<sup>4</sup>.

- Convention for the Protection of the Natural Resources and Environment of the South Pacific Region;
- Protocol Concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region;
- Protocol for the Prevention of Pollution of the South Pacific Region by Dumping.

The Convention is a comprehensive umbrella agreement for the protection, management and development of the marine and coastal environment of the South Pacific Region. It lists the sources of pollution which require control: pollution from ships, dumping, land-based sources, seabed exploration and exploitation, atmospheric discharges, storage of toxic and hazardous wastes, testing of nuclear devices, mining and coastal erosion. It also identifies environmental management issues requiring regional co-operation: specially protected areas, pollution in cases of emergency, environmental impact assessment, scientific and technical co-operation, technical assistance, and liability and compensation for damage resulting from pollution.

Considerable support to the implementation of the Action Plan is received from a number of South Pacific research and training institutions. Periodic consultative meetings of these institutions are convened to discuss the environmental problems of the region which may be mitigated or solved through the Action Plan and to identify activities which may contribute toward the goal of SPREP. The present report was commissioned by UNEP as such a contribution. The report has been prepared by Shamila Naidu, W.G.L. Aalbersberg, J.E. Brodie, V.A. Fuavao, M. Maata, Milika Naqasima, Penelope Whippy and R.J. Morrison.

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<sup>4</sup> Convention for the protection of the natural resources and environment of the South Pacific Region and related protocols, UNEP 1987.

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## **ABSTRACT**

This report presents the results of studies made on five Pacific lagoons located at Suva, Fiji; Vila, Vanuatu; Tarawa, Kiribati; Tongatapu, Tonga; and Marovo, Western Province, Solomon Islands. Studies were made on water quality by physical, chemical and microbiological analyses. Analyses of shellfish and sediments were also completed for some sites.

The results indicate that the major problems in four lagoons were sewage-related. At Marovo, the limited data available indicated that the lagoon is effectively unpolluted except for isolated areas close to large villages. For the Suva, Vila and Tarawa lagoons faecal coliform counts in water and shellfish were frequently high, indicative of potential health problems. This situation requires particular attention by local government authorities. These three lagoons plus that in Tongatapu also had relatively high nutrient (nitrate and phosphate) concentrations, sufficient to have detrimental effects on coral growth.

No analyses of pesticide residues were completed but possible pollution problems were only anticipated at Suva and Tongatapu. For trace metals, the results indicated that possible problems exist for Suva, Vila and Tongatapu. The problems were generally very localized but increasing numbers of metal-based industries are cause for concern.

There is generally a lack of monitoring activities in the countries covered by this study. If governments are to have warning of potential coastal pollution problems then some locally-based long-term monitoring is essential. This is particularly critical given the fragility of coastal ecosystems and their economic and social importance in the Pacific Islands.

# 1. GENERAL INTRODUCTION

Over the last twenty years the South Pacific region has seen numerous changes in the environment due to human related activities such as increased industrialization and rapid urbanization. While increased industrialization has led to the production of large volumes of waste products/water requiring subsequent disposal (usually into surrounding marine environments), the rapid urbanization has resulted in increased discharge of human wastes and domestic rubbish into surrounding aquatic environments due to inadequate waste disposal facilities. One likely consequence of such activities is the degradation or destabilization of the ecosystems to levels where it is impossible to maintain the natural resources on which most of the island communities depend.

While industrialization was initially looked on favourably as a tool for achieving higher standards of living, the increased pollution resulting from such activities has caused concern among those interested in the maintenance of good environmental standards. Industrial waste disposal can jeopardise the health of a range of organisms (including humans) and certain types of waste products may render some areas unfit for normal habitation. There is, therefore, a need to monitor pollution resulting from both industrialization and urbanization. With this in mind, the University of the South Pacific Institute of Natural Resources (USP/INR) using financial support from the South Pacific Regional Environmental Programme (SPREP) initiated a programme in 1987 to monitor in detail some chemical and biological parameters of five lagoons/harbours within countries of the South Pacific. The five areas selected for study were:

- (i) Laucala Bay/Suva Harbour, Suva, Fiji
- (ii) Vila Harbour and Erakor Lagoon, Vanuatu
- (iii) Tarawa Lagoon, Kiribati
- (iv) Fanga'uta Lagoon, Tonga
- (v) Morovo Lagoon, Solomon Islands

The locations of the study sites are given in Figure 1.1.

These lagoons were selected as being representative of different environmental situations. The Laucala Bay area close to the major Suva city centre is representative of a situation where the influence of urbanization/industrialization is considerable. Vila Harbour is a situation where rapid expansion of industrialization is taking place. Tarawa Lagoon was chosen as being representative of an atoll lagoon affected by high population density but little industry, whereas Fanga'uta Lagoon is located in a low lying island of high population density, but with some industrialization occurring. Morovo Lagoon is located in an area which is virtually free of industrialization but intensification of fishing, agriculture and forestry may lead to significant changes in the lagoon environment. Thus, four of the study sites are in areas where pollution problems are expected and one is a 'clean' site.

The objectives of the study were:

- (i) **Suva** : To gather data on the state of water quality in Suva Harbour and Laucala Bay so that appropriate action may be taken, if required, to improve or maintain quality by control of effluent discharge.
- (ii) **Vila** : To follow-up the work of Carter (1983) in Vila Harbour and Erakor Lagoon and to monitor the current state of water quality in the harbour and in the lagoon.
- (iii) **Tarawa** : To monitor the present water and biota quality in the southern part of Tarawa Lagoon and to assess any improvement which may have occurred since the installation of the sewerage system on South Tarawa by comparison with the data in the report of Johannes *et al.* (1979).
- (iv) **Fanga'uta** : To gather data on the state of water quality in Fanga'uta Lagoon and assess any changes which may have occurred since the study of Zann *et al.* (1984) as a result of increased population and industrial development.

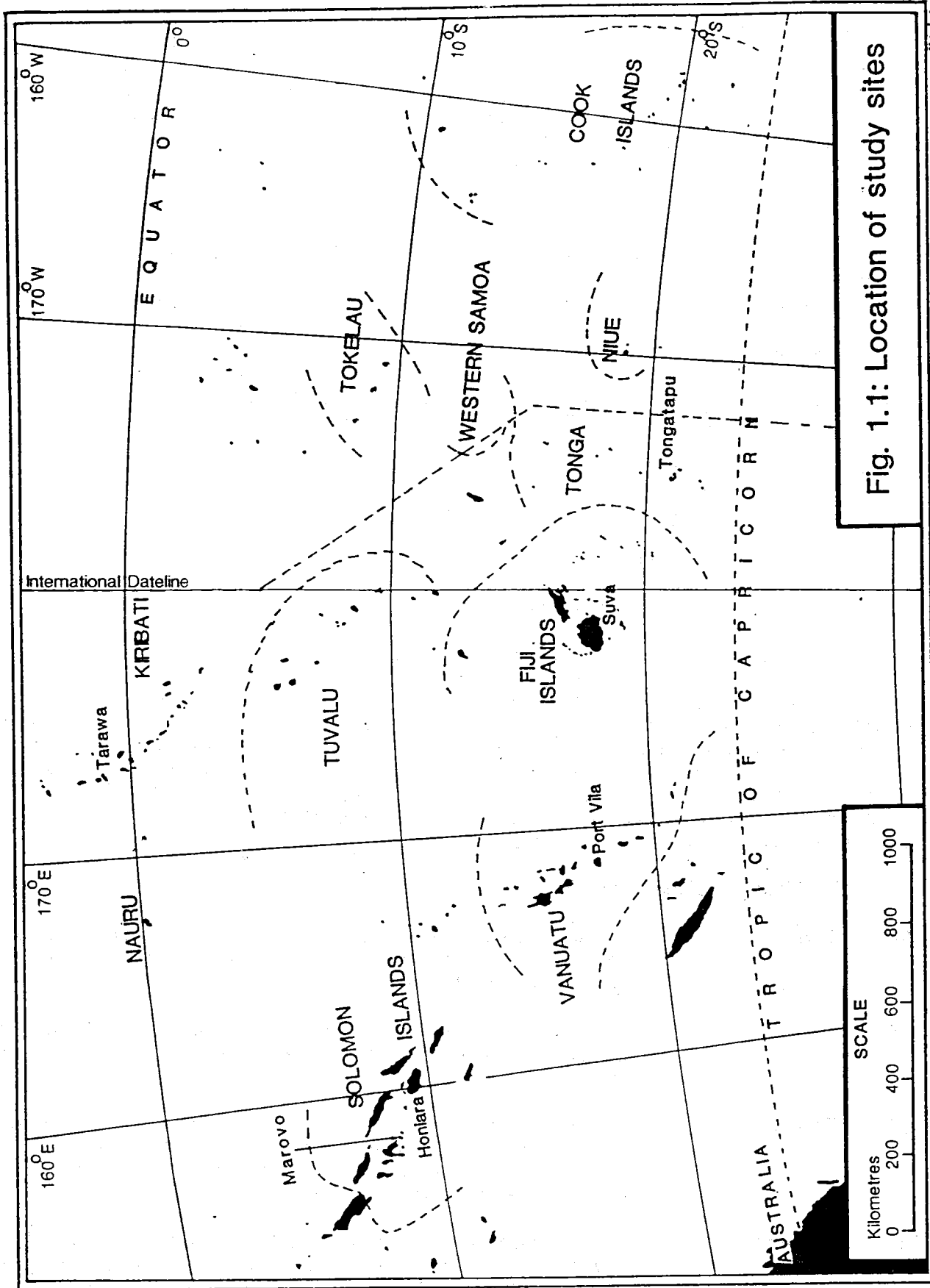


Fig. 1.1: Location of study sites

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- (v) **Marovo** : To provide baseline water quality data on an essentially unpolluted lagoon so that the impact of proposed development activities may be ascertained.

The projects were run in collaboration with

- (a) Public Works Department, Fiji
- (b) Environment Unit, Vanuatu
- (c) USP Atoll Research and Development Unit, Kiribati and the Kiribati Ministry of Health
- (d) Environment Unit, Tonga
- (e) Ministry of Health and Department of Fisheries, Solomon Islands

The present report describes the findings of the chemical and biological monitoring of the five lagoons in 1987 and 1988.

## 2. GENERAL METHODS

### 2.1 SAMPLING

For general water quality assessment of an area the type of sample that is usually collected is the actual water itself. However, when water is being assessed for pollution studies it is often desirable to measure parameters that are present in extremely low concentrations and hence detection is sometimes impossible with the facilities available. Sediments and shellfish can be very good indicators of water quality because polluting agents such as trace (toxic) metals and organochlorine residues tend to concentrate in these materials and are thus easier to detect. A further advantage of studying pollution levels in shellfish is that this would give indications as to whether the shellfish meet requirements for human consumption. With these factors in mind, it was decided that water and shellfish samples would be collected for general water quality, trace metal studies and coliform status determinations.

Water samples were collected from the surface directly into clean polyethylene containers. In general, a minimum of one litre was collected. Samples for heavy metal determinations were treated with concentrated nitric acid to reduce the pH below 2. Samples for mercury analysis were further preserved by addition of potassium dichromate. Samples were transported in polystyrene boxes with ice packs. Nutrient analyses and bacteriological analyses were started on the day of collection while trace metal samples were stored in the refrigerator.

Shellfish samples were obtained by collecting 20-30 samples of the selected species at each site. If the samples could not be analysed for trace metals immediately they were frozen. An attempt was made to collect shellfish of approximately the same size at each site.

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