Issues for Community-based Sustainable Resource Management and Conservation: Considerations for the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States

Volume 3: A Synopsis of Information Relating to Waste Management, Pollution Prevention and Improved Sanitation with a Focus on Communities in the Pacific Islands Region

by Leonie Crennan and Greg Berry

Technical Report 2002/03

Participating Countries in the International Waters Programme

Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

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FOREWORD

The South Pacific Regional Environment Programme (SPREP) has been involved in many large regional initiatives since it was established in 1982. Among the more notable are the National Environment Management Strategies, State of Environment Reports, regional preparations for the United Nations Conference on Environment and Development in Rio de Janeiro in 1992; the South Pacific Biodiversity Conservation Programme which also started in 1992 and concluded in 2001, preparations leading up to the World Summit on Sustainable Development scheduled for Johannesburg, South Africa in 2002 and this programme, the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States (the IWP).

The IWP is novel in many respects. It is the first large programme in which several Pacific regional organisations, united under the umbrella of the Council of Regional Organisations in the Pacific (CROP), are formally collaborating. While SPREP is the executing agency, responsibilities for the execution of the oceanic component of the Programme rest with the Secretariat of the Pacific Community (SPC), based in New Caledonia, and the South Pacific Forum Fisheries Agency (FFA), which is based in Solomon Islands. These two organisations are providing the science and the management advice respectively to assist the 14 countries participating in the Programme develop comprehensive conservation and management arrangements for the region's major renewable resource, tuna.

The Project Coordination Unit (PCU) of IWP is based at the SPREP Secretariat in Samoa. It is responsible for the implementation of the coastal component of the Programme. The objective of this component is to design and implement a project in each of the 14 participating countries that seeks to address priority environmental concerns in respect of coastal fisheries, marine protected areas, waste management or the preservation and conservation of freshwater resources. The focus of the projects, termed pilot projects in the Project Document, is to promote increased community involvement and responsibility for local resource management and conservation initiatives.

The Programme is an ambitious one. Involving 14 countries stretching over 30 million square kilometers of the western central Pacific, and working principally in isolated rural communities, there are bound to be many challenges encountered as the Programme is implemented over the next four years. Nevertheless, if in that short time frame we can learn more about processes that will motivate and support local communities to take a more proactive role in the sustainable utilisation and conservation of their renewable resources, we will have made a significant contribution to the future well-being of the Pacific region and the ecosystems it supports.

This report is one of six reports produced at the start of the Programme and, as such represents the first major output for the Programme. This series of reports seek to synthesize all the available information for each of the priority areas of interest to the IWP - coastal fisheries, marine protected areas, waste and freshwater as they relate to tropical island ecosystems, particularly in the western and central Pacific. The reviews of these four technical areas are supplemented with complementary reviews, in separate volumes, of economic issues to be considered in planning and implementing community-based sustainable resource management and conservation initiatives in island ecosystems, and of lessons learned from previous national and regional projects and activities related to the future areas of work for the IWP. Not only do these documents provide a useful reference for practitioners working on the priority environmental concerns of the region in relation to each of these four areas of interest but they also provide a comprehensive snapshot of our understanding of these critical issues in the region in early 2002.

As a result, these reports will provide a useful reference for understanding the baseline situation that existed in the region at the start of the IWP. They provide a valuable reference against which the situation in 2005 may be assessed. This will be a measure of whether progress was made in addressing these pressing issues during the Programme or if we continue to threaten the future of our fragile environment through poor management of the natural systems and resources with which we are blessed.

SPREP looks forward to working with participating countries on the successful execution of this Programme.

Tamari'i Tutangata
Director
SPREP

INTRODUCTION

Background

The member countries and territories[1] of the South Pacific Regional Environment Programme (SPREP), at their 8th Annual Meeting in October 1995, endorsed a project to prepare the Strategic Action Programme (SAP), under the International Waters focal area of the Global Environment Facility (GEF).

The GEF was created in 1994 to fulfill a unique niche – that of providing financing for programmes and projects to achieve global environment benefits in four focal areas: biodiversity, climate change, international waters, and ozone layer depletion - and in land degradation as it relates to these focal areas.

According to the GEF definition, international waters include oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries as well as rivers, lakes, groundwater systems, and wetlands with trans-boundary drainage basins or common borders involving two or more countries. The ecosystems and habitats associated with these waters are essential parts of the system. Because the global hydrological cycle links watersheds, the atmosphere, estuaries, and coastal and marine waters through transboundary movement of water, pollutants and living resources, international waters extend far inland and far out to sea.

The Pacific region's premier political body, the Pacific Islands Forum, at its Annual Session in September 1996, requested SPREP to coordinate development of the project. Formulation of the SAP, funded by GEF through project development funds (PDF Block-B), began in April 1997. The SAP was to combine the following activity areas:

- Integrated conservation and sustainable management of coastal resources, including freshwater resources;
- Integrated conservation and sustainable management of oceanic resources;
- Prevention of pollution through the integrated management of land- or marine-based wastes; and
- Monitoring and analysis of shore and near-shore environments to determine vulnerability to environmental degradation.

The basis for developing a Programme focus in these areas is found in the joint regional position prepared by Pacific island countries for the 1992 United Nations Conference on Environment and Development (UNCED), the simultaneous preparation of National Environmental Management Strategies (NEMS) by Pacific island countries between 1990 and 1996, as well as the Action Plan for Managing the Environment of the South Pacific Region (1997-2000).[2]

A Regional Task Force (RTF) was established to oversee preparation of the SAP. It was composed of one representative from the Governments of Fiji, Marshall Islands, Samoa, Tonga, and Vanuatu, with additional members from the Pacific Islands Forum; SPC, SPREP, the three GEF Implementing Agencies (the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and The World Bank (TWB)), two international non-governmental organisations (the World Conservation Union (IUCN) and The Nature Conservancy (TNC)), and one private sector representative (Fiji Dive Operators Association, recommended by the Tourism Council of the South Pacific (TCSP)). The Asian Development Bank (ADB) and the Economic and Social Commission for Asia and the Pacific (ESCAP) also participated.

Work undertaken during the SAP formulation process resulted in the identification of three priority transboundary concerns related to International Waters:

- degradation of their quality;
- degradation of their associated critical habitats; and
- unsustainable use of their living and non-living resources.

The SAP was reviewed and subsequently endorsed by the Heads of Government of the Pacific Islands Forum at its Session in Rarotonga in 1997. Refinement over a period of almost two years resulted in GEF Council approval of the SAP in August 1999. Execution by SPREP commenced in early 2000.

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1 American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, France, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, United States of America, Vanuatu and Wallis and Futuna.

2 Revised in late 2000 as the Action Plan for Managing the Environment of the Pacific Islands Region (2001-2004) adopted by the 11th SPREP Meeting, Guam, USA, 9-12 October 2000.

The International Waters Programme (IWP), or Strategic Action Programme (SAP) in GEF parlance, is designed to assist Pacific island countries[3] improve regional capacity for management of transboundary water resources and create improved management structures to address environmental degradation and ensure the long-term sustainability of ocean fisheries in the Western and Central Pacific ecosystem. The IWP also intends to promote improved integration of environmental concerns into local, national and regional policy, and improved water quality and the conservation of key coastal and ocean ecological areas.

The GEF and UNDP view the "pilot" or "demonstration" nature of the 14 projects to be implemented under the national components of the IWP as providing the basis for future funding opportunities from GEF facilities for participating countries. The IWP, as a Strategic Action Programme, is considered an initial step leading to the development of Medium-Sized (up to US$1 million) or Full Projects (in excess of US$1 million) for technical assistance, capacity building or investment. Such projects may be regional or national in scale. As a result, the later stages of the IWP are likely to devote considerable effort to analyzing the results of the IWP to assist countries with the formulation of follow-up activities supported through the GEF and alternative sources of financing assistance.

Key Elements and Assumptions

The Project Document is formulated on the basis that the International Waters in the Pacific region are subject to threats that give rise to transboundary concerns. During the formulation of the IWP, threats were examined from the perspective of critical species and their habitats and living and non-living marine resources. Identified threats include:

- pollution of marine and freshwater (including groundwater) from land-based activities;
- the long term sustainable use of marine and freshwater resources;
- physical, ecological and hydrological modification of critical habitats; and
- unsustainable exploitation of living and non-living resources, particularly, although not exclusively, the unsustainable and/or inefficient exploitation of coastal and ocean fishery resources.

The IWP formulation process examined each threat in a legal, institutional, socio-economic and environmental context. The ultimate root cause underlying imminent threats was identified as deficiencies in management. Factors contributing to the management root cause were grouped into two linked subsets: a) governance, and b) understanding.

The governance subset was characterised by the need for mechanisms to integrate environmental concerns, development planning, and decision-making. The understanding subset was characterised by the need to achieve island-wide ecosystem awareness through improved education and participation. Island-wide awareness and participation will facilitate the development and implementation of measures to protect International Waters.

The IWP analysis revealed a set of information gaps required by decision-makers to responsibly address ultimate root causes and respond to imminent threats. Particularly important is the lack of strategic information presented in an appropriate manner to decision-makers, resource users, managers and communities to evaluate costs and benefits of, and to decide among, alternative activities. Improving information input and exchange at the regional, national, and community levels is an objective of the Programme.

The IWP provides for targeted actions to address the root causes of degradation of International Waters. The actions are to be carried out in two complementary, linked consultative contexts: Integrated Coastal and Watershed Management (ICWM) and Oceanic Fisheries Management (OFM). Through the ICWM and OFM approaches, the IWP suggests a path for the transition of Pacific islands from sectoral to integrated management of International Waters as a whole, the evolution of which is essential for their protection over the long term.

The IWP will place priority on liaising with donors who are active in the region to plan and coordinate regional and national development assistance for International Waters to address imminent threats and their root causes more effectively. The IWP is designed to provide a framework for overall national and regional planning and assistance for the management of International Waters and provide a catalyst for leveraging the participation of other donors in the project.

[3] The 14 countries participating in the IWP are: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

The Project Document acknowledges that all sustainable development issues related to International Waters cannot be addressed at once. Therefore, four high priority areas have been identified for immediate intervention:

- improved waste management;
- better water quality;
- sustainable fisheries; and
- effective marine protected areas.

Targeted action within these activity areas is proposed in five categories:

- management;
- capacity building;
- awareness/education;
- research/information for decision-making; and
- investment.

Institutional strengthening is included under management and capacity building.

The principal components of the IWP, as described in the PD, are summarised in Table 1.

Table 1. A summary of the principal components of the IWP including the broad Programme objectives and activity areas designed to address priority environmental concerns of participating countries.

Goal	To achieve global benefit by developing and implementing measures to conserve, sustainably manage and restore coastal and oceanic resources in the Pacific Region [Integrated sustainable development and management of International Waters]
Priority Concerns	Degradation of water quality • Degradation of associated critical habitats • Unsustainable use of resources
Imminent Threats	Pollution from land-based activities • Modification of critical habitats • Unsustainable exploitation of resources
Ultimate Root	Management deficiencies • Governance • Understanding
Solutions	• Integrated Coastal and Watershed Management, and • Oceanic Fisheries Management. (ICWM), (OFM)
ICWM Activity Areas	• Improved waste management • Better water quality • Sustainable fisheries • Effective marine protected areas
OFM Activity Areas	• Sustainable ocean fisheries • Improved national and regional management capability • Stock and by-catch monitoring and research • Enhanced national and regional management links
Targeted actions	• Management/institutional strengthening • Capacity-building/institutional strengthening • Awareness/education • Research/information for decision-making • Investment

UNDP is the GEF Implementing Agency and SPREP is the Executing Agency, on behalf of other CROP agencies associated with the Programme, the SPC and FFA.

This Review

This review is one of six reviews that were compiled during the early stages of IWP implementation for two reasons. The first is to provide a source of current information for practioners – principally those practioners associated with the implementation of the pilot projects in each of the participating countries as it relates to the areas of primary interest to the IWP (waste, freshwater, marine protected areas and coastal fisheries). To provide as much practical benefit as possible, these reviews are supplemented with additional synopses of information concerning economic issues and lessons learnt in the design and implementation of community-based sustainable resource management and conservation initiatives.

The second reason for these reviews is to provide a snapshot of what is known about each of the four areas of primary interest to the IWP in 2001 and early 2002. This is done to provide a baseline overview of available information in the areas of primary interest at the commencement of the Programme. As a result, any review of these areas of interest towards the end of the Programme, in 2005, will have a useful reference for assessing change in relation to the management and conservation of these resources in the Pacific region.

The first of the six reviews was prepared by Mike Huber and Kerry McGregor who comprehensively reviewed activities and current thinking in relation to marine protected areas (MPAs) and their application to the management and conservation of coastal resources. While the focus of the review is the Pacific islands region, their presentation is supplemented with examples from other ocean regions. The review examines resource conservation and related habitat issues, management approaches, governance, and past and current priorities in respect of marine protected areas at the national level within the 14 countries participating in the Programme and regional initiatives relating to marine protected areas.

The second volume in the series addresses issues relating to the conservation and management of freshwater resources in the Pacific islands region. It was prepared by Tony Falkland who provides a review of published and other information relating to freshwater quality, supply, management and conservation. The review places emphasis on community-based issues associated with the conservation and sustainable management of freshwater resources, reflecting the planned focus of subsequent pilot projects that may be instigated under the International Waters Programme.

This, the third volume in the series, provides an examination of issues relating to waste reduction, pollution prevention and improved sanitation in the Pacific islands region, and elsewhere, as it relates to the objectives of the International Waters Programme in terms of promoting management for improved waste reduction initiatives in communities. It was prepared by Leonie Crennan and Greg Berry who summarise activities in the region that have attempted to address low cost/no cost alternatives to reduce loadings of solid and liquid wastes, particularly in coastal and watershed communities where quality of drinking water resources is at risk. Information includes a review of priority waste concerns in Pacific island communities, management and governance issues, and options for increased community responsibility for managing waste problems.

In the fourth volume, Paul Dalzell and Don Schug review current information relating to sustainable coastal fisheries in the Pacific islands region and elsewhere as it relates to the objectives of the Programme in terms of promoting capacity building for improved resource management responsibility in communities. Information presented includes a review of coastal fisheries in the Pacific region, discussion of resource management and governance issues, customary marine tenure (CMT), the role of MPAs and past and current priorities in respect of the sustainable management of coastal fisheries at local, provincial, national and regional scales. Their review includes consideration of gender issues and women's activities in the coastal zone including the role of women in subsistence and artisanal fisheries in the 14 countries participating in the Programme. They also discuss cases that illustrate particular issues in community-based management of subsistence and artisanal fisheries; including government support for community actions.

Padma Lal and Meg Keen present a review of economic issues that should be considered in the design, implementation, monitoring and evaluation of community-based resource management and environment conservation projects in island ecosystems – the fifth volume. They describe economic issues that require detailed consultation with community members during the design, implementation and monitoring of projects such as those to be supported under the Programme. This includes the identification of institutional issues, socio-economic implications for communities (benefit/ cost analysis and cost effective analysis), and suggested strategies for promoting broad community participation and support in conservation and sustainable resource use initiatives (incentives and transaction costs).

In the sixth and final volume in this series, Jenny Whyte and her colleagues at the Foundation of the Peoples of the South Pacific International and affiliated organizations provide a review of information relating to lessons learned and best practices for resource and habitat conservation and sustainable management initiatives in the Pacific islands region. The review focuses on community-based (participatory) issues associated with the conservation and sustainable management of resources and habitats in island ecosystems with emphasis on the four focal areas for the International Waters Programme (sustainable coastal fisheries, marine protected areas, community-based waste reduction and preservation of freshwater resources). Issues are considered in context of the entire project cycle - from project planning

and design; selection of sites; method of community entry; community baseline assessments; participation of communities; the role and participation of governments and, if they are involved, external agencies, NGOs and development assistance agencies; education and awareness activities, completion and exit considerations such as alternative income generation, and monitoring and evaluation. The review considers social, cultural, economic, environmental, administrative, managerial, legal and political dimensions of such projects.

As a supplement, each author was asked to consider examples of what a pilot project might look like. As a result, at the conclusion of each review, three examples of community-based initiatives that may serve as a model or a template for a pilot project are presented.

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There are many others in the region, too many to mention here, who deserve thanks. Each review called on an extensive regional and international network of colleagues and contacts who freely supplied material that assisted in the preparation of these reviews. Each volume lists those whose voluntary assistance was gratefully provided to assist with the preparation of each review. To all those who assisted, particularly those who assisted Anna, we express our sincere appreciation.

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ABOUT THE AUTHORS

Dr Leonie Crennan began her working life as a lawyer and later retrained in environmental science, with a particular interest in the use and abuse of water. Early technical fieldwork included the design of ecological sanitation systems for high conservation areas in Australia and the United States. This led to adaptation of these systems for developing countries where water resources were threatened by conventional sanitation practices. Leonie has worked in the Asia-Pacific region, Central America, India and China on a range of land-use and resource management programmes, often focusing on the nexus between technical and social science.

Dr Greg Berry operates an international multi-disciplinary consultancy in design, demonstration, research, and training for site specific management of all household waste. The consultancy specialises in the integration of multi-faceted plant production systems and energy-efficient dwellings, with de-centralised management of excreta and greywater. Greg has over 25 years experience in sustainable living strategies with a particular focus on domestic and community food production, and water efficiency. Since the 1970s he has practiced urban agriculture at intra and peri-urban levels in a variety of locations throughout Australasia.

Executive Summary

Water supply and sanitary services have been provided by communities to their inhabitants from the beginning of organised urban settlements. Services have included central water and sewer systems, solid *waste* collection from the roadside, and storm drains. These systems changed very little until well into the twentieth century, when increasing populations, proliferation of manufactured goods, and indiscriminate discharges of untreated *wastes* created intolerable pollution problems. With a better understanding of the relationship between *waste* disposal and environmental impact, increasingly sophisticated treatment methods have been developed, in an attempt to reduce ecological damage as much as possible. The process of adaptation continues in industrialised or developed countries, where there is ongoing agitation for additional control measures and more sophisticated treatment, as new pollutants and associated impacts are identified.

However, developing countries, including Pacific Island Countries (PICS) generally do not have the financial, technical, or institutional resources to keep pace with increasing pollution and the parallel need to improve *waste* management services. Moreover, industrialised countries have had comparatively much more time to deal with these problems. In developing countries, especially those with fast-growing economies, this process has been compressed into one generation or less. Consequently, the sanitary and environmental conditions in some urban and peripheral urban areas in developing countries have become a serious threat to public health and the preservation of natural assets The peri-urban settlements which are often illegal or informal, are usually the centre of population growth as a product of inward migration and urbanisation.

There has been a tendency to develop systems that respond to problems of environmental *waste* management as perceived by policy makers and professionals, rather than to address households' and communities' perceptions of their actual needs and limitations. Decisions regarding interventions, especially those requiring sophisticated technology, such as sewerage, are commonly taken at a political or administrative level far removed from the people to be served. This has often resulted in a reluctance by the supposed users of services to accept operational or financial responsibility, furthermore jeopardising the sustainability of the service. To promote user ownership of services, decisions should be taken at a level as close as possible to the source of the problem and in consultation with the people most directly affected.

In the past, services and programs have not been devised in an integrated way that takes into account all potential impacts. For example, the positive benefit of providing a water supply may be outweighed by the health hazards and poor living conditions which could result from not considering the appropriate disposal of used water which may create standing water and/or pollution of receiving water bodies. In addition, there is insufficient attention paid to the fact that reduction of *waste* and the more efficient use and re-use of water and materials is the most effective way to reduce demand for *waste* treatment and disposal. The need for holistic and integrated planning has not been fully recognised. This is particularly necessary in the context of the fragile ecology and geographical isolation of the small island states.

Having learnt from past experience, there are an increasing number of programs and initiatives in PICS, and elsewhere, which focus on community-based solutions to protect natural assets and public health. A selection of these activities are described in this review. Strategies have been introduced which attempt to manage *waste* as close as possible to its source, minimise the use of water to transport *waste*, and develop and utilise alternative or intermediate technologies, to encourage household and community-level construction, operation and management of facilities, and permit re-use and/or disposal at the local level. As a result, a more integrated approach, which considers all inputs and outputs of the municipal ecosystem, including the complexity of human behaviour, is gradually evolving.

Experience also indicates that investments should be based on *effective demand*. Where possible, facilities should be provided only if the prospective users have agreed that they are willing and able to cover some, or all of the investment costs in cash, or by in-kind contributions of labour and materials and at least all of the costs for operation and maintenance.

To achieve community mobilisation, adequate time and flexibility is required to allow people to comprehend what is at stake, and to develop the necessary skills to create constructive solutions. In relation to *waste* management and pollution control, there are many complex issues involved in the PIC context including, customary land tenure, taboo and privacy concerns, varying concepts of disease, contrary notions of communal responsibility, extended family obligations and allegiances; and in some communities the day-to-day preoccupation with survival.

Partnerships are required between government, community, the private sector and non-government organisations to facilitate the recovery of resources and minimise environmental degradation. In order to accomplish *waste* reduction and pollution control objectives, it is productive to encourage the creation of joint ventures and other types of relationships between businesses and community-based organisations. Local governments need little or no additional authority or resources to develop creative strategies for dealing with *waste*. Rather than trying to persuade communities to act, the challenge is to offer more attractive alternatives to conventional approaches such as land filling, incineration, or relinquishing control of a potential resource. By building alliances, resources are shared, communities

are empowered and employed, money is saved and people and systems can compliment each other to reach a common goal.

Participatory education and information exchange can contribute to the development of ecologically sustainable and empowering strategies to conserve natural assets and enhance the quality of life of the people of PICs.

1. Introduction

In most parts of the world, human activity has damaged the ecosystems which sustain us. The troublesome environmental trends are global, and threaten humanity. Many of the problems are related to high levels of consumption and the bi-products of consumption, commonly regarded as *waste*. It is the unsustainably *developed* cities of the world which produce most of the world's solid and liquid *waste*, consume most of the world fossil fuels, emit the majority of ozone destructive compounds and toxic gases, and give economic incentive to clearing of the world's forests and agricultural lands and depletion of marine assets (UNEP, 1990).

Developed or industrialised societies have access to resources from most regions of the world. They have the infrastructure, finances and usually ample physical space to dispose of *waste* that results from consumption of those resources. This is not the case in the Pacific region where most PICS have limited land mass. All PICS have small islands within their borders even if the main island is large (e.g. Papua New Guinea). Geographical isolation impacts on transport and communications. Excluding Papua New Guinea the remaining 21 countries and territories of the Pacific region consists of only 65,000 sq km of land with approximately 1.8 million inhabitants spread across 29 million sq.km. of ocean. Other specific constraints in the PICS include:

- Fragility of the island environment;
- Rapid population growth focused on urban areas;
- A limited natural resource base;
- Fundamental dependence on marine ecosystems; and
- Vulnerability to natural hazards such as cyclones and external variables such as trade and capital markets; and, in most cases, reliance on one or two economic sectors such as tourism and fishing (UNEP, 2000).

Although causes and impacts are global in scope, it is generally recognised that if destructive environmental trends are to be reversed or even slowed down, action has to be taken at the local level. This requires a national, community and individual response.

How is this pro-active response to be inspired? The evidence of global resource depletion is forcing an admission that existing patterns of resource use are not sustainable. Conservative economists even admit that sustainable development means that current human activities do not deplete what has been referred to as *natural capital or environmental capital*. Natural capital is described as any stock of natural assets that will yield a flow of valuable goods and services into the future and this could be an aquifer, a fish stock, or a forest. These environmental assets need to be managed, not overexploited or polluted, so that an ongoing sustainable harvest or *natural income* can be maintained (Roseland, 1999). As a fisherman in Kiribati commented the *sea is my bank* as this is where his livelihood is kept and earned, but like most investments, if not used properly, his capital will be depleted. If managed wisely, his capital can increase over time (Saito, 1997).

To protect and improve our stock of natural capital it is necessary to nourish and increase the positive characteristics of *social capital*. Social capital has been described as the features of social organisation such as networks, shared knowledge, patterns of understanding and interaction that create trust and codes of behaviour which allow people to live and work together (Coleman 1988; Putamen *et al*., 1993). In this sense, while PICS may have limited and sensitive natural capital there is a significant reserve of social capital that could be drawn upon to address the challenges of consumption management and pollution control. One of the striking features of Pacific communities, from an outsider's point of view, is the fabric of multiple networks that link people and provide daily motivation and identity, such as church groups, choirs, dance groups, kava clubs, women's and men's groups and youth groups. Underlying these associations is the ongoing mutual obligations of the extended family, and the civic responsibilities and commitments of the village committees and town councils that operate through town officers and other local leaders.

Social capital is different from physical or environmental capital in a number of ways;

> First, social capital does not wear out upon being used more and more… using social capital for an initial purpose creates mutual understandings and ways of relating that can frequently be used to accomplish entirely different joint activities at much lower start-up costs…
>
> Second, if social capital is unused it deteriorates at a relatively rapid rate. Individuals who do not exercise their own skills can lose human capital relatively rapidly (Ostrom, 1993).

These ideas draw attention to other noticeable characteristics of Pacific communities that can be utilised in the development of strategies to manage *waste*. It is apparent that, if motivated, people are skilled at working together for a common cause, such as fundraising to build a new church or to support the local priest. In addition, householders seem to prefer to manage the practicalities of their own lives, especially on their house compound, and do not welcome instruction from outsiders. There is also reluctance among government employees to enforce regulations onto their communities where many people are related, or they do not wish to intrude into other peoples lives (Jones 1995; White *et al*.,1999). While there is a need for active government involvement in *waste* management especially in urban areas, there is great potential for self-maintenance in partnership with centralised services. Self-reliant management of life support systems has been common practice in PICs (e.g. private wells, subsistence fishing, gardens and livestock production, on-site toilets), whereas in the developed countries, people usually have to be re-educated to take more personal control and responsibility for the systems that support their lives (Sarac 2000; Lovell 2001).

While it is foolish to generalise about people in the PICs, a further relevant skill that has been observed is the common ability to make something out of nothing. To improvise, to innovate, to recycle. There are many examples from the ordinary to the decorative and ceremonial, e.g. re-lining worn bicycle tyres with strips of car tyres and cloth, and the weaving of threads from plastic sacks to make elegant *ta'ovala* in Tonga or crafted bags and backpacks in the Marshall Islands, (Ecowoman, 2000). These skills relate to another distinctive aspect of social capital. Social capital is not reduced by lack of material resources. It's creative capacity is limited only by imagination.

In conclusion, communities worldwide will have to come to terms with the impacts of consumption on our natural capital. *Waste* management and pollution control in the PICs raises particular urgent challenges, but there are also particular strengths within the social capital of the region that can be harnessed to conserve environmental assets for the current and future health and well being of its people.

1.1 Purpose of report

This report will be used by the Project Co-ordination Unit (PCU) and stakeholders in the 14 participating countries as a general resource, and to assist with the selection, design, implementation, monitoring and evaluation of pilot projects implemented under the International Waters Program (IWP). The participating countries are the Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

The pilot projects will address the following issues:

- Reducing community *waste* impacts upon the environment;
- Sustainable management of freshwater resources;
- Management of marine protected areas; and
- Sustainable management of coastal fisheries.

1.2 Scope and structure of report

This review summarises activities within the Pacific region and elsewhere that have attempted low cost/no cost strategies to reduce loadings of solid and liquid *waste* particularly in coastal and watershed communities where the quality of drinking water is at risk. The solid and liquid *waste*s which are discussed include domestic rubbish, leaves and branches from trees and plants, animal manure, human excreta, sewage, sludge and effluent from septic tanks, agricultural and industrial chemicals, and potentially dangerous residues or hazardous *waste*s such as batteries and used oil. (Refer to Annex 1, Glossary of Terms, and Annex II, Table of *Waste* Management Options, for details of types of *waste*).

The review covers information relating to the reduction of *waste* and its impact on the environment. Various strategies are explored which aim to prevent pollution from solid and liquid *waste*s and protect public health. The review focuses on community-based issues and initiatives associated with the conservation and sustainable management of resources and natural assets, and provides summaries of a variety of projects and activities where a demonstrative and mobilising process has been attempted.

In the past, some *waste* management and pollution control strategies which have focused on infrastructure projects, have not sufficiently involved the major stakeholder, that is, the user of the scheme. The activities described in the review involve collaborations between Community-Based Organisations (CBOs), Non Government Organisations (NGOs) and, the private sector and/or local government. Examples which illustrate possible solutions and likely difficulties are taken from PICs and elsewhere.

In addition to this report there are six other reviews which address the inter-related aims of the IWP:

- A synopsis of information relating to marine protected areas;

- A synopsis of information relating to the quality of freshwater and watershed management issues in the Pacific Islands region;
- A synopsis of information relating to sustainable coastal fisheries;
- A review of natural resource economic issues associated with community-based sustainable resource management and conservation initiatives in the Pacific Islands region;
- A review of lessons learned and best practice associated with community-based sustainable resource management and conservation initiatives in the Pacific Islands region; and
- A review of past, current and planned country activity as it relates to potential work of the IWP.

Section One of this review is this Introduction. The topics covered in the following Sections overlap in some cases and have been allocated to specific categories, or Sections, only to provide a useable structure to the report. All the activities described have intentional and unintentional impacts on aspects of the daily of life of local communities. While some of the activities described may be referred to as *projects or programs* with a specific purpose, a beginning and an end, they are often complex cross-cultural processes that have multi-dimensional ramifications long after the last adviser has gone home.

Section Two explores the reasons for focusing on community-based activities in *waste* minimisation and pollution control and includes the technical, economic, institutional and social factors. Community initiative is the logical beginning for change in current *waste* management practice and related environmental conditions. Although the Section is focused on conditions in PICs, some common trends and experiences in other regions are also included to provide a broader context for discussion and understanding.

Section Three addresses the subject of pollution control closest to home, which is sanitation. This is often the most sensitive issue to approach in environmental management, and changes in attitude and behaviour related to personal hygiene and sanitation are the most difficult to achieve especially among adults (in any society). Often sanitation is relegated to the too hard basket in projects that set out to address it, or a top down approach or centralised solution is imposed so that the complexity of the issue is avoided. Experiences of on-site sanitation projects are summarised and reference is made to processes resulting in an increase in technology transfer in PICs and other countries. Centralised or off-site sanitation activities are briefly described Strategies and technologies which reduce pollution from sanitation systems, including composting toilets, sludge co-composting, and constructed wetlands which use native plants to absorb pollutants from *waste* water are referred to.

To adequately cover the environmental and socioeconomic implications of sanitation programs alone would require a separate review. In many reports and discussions it is often combined with or *added on* to water issues. In this review, the Terms of Reference (TOR) require sanitation to be included in activities to reduce the loadings of a wide range of solid and liquid *waste*s. While this requirement reflects a valid recognition of the inter-relatedness of activities and consequent impacts, it has required a somewhat lengthy report to provide at least some practical insight into these diverse topics.

Section Four examines a number of programs selected from across the region, and elsewhere, which have attempted an integrated approach to a range of *waste* minimisation and pollution control issues. As the projects have many components, particular activities are described in detail to illustrate strategies that can have a general application in PICs. Background conditions are summarised to indicate why the programs were undertaken, and to provide examples of typical challenges faced in PICs, and other developing countries.

Section Five examines the interdependent relationships that can enable communities to take responsibility for minimising *waste*, recovering resources and reducing pollution. These relationships involve partnerships with government and the private sector, and non-government organisations. This Section focuses on examples of resource recovery and *waste* management in the private sector in PICs and elsewhere, and suggests low-cost practical support that can be offered by PIC governments to facilitate local operations. The need for co-operative management of hazardous *waste* is briefly discussed.

Section Six describes activities of networks and organisations in PICs which work with communities to raise awareness and enhance skills relating to environmental degradation and the related decline in public health. Strategies are selected which attempt to maximise participation and mutual understanding, emphasising *waste* management and pollution control.,

Section Seven provides a list of references cited in the review and additional related source material

Section Eight lists personal communications referred to in the review. Information was provided by telephone, e-mail and face-to-face communication with the authors.

The Annexes provide a glossary of the terms used in this review, a summary of *waste* minimisation options, outlines of three model community-based pilot projects, suggestions for other community-based projects, a list of potential resource personnel and contact details, and a list of useful websites.

As one of the themes of this work is to consider the bi-products of consumption as a potential resource, rather than as something *waste*d, the word *waste* is highlighted (as *'waste'*), to emphasise that it is a common term (which requires revision) rather than an accurate description. Similarly, with the use of the composite word *waste*water, as language reflects and informs attitude, and a basic objective is to separate *waste* from water, then at least the term should be constructed accordingly, that is, *waste water*.

1.3 Methodology

This review was a desk-based exercise. Information was gathered from a variety of sources. No site visits for the purpose of this review were undertaken. Sources of information include:

- Regional meetings and workshops in the Pacific Islands region and elsewhere concerned with land use, water supply, sanitation and pollution control;
- Reports on regional activities and bilateral aid projects and reports by educational and research organisations within the Pacific Region and elsewhere;
- Communications with donor organisations such as AusAID, DFAT, JICA, SIDA, and SANDEC;
- Prior and current communications and discussions with local personnel from government, NGOs and communities, who are involved with community education, resource management sanitation and *waste* management in the Pacific Islands and elsewhere;
- The authors' own experience working on projects in the Pacific region and elsewhere; and
- The Internet which was used extensively for background information and project research.

Many projects and activities were investigated but only those where a recent update could be obtained on the status of the program and/or its outcome are discussed in any detail. In many cases, projects were researched and summarised by the authors, and material was amended and approved by personnel involved in these programs. This review covers a broad range of *waste* management and pollution control issues and is focused on communities in diverse climatic, geological and socioeconomic contexts. However, a varied selection of activities and countries provides an overview of priority concerns and attempted strategies toward resolution.

2. Why focus on community-based initiatives?

There are many comprehensive surveys and reports written on environmental degradation and what should be done in PICs about *waste* and pollution control (Detay 1989, Convard 1993, UNEP2000). The situation is complex and controversial, as is the case in developed countries. Because of limited technical skills and economic resources, and a fragile environment the PICs have specific urgent challenges to face. It is important to aim for goals that are realistic, and achievable in the short term, and concentrate on the strengths of the communities to face challenges, rather than focus on what is lacking in institutional and financial support. As the Chief Executive of the Fiji Visitors Bureau said;

> The *waste* problem has to be personalised and localised. *Waste* starts with people living in communities and the solution will have to be found there… a Clean Neighbourhood scheme should be started similar to the Neighbourhood Watch scheme, (A-N-D, 2000).

Although there are roles for national and local government and other agencies in *waste* minimisation and pollution control, there are a number of good reasons why it is important to focus on initiatives where communities take responsibility for protecting their quality of life and security. When thinking about who should be doing what, the following questions can be discussed.

2.1 Who pays?

Provision of centralised solid or liquid *waste* management services by government or the private sector is expensive. Ongoing funding is usually provided by the community either directly through user fees and/or indirectly through income taxes.

It is costly to develop even basic infrastructure to collect and treat solid*waste* and most PIC local governments do not have the necessary funds, or do not see this as a priority in allocation of funds.

In some cases national and local governments have introduced user-pay charges, but collection rates are very low or the collection is not enforced because most users are not able to afford such charges, or people can only make payments occasionally. Those that can afford it are also often reluctant to pay because of the irregular and ineffective service provided (Saito 1997; A-N-D 2000).

In relation to *waste*water (also referred to as liquid *waste* or sewerage), some urban areas of PICs have sewerage systems, but most of the population (90 per cent) rely on on-site systems. It is unlikely that there will be the funds to build and maintain a centralised reticulated system in most cases, although many PIC water sector managers may see this as the most desirable option (SWA, 1998).

Even if a sewerage system is provided, the cost of treatment to allow for a non-polluting discharge to receiving waters is very expensive and technically demanding in any country (Refer Section.3). For example, in an eastcoast suburb in Australia it costs $A3,000 for an average houseblock to be connected to a sewer and $A350/per annum for ongoing connection, and yet effluent is still discharged close to the beach with inadequate treatment. In addition to the contribution from users, the cost of operating centralised sewerage systems in Australia is subsidised by governments. Operational costs alone exceed user contributions and there is the asset costs of mains, pumping stations, treatment plants and dams. Of the 208.8 megalitre average daily water consumption in the city of Newcastle, Australia, in 1998-1999, 120 megalitres were used specifically for sewerage distribution (total flow of black and greywater in the sewers) and *waste*water treatment (Hunter Water Corporation, 2000).

Centralised waterborne systems require considerable energy to operate. For example, the sewerage system in Newcastle consumes 30, 632, 577 kilowatts per annum of coal fired power to transport and treat liquid*waste* (*Pers. comm.* Jacobson 2000). It is estimated that the marginal cost of supplying water for the transport and treatment of sewage in Australia is $A120 million (Howe and White 1999;*Pers. comm.* S. White 2000). (Marginal cost is the extra cost incurred directly by each megalitre of water used for sewage services or saved if a megalitre is reduced).

The reticulated sewerage systems that do operate throughout PICs often discharge untreated or partially treated effluent close to the shoreline. The remainder of the population use on-site toilets such as pit latrines, flush septic tanks, composting toilets, Ventilated Improved Latrines (VIPs), or the bush or the beach. Greywater is rarely treated in on-site systems (Convard, 1993).

Even with services that are considered essential, such as reticulated water, householders in PICs often do not pay their utility bills, despite the low charges and threat of disconnection if payment is not received (Crocker, 1996). Any funding of centralised *waste* management services in PICs will have to take into account the likely inability of low-income families to make regular cash contributions (SWA, 1997; Raj, 2000). This indicates an economic imperative to develop low cost options for improved sanitation and community responsibility for *waste* management, in order to reduce pollution loadings.

2.2 Who can do the work and who makes the decisions?

In many PICs, there is a shortage of personnel with the necessary technical expertise to be responsible for solid *waste* management planning and operation, especially where it involves the design and construction of properly designated disposal sites.

Although a variety of technical training has been provided for many years, sometimes there is only one environmental health officer for a whole island group and he or she is responsible for everything from building applications to outbreaks of cholera (*Pers. comm.*, Fifita, 1999). When training is provided, some skilled local personnel then seek employment in other countries where wages are higher.

Centralised *waste* management services require efficient institutions to ensure that *waste* is collected as expected, disposal and treatment facilities are operated and maintained effectively, and revenues collected. This requirement for effective organisation also applies to the maintenance of centralised sewerage systems, and to the supervision of on-site sanitation systems.

In many Pacific island urban centres, deferred maintenance threatens the survival of centralised systems, ADB, (2000). For example, the sewerage system on South Tarawa, Kiribati, which only covers about 30 per cent of the urban population, is increasingly run-down with toilets blocked with sand, coral and coconut husks, cubicles and cisterns vandalised and repairs to the main trunk line suffering from a lack of equipment and basic maintenance tools (Jones, 1995; MFEP 1999) (Refer Section.4.5). In Honiara, Solomon Islands, breakdowns and mains backflows are commonplace. In Suva, Fiji, maintenance for water and sewerage was estimated to be seven years behind schedule, World Bank, (1995).

There are often no clear roles or functions of the various agencies defined in relation to solid or liquid *waste* management, nor a single agency or committee designated to co-ordinate their projects and activities. For example, the Ministry of Health may deal with supervision, the utilities board may be responsible for maintenance of infrastructure, and the Ministry of Lands and Survey may have to control land use. It is often difficult to get personnel from the various agencies to communicate about inter-related problems and solutions, much less co-operate, pers.comm.;.Helu 1999). This lack of communication can also happen within departments. As one public servant commented:

People here don't poke their nose into other peoples business… and it happens in the office too, we don't usually know what other sections of the Division are doing. When the head of the Division or others go to a conference, nobody knows where they have gone or what happened when they came back. There is no exchange of information (Pers. comm.;. Kamauti 1998).

The lack of co-ordination among agencies can also result in lack of communication between donor funded programs. This can lead to duplication of efforts, wasting of resources, and unsustainability of *waste* management program, Raj, (2000).

While government institutions may be responsible for planning and operating *waste* management facilities, a pre-requisite is the acquisition of suitable land. In PICs most land is customary owned (or Crown owned as in Tonga) and land use decisions are often community-based. This may lead to difficulty and expense acquiring land for *waste* management activity including landfill, or other public utilities such as reticulated water or sewerage systems, as governments may not be in a position to make the necessary land-use decisions or afford compensation (Jones1995; SPREP:SKM- Kiribati, 2000; Dever, 2000; ADB, 2000). Customary lands are diverse in their tenures and cultural past. Problems encountered by government and private developers include protracted negotiations for land leasing and acquisition, unresolved land disputes and demand for ad hoc increases in rent by indigenous landowners (World Bank, 1993; White et al; 1999; ADB 2000). Once acquired for public purposes, land can become orphaned and people may not feel responsibility to care for it. Family compounds may be swept at least once a day while areas under government control are often carelessly littered (Saito 1997; *Pers. comm*., Vi 2002).

Initiatives to promote government controlled zoning have been unpopular in most of the independent Pacific islands. Community-based programs have had more success. For example, the 1994 AusAID Vanuatu Land Use Planning Project integrated a broad set of principles and guidelines for development of land resources. The project promoted a Community Area Resource Management Activity (CARMA) Bridging the Gap that incorporate GIS land-use plans to assist the process of integrating community, provincial government and national government interests and capabilities across all sectors. Communities proved willing to plan the use of the land so long as they were involved on an equal basis in developing the plan (UNESCAP, 2000).

Domestic animals, particularly pigs, are often kept on urban family compounds and allowed to wander through the streets. It is reported that pig *waste* is considered to be a more significant pollution problem than human sewerage in some areas (Pers. comm., Lawrence, 1997; Chowdhury, 2001). In terms of government control over the private domain this presents a further reason to focus on processes that mobilise communities to initiate their own *waste* minimisation and pollution control schemes, as imposed prohibitions and restrictions are unlikely to be observed

2.3 What do people think?

What people think about *waste* and its components will influence how it is managed. People from all societies have their particular attitude to *waste*. The English word *waste* has a negative connotation and suggests something lost. Perhaps this comes from a time when new concepts of disease were developing and authorities were trying to persuade people to clean up their situation and get rid of the goods and chattels that surrounded them. In those early days, however, even the new sanitarians advocated that sewerage shouldn't be *waste*d (Chadwick, 1887).

Now that *waste* management has become a serious challenge for most local governments worldwide, the trend in developed countries is to persuade citizens to regard their *waste* constructively i.e. to reduce, re-use and recycle their *waste*. Recycling and re-use have become acceptable procedures in many countries. However, this civic message to reduce *waste* is countered by the far more powerful and well-funded commercial message to consume as much quantity and variety of goods as possible, which in turn produces vast quantities of solid *waste*. For example, *waste* streams generated includes:

- Packaging of food and drinks (and of anything else from nails to socks);
- The constant replacement and up-grading of goods designed not to last; and
- Discarded gadgets for every imaginable function.

Successfully persuading people to purchase and consume as much as possible is perceived by many economic analysts as the sign of a healthy economy (Roseland, 1999). These two trends of persuasion are on a constant collision course and have been for many decades. From as early as the 1950s, excessive consumption was already predicted to be a problem.

If we are concerned about our great appetite for materials, it is plausible to seek to increase the supply, to decrease *waste*, to make better use of the stocks that are available, and to develop substitutes. But what of the appetite itself? Surely this is the ultimate source of the problem. If it continues its geometric course, will it not one day have to be restrained? Yet in the literature of the resource problem this is the forbidden question (Galbraith, 1958: 92).

The public's attitudes to *waste* can be understood from the language commonly used to describe it. In PIC community surveys reveal that *waste* is often referred to as something that is filthy and useless, which smells, is ugly and the government should get rid of it (Saito, 1995; Crennan, 1996; Crocker, 1996; Saito, 1997; A-N-D, 2000). People involved in handling *waste* (rubbish collectors, pickers, sorters, scavengers) often have a low status in the community (UNEP-IETC, 1999). There can be disrespect for the tasks being done by the *waste* handlers, and this may produce poor work ethics and low quality work. Similarly people who work in sewerage treatment plants or who specialise in sanitation systems are often regarded as inferior (Pers. comm.; Nie, 1999).

If individuals and communities are able to think of the components of *waste* as a source of something useful, then this will reduce the amount of *waste* that requires disposal to the environment, and this reduction in *waste* may in

turn have immediate effects on quality of life. Re-use and recycling of some materials has been common, such as glass bottles, and the composting of organic matter is viewed positively as it relates to traditional practice (Saito, 1997: A-N-D, 2000). It is important that re-use is harmless. For example, the use of lead from batteries as fishing sinkers should be avoided, and tins and bottles that have contained toxic materials should not be re-used. Rubbish used for land reclamation and sea walls should not contaminate water catchments or cause erosion elsewhere.

Specific aversions and taboos need to be understood, and there is a practical reason for some activities, that may not be obvious to an outsider. For example, the rigorous daily sweeping and burning of leaves and grass from the compound may seem unnecessary, but it ensures the removal of centipedes, scorpions and other creatures that bite. *Waste* minimisation and pollution control schemes that evolve from the community will be informed by local attitudes and concerns and therefore should be more able to accommodate them (Pickford, 1995).

2.4 Who cares?

The OECD has recently published a lengthy report, which describes environmental trends in the OECD's 29 member nations (including Australia and New Zealand). The document contains an overview from an OECD perspective.

It is becoming clearer that we don't own this world, but rather have borrowed it from our children and the generations that will follow them. We have responsibility to pass it on in a state which will allow them to fulfill ambitions similar to ours. Ambitions not only with respect to economic aspirations, but also in terms of living in good health and in a clean environment, without natural resources becoming scarce… However, the road to the future has more red and yellow lights than green ones. Were the late philosopher Lewis Mumford to review this Outlook he would likely repeat his famous observation of being optimistic about the possibilities; pessimistic about the probabilities (OECD, 2001).

People need to be inspired to care about what is happening and to change their attitudes and behaviour. They need to be aware that something is wrong, they have to believe the information they are receiving, they need to feel it affects their self-interest, and there has to be something within their power that they can do something about it. The above quotation attempts to engender a feeling of responsibility toward future generations. Is this a sufficient incentive for the people of the PICs?

Most education and awareness programs use either a threat or an incentive, more commonly a threat. For example, in the PICs, if something is not done to minimise *waste* and control pollution the following threats have been identified from scientific studies and simple observation of current impacts:

- Degradation of marine and freshwater quality;
- Destruction of habitats;
- Loss of tourism/ recreation value;
- Loss of aesthetic values;
- Changes to fisheries value;
- Eutrophication of lagoons and bays;
- Loss of property values;
- Increased cost of fish surveillance;
- Processing for toxin prevention; and
- Reduced fish marketability, (UNEP, 2000).

In PIC communities, it appears that the recognition of environmental problems is directly related to an individual's experiences and her/his pre-occupation with survival. People are often more concerned with the social environment i.e. family and community responsibilities, alcohol-related problems, over-population, and the availability of land and cash-in-hand. So, while many people are concerned with water supply and quality, only those who own land adjacent to the coast are particularly concerned with erosion. Fishermen are more aware of the decline of certain species of fish than fish consumers and women notice the decline of shellfish because the collection of shellfish is commonly their task.Few people seem to be worried about wild birds as they are not usually included in the diet (Saito, 1997).

How can one convince PIC communities that the far-reaching inter-related losses described by UNEP and other studies are urgent concerns? Repetitive messages in school curricular, on radio and television, in theatre productions and through workshops, can have some impact. Messages are more effective if presented by respected and/or interesting personalities, and these kind of educational programs have been conducted throughout PICs, and are further discussed in Section Six. The means to respond to messages must be available, that is, institutional support should be provided where necessary to enable responsible action. However, the most effective message is one conveyed through personally experiencing the benefits of changed behaviour and alternative possibilities.

2.5 Who suffers?

The economic costs and efforts required in undertaking *waste* minimisation should take into account the cost of not doing anything. Government, institutions and community members need to support efforts to help people minimise and manage their *waste*.

Various reports cite *waste* from domestic sources as the dominant contributor to pollution in PICs (Convard 1993;UNEP 2000). The serious threat to the environment and consequent effect on livelihood have been identified. Similarly, studies show that one of the most significant health costs globally is due to the impact of infectious disease. The context of greatest importance in the spread and control of infectious disease is the household environment, which is where the majority of susceptible people (especially small children) spend most of their time (DFID, 1998; Pers. comm.; Biran, 2002).

Diarrhoea is a common infectious condition in some PIC communities (Dahal 1994; Saitala and Paelate 1996; ADB, 1996; SWA, 1997; ADB, 2000; Beatty, 2001; *Pers. comm.*, Fonua, 1999; Karawaiti, 1999; Tim, 1996). Diarrhoea is not a disease in itself but a debilitating symptom of diseases caused by viruses, bacteria and parasites. As such, addressing the problem lacks the kind of focus required of a single organism disease such as Aquired Immune Deficiency Syndrome (AIDS) or tuberculosis (TB). However similar interventions are required to address the prevention of diarrhoea, irrespective of the organism, and these interventions mainly focus on improving the household and communal living environment.

A resource economics study on the costs of diarrhoea and epidemic dysentery in South Africa was commissioned in 1996 (Pegram et al., 1996). The findings indicated that there are 24 million incidents of diarrhoea of which three million incidents receive medical intervention each year in South Africa, that the direct financial costs are at least R4 billion (US$0.88 billion, 28 May 1997) and that at a conservative estimate there are about 43,000 deaths from all types of diarrhoea per year.

Thus diarrhoea is the leading cause of death in South Africa but diarrhoea is presently not a political issue. It is believed that this is because those who are most directly affected are primarily children from low-income families under five years of age, who do not have a political voice. In addition, discussing defecation is not a comfortable topic for community members and policy makers alike and is often restrained by strict taboo. In South Africa, many more people die from diarrhoea than from crime, political violence, motor accidents, tuberculosis (TB) and AIDS. However, the coverage in the media and the attention paid by politicians and resource providers is similar to that for problems such as malaria or bilharzia which, although serious, cause minimal deaths (Espey, 1997).

There are few studies of the indirect costs of inadequate pollution control in PICs. However, in a study conducted by the Child Survival Project in 1994 in Kiribati, 60 per cent of children under two years of age suffered from diarrhoea in a four week period. The infant mortality rate was 60 deaths per 1000 live births in 1990 which stimulated the research into possible causes. Diarrhoea was more prevalent in urban areas, such as Betio (68 per cent) compared to outer islands such as Butaritari (61 per cent) Onotoa (40 per cent) and Maiana (40 per cent). Inadequate sanitation and contaminated water were considered the main contributing factors in the highly populated areas (Saito, 1995). Hygiene issues were also implicated.

In a limited study of adults and children conducted for WHO/SOPAC on Kiritimati in 1998 it was revealed that those surveyed were infected with two to threee enteric pathogens or parasites. The pathogens identified were Dwarf tapeworm (Giardia lambia, Hymenolepis nana), Hookworm (Ancylostoma duodenale ova), Whipworm (Trichuris trichuria ova), Blastocystis hominis cysts and Entomoeba coli cysts (Berry, 1998). Being infected with just one of these pathogens can result in fatigue, lack of motivation and general ill health and yet residents of Kiritimati accepted their symptoms as just part of life (Pers. comm., Karawaiti, 2002). It was also reported that 40 per cent of children under five who were presenting at the local clinics with diarrhoea were infected with Giardia and 30 per cent were infected with Cryptosporidium (Pers. comm, Depledge 1998).

These conditions are not just faced by communities in Kiribati. Health officials in other PICs report that many children in their communities under five years of age have diarrhoeal diseases, and it is a leading cause of death in the population (*Pers. comm*., Fonua, 1999; Dahal 1994; Saitala and Paelate, 1996; ADB, 2000; Beatty, 2001). There are also studies throughout the region which demonstrate contaminated water supplies, which is considered to be one of the main causes of enteric illness and many other infectious diseases (Brodie et al., 1984; Lau and Mink, 1987; Detay, 1989; Miller et al., 1991; Crennan et al., 1999; Anderson et al., 1999; TSP, undated).

Apart from the human suffering involved, these preventable diseases have an indirect as well as a direct impact, which can be estimated in monetary terms. For example:

- direct costs to health (treatment expenses, lost income)- it has been estimated that bathing in contaminated water and eating shellfish from polluted seas costs approximately $US 12-24 billion per year GESAMP, (1999);
- indirect costs-an outbreak of cholera in Peru in 1992 due to inadequate sanitation and unclean water caused

losses in fish exports and tourism (normally bringing in 34% of GDP) which, when added to health costs, were estimated at $US1 billion, UNEP/GPA, (2001).

- unpublished work from 1989 suggests that the following savings across Africa, Asia and Latin America are achievable from water and sanitation interventions projecting the benefits forty years into the future:

  $873 billion saved across Africa, Asia and Latin America by the prevention of diarrhoeal disease;

  $662 million by prevention of ascaris (round worm);

  $13 billion by prevention of guinea worm (Africa and Asia);

  $24 billion by prevention of schistosomiasis; and

Estimated total benefit across Asia, Africa and Latin America $911 billion. This is balanced against the estimated total cost of $372 billion for providing adequate clean water and appropriate sewage and *waste*management (*Pers. comm*., Darin 2002).

Disability-Adjusted Life Years (DALYs) is a new concept recently developed by the World Health Organization (WHO) and the World Bank (Murray and Lopez, 1996; World Development Report, 1993). DALYs are intended to be a transparent tool to enhance dialogue on the major health challenges facing humanity. This approach calculates:

a) Losses from premature death, which is defined as the difference between the actual age of death and life expectancy at that age in a low-mortality population; and

b) Years of loss of healthy life resulting from disability.

Premature death is defined as a death that occurs before the age to which the dying person could have expected to survive if they were a member of a standardised model population with a life expectancy at birth equal to that of the world's longest-surviving population, i.e., Japan.

According to the DALY calculation, the money value of the economic loss of one productive year of life due to death, or one DALY, is conservatively estimated by Shuval (1999) as being about $US4,000. This figure approximates the global mean annual Gross Domestic Product (GDP) per capita.

Sewerage effluent and urban/domestic *waste* water can contain all categories of pathogenic organisms (Feachem et al., 1983). Pathogenic bacteria can remain viable in the sea for days to weeks, and viruses and protozoa can survive in the marine environment or in the tissues of fish and seafood for many months (Gerba, 1988; Ashbolt, 1995; Eyles and Davey, 1989). The health impact of *waste* water pollution of receiving waters, in addition to the impact of the illness associated with other land-based marine pollution is estimated by Shuval to be about 3.2 million DALYs/year, with an estimated economic loss of more than $US13 billion per year.

Surveys undertaken in PICs indicate that only a small percentage of people fully understand or are interested in the adverse affects of their own behaviour on their natural assets (Crocker 1996; A-N-D 2000).There does not appear to be a sense of urgency, perhaps because communities are no longer solely dependent on natural resources for their survival. Some communities do not appreciate the direct and indirect cost (time, inconvenience, anxiety about sick children) which they have already been paying because of environmental degradation. For example, having to boil water because it is contaminated;,tolerating skin irritations from excessively chlorinated water;,suffering from various illnesses related to inappropriate sewerage and solid *waste* disposal; and needing to travel greater distances in order to catch an inadequate amount of fish (Saito 1997; Saitala and Paelate, 1996; pers.comm., Fonua, 1999).

The unsanitary conditions in some PIC communities are not unique. The latest statistics show that 1.1 billion people still do not have access to safe drinking water and between 2.4 to three billion people do not have access to proper sanitation (Jeppsson *et al*., 1999; Bellamy and Desai, 1998; Warner, 1996). Over three million children die annually from diarrhoeal diseases (UNICEF, 1992; Niemczynowicz, 1997). It is also estimated that 10 million people die annually from diseases that are caused by unsanitary conditions, such as hepatitis, typhoid or cholera (Hellstrom, 1999). In many urban areas of developing countries, less than 50 per cent of the municipal solid *waste* is being collected and only a small percentage of it is disposed of in an environmentally safe manner (WHO/UNICEF/WSSCC 2000). These conditions are not only causing illnesses and deaths but also are slowing the economic progress of hundreds of millions of people who live in developing countries. At the same time, the world's natural supply of freshwater is subject to increasing environmental and economic pressures. The situation is likely to worsen unless determined action is taken, because continuing population increases and increasing per capita water demand, accelerated by improving economic conditions, will further contaminate and deplete sources of water which in many countries is already over-exploited (Schertenleib, 2001).

In this regard, PIC communities can benefit from the isolation, relatively small populations, and limited land mass that is otherwise seen as an economic disadvantage. There is more opportunity to control the inputs and outputs of their municipal ecosystem than in continental Africa, Asia or South America. If sufficient motivation and imagination is stimulated within PIC communities, and there is the political will, then there is still time to take remedial action, while

their natural assets are relatively intact. Developing models of community-based *waste* management and pollution control will not only protect their security but they will have a desirable product to market internationally. Everyone wants to know how to do it. For a welcome change, the *expertise* could be exported rather than imported. This is one of the many ways that income can be made from conserving natural assets rather than destroying them.

2.6 What is in the rubbish and where does it come from?

Before it can be decided what to do with solid *waste*, it is necessary to know what is in it, because different materials can be dealt with in different ways. Similar understanding is needed when dealing with the components of liquid *wastes* or *waste* water.

Waste characterisation studies establish what types and quantities of solid *waste* are generated, providing reliable baseline data which make it possible to set realistic targets for *waste* minimisation. It may also help to identify where the *waste* is coming from so that particular groups can be targeted for participation, education and awareness programs to assist them to effectively manage *waste* at the household and community level. In addition, data generated by *waste* characterisation studies can be used to inform decision-makers and legislators.

One of the components of the Pacific Regional *Waste* Education and Awareness Programme (*WASTE*) co-ordinated by SPREP, concentrated on solid *waste* characterisation studies, undertaken during the second half of 1999. The results of the studies are used to identify components of the *waste* stream that could be reduced, reused or recycled. Comparison with data from 1990-1994 (Table 2) is being used to highlight changes in the quantities and nature of the solid *waste* generated (Raj, 2000).

Table 2. Characteristics of solid *waste* in selected PICs 1990 - 1994 (Raj 2000)

Item	Nuku'alofa Tonga	Honiara Solomon Islands	Pohnpei FSM	Majuro Marshall Islands	Apia Samoa	Rarotonga Cook Islands	Average Wt %
Year	**1994**	**1990**	**1991**	**1991**	**1993**	**1994**	**1990-94**
Composition (% by wet weight)							
Vegetable/Putrescible	60	18	11	2	45	7	24
Paper	16	2	13	13	13	11	11
Textile	2	0	1	3	3	1	2
Leather/Rubber	0	0	1	2	0	1	1
Plastic	9	4	17	16	8	13	11
Metal	7	8	17	10	14	12	11
Glass/Ceramic	2	2	8	6	2	17	6
Garden "waste"	4	0	32	44	14	28	20
Miscellaneous	0	66	0	6	1	10	14
Bulk Density (kg/m^3)	**Not known**	**270**	**120**	**110**	**350**	**100**	**190**
Generation Rate (kg/capita/day)	**0.68**	**0.38**	**0.38**	**0.38**	**0.52**	**0.19**	**0.42**

On the basis of data generated between 1990 and 1994, it can be estimated that domestic solid*waste* generation rate in PICs was of the order of 0.3-0.7 kg/capita/day with an average of 0.42 kg/capita/day. Biodegradable material (vegetable/putrescible and garden *waste*) generally made up about 50 per cent of this amount. Other significant components of the solid *waste* stream included plastics, glass, metals and paper.

The results of the *waste* characterisation studies undertaken in eight PICs in 1999 indicate that the average generation rate is 0.66 kg/capita/day. This is 57 per cent higher than the average generation rate calculated from the data in 1990-1994. This demonstrated that there is a substantial increase in solid *waste* generation rates over a period of five to nine years. Another significant difference between the results of each period is that during 1990-1994, on average about 24 wt per cent vegetable/putrescible matter was discarded as household *waste*. However, by 1999 this practice appears to have ceased probably because most householders were feeding this component to pigs, dogs and poultry.

Two urban centres, Nuku'alofa (Tonga) and Honiara (Solomon Islands) are covered in both the surveys reported in 1994 and 1999. This allows direct comparison of the results from these two urban centres.

An examination of the Nuku'alofa results indicates that the per capita generation rate increased by 21 per cent over five years and paper based material increased 96 per centr over five years. The main reason for this is the increased use of disposable diapers. This was confirmed during the 1999 characterisation study. Examination of the Honiara results indicates that the per capita generation rate increased by 63per cent over nine years, which was due to a high increase in the disposal of paper (mainly disposable diapers), plastics and glass (Raj, 2000).

Table 3. Characteristics of solid *waste* in selected PICS 1990 - 1994 (Raj 2000)

'Waste' Classification	**Honiara Solomon Islands**	**Nuku'alofa Tonga**	**Lautoka Fiji Islands**	**Port Vila Vanuatu**	**Average Wt %**
(% by wet weight per cent)					
Paper	5.9	31.3	14.7	11.4	15.8
Plastic	16.8	5.2	8.1	7.7	9.5
Glass	4.5	3.3	2.7	3.3	3.5
Metals	6.1	8	3.2	3.6	5.2
Biodegradable	64.6	47.2	67.8	71	62.7
Textiles	1.8	3.7	3	1.6	2.5
Potentially Hazardous	0.1	<1	0.2	0.7	0.5
Construction and Demolition	0.1	1	0	0.7	0.5
Other	0	0.3	0.2	0	0.1
Total	100%	100%	100%	100%	100%
Average Bulk Density (kg/m^3)	**209**	**159**	**169**	**158**	**174**
Generation Rate (kg/capita/day)	**0.62**	**0.82**	**0.94**	**0.65**	**0.76**

The predominance of biodegradable (or green) matter in the *waste* stream is evident from the results of Tables 2 and 3 and indicates the opportunity to reduce the *waste* stream by using this organic material for mulch or making compost. Green *waste*s are a valuable resource for soil improvement, particularly on the atolls. In general, the results from these two studies indicate the important role communities can play in minimising *waste*.

2.7 Who can reduce *waste* and control pollution?

Communities can contribute to the control of pollution from liquid *waste*, sewerage or *waste* waters by using ecologically appropriate sanitary installations and practices and properly maintaining their on-site systems. In terms of existing systems this may require community training in how the systems work and how they can pollute (Refer Section 5.6.1). The introduction of new systems involves comprehensive demonstration programs. These issues and activities will be discussed in Section Three.

Similarly, there are certain actions that people can take in their daily life which can minimise the amount of solid *waste* that is generated, and reduce the amount that requires disposal, thus decreasing pollution and degradation of their natural assets and protecting their family's health. Some activities require partnership with government or the private sector, which will be discussed in Section Five, but all the strategies listed below begin at the community level (Refer Annex 2 for more detail). A selection of community-based initiatives in PICs and elsewhere which have involved some of these activities will be described in Section Four, Five and Six of this review.

Waste **avoidance**

Buying unwrapped fresh produce instead of packaged products.

Buying goods in bulk, thus minimising packaging.

Using a reusable basket or bag when shopping instead of plastic shopping bags.

Using washable nappies instead of disposable diapers.

Waste **reuse**

Returning beer bottles to local breweries, such as Royal in Tonga.

Feeding kitchen scraps to pigs and chickens.

Reusing thoroughly cleaned glass jars and bottles in the home.

Using used drums for garbage bins.

Reusing of second hand car parts.

Reusing left-over non-hazardous building materials.

Waste **recycling and reprocessing**

Kitchen food scraps and green *waste* composted or mulched for garden or agricultural use.

Separating aluminium cans for collection and transport for recycling by the aluminium industry.

Separating PET plastic for collection to be recycled into carpet etc.

Separating HDPE plastic for recycling into garbage bins and worm farms etc.

When identifying and evaluating options for *waste* minimisation and pollution control consideration could include the following criteria:

- The potential for *waste* reduction;
- Technical feasibility e.g. equipment capital and operating costs, market location and value of the recovered materials and potential income, material collection and transport costs, any need for subsidy, and the long term viability of the strategy;
- Potential environmental impacts of the *waste* minimisation options e. G. water pollution, noise pollution, air pollution (dust, odour); and
- Social and cultural questions such as:

  Is the cost of the option sustainable/acceptable to the local community?

  Does the option involve activities which conflict with local culture and customs?

  What are the socioeconomic costs or hidden costs of not adopting a particular strategy for *waste* minimisation or pollution control?

In conclusion, this Section has examined the reasons why the IWP is focusing on community-based activities to minimise *waste* and control pollution. A range of socioeconomic conditions have been discussed including the lack of funding and skilled personnel to operate and maintain centralised *waste* management systems, the predominance of on-site sanitation systems in PICs, community control of land use, attitudes to *waste* and lack of awareness of its impact on natural assets and family health, the direct and indirect costs to communities from inadequate pollution prevention, the types of rubbish generated by the community, and what people can do to minimise *waste*.

All these considerations indicate the need for mobilisation of communities to identify priorities and undertake strategies, which address current environmental and public health conditions in PICs.

3. Environmental Sanitation and the Household Centred Approach

3.1 Introduction

Section Three examines a number of projects and activities where strategies were undertaken to improve sanitation and pollution control at the community level in PICs and elsewhere.

The implementation of Environmental Sanitation is intended to contribute to the improvement of quality of life and the achievement of social development. It is stated that *the universal goal of environmental sanitation is water and sanitation for all within a framework which balances the needs of people with those of the environment to support healthy life on earth* (SANDEC/ Water Supply and Sanitation Collaborative Council, WSSCC, 1999). This notion is also reflected in the term *Ecological Sanitation* which was coined in the early 1990s by people working in PICs in an attempt to describe water and sanitation management strategies that served human communities while conserving the natural environment (Berry and Crennan, 1996).

The implementation of Ecological Sanitation in PICs was guided by a recognition that outputs and *waste*s of one system are inputs to other systems, and that actions taken now have unpredictable effects for decades to come. On this understanding efforts were made to:

- Manage *waste* as close as possible to its source;
- Minimise the use of water to transport *waste*; and
- Develop and utilise appropriate or intermediate technologies, so as to encourage household and community-level construction, operation and management of facilities, and permit re-use and/or disposal at the local level, Crennan,(1992).

A review of international literature, and water and sanitation projects in developing countries indicates that conventional approaches to environmental sanitation have been unable to make a significant reduction in the service backlog, which exists worldwide. At an international conference in 2000 of the Environmental Sanitation Working Group of the Water Supply and Sanitation Collaborative Council (WSSCC) at Bellagio, in Italy, attempts were made to identify ways to overcome barriers to progress in sanitation. The participants from developed and developing countries acknowledged the need to challenge conventional thinking, and to do so persuasively to the wider international water

resources and *waste* management community, public and private, as well as among the broader community of economic, social, and urban policy-makers, (SANDEC/WSSCC, 2000).

The Environmental Sanitation Group expressed their frustrations with conventional approaches in uncompromising terms:

- *Business as usual* cannot provide services for the poor; the rapid rate of urbanisation poses particular problems of squalor, human indignity, and threat of epidemic;
- *Business as usual* is not sustainable even in the industrialised world, sewerage and drainage systems are over-extended and the use of water of drinking quality to transport human excreta is extravagant, *waste*ful, and the *waste*s thereby flushed add to the pollution of the environment; and every new discovery of pollutant damage quickly leads to agitation for additional control measures and more sophisticated and expensive treatment;
- The under-utilisation of organic residues is economically wasteful, and belongs to a distorted view of *waste* management as confined to issues of disposal as opposed to resource utilisation;
- Centralised systems designed and implemented without consultation with, and the participation of, stakeholders at all levels are out-dated responses to public health and environmental problems, and are ineffective in today's world. Stakeholder participation is vital;
- There is a lack of integration between excreta disposal, *waste* water disposal, solid *waste* disposal, and storm drainage. Many problems would be resolved by a new paradigm which placed all aspects of water and *waste* within one integrated service delivery framework;
- The pressures of humanity on a fragile water resource base, and the corresponding need for environmental protection and freshwater savings, require that *waste* water and *waste*s be recycled and used as a resource, within a circular system based on the household, community, and municipality, rather than a linear system.
- The export of industrialised-world models of sanitation to environments characterised by water and resource scarcity is inappropriate, and amounts to an amoral continuation of wrong solutions, (Schertenleib, 2001).

The Environmental Sanitation Working Group conceived a new strategy for planning environmental sanitation services referred to as the Household Centred Environmental Sanitation (HCES) approach. The HCES approach seeks to overcome the shortcomings of business as usual by correcting existing unsustainable practices of planning and resource management as follows:

1) HCES makes the household the focal point of Environmental Sanitation Planning, reversing the customary order of centralised *top-down* planning. It is based on the concept that the user of services should have a deciding voice in the design of the service, and that environmental sanitation problems should be solved as close as possible to the site where they occur. Only problems not manageable at the household level should be *exported* to the neighbourhood, town, city and so on up to larger jurisdiction. Making the household the key stakeholder also provides women with a strong voice in the planning process, and changes the government's role from that of provider to that of enabler; and

2) The Circular System of Resource Management (CSRM) that, in contrast to the current linear system, emphasises conservation, recycling and reuse of resources. The circular system practices what economists preach, *waste* is a misplaced resource. By applying this concept, the circular system reduces pollution *downstream* (SANDEC/WSSCC, 1999; Schertenleib and Heinss, 2000).

It was explained that programs and projects designed in accordance with the HCES approach will, like any sustainable strategies, have to address all aspects of development; social, institutional, economic and technological. The difference is that planning will begin with the informed preferences and capabilities of the households instead of the conventional *top down approach*. However, it has been emphasised that the HCES approach does not automatically imply that sanitation can and should be entirely solved at the household level. There might be good reasons why sanitation can better be addressed at the community or even city level. But in any case, the thinking and search for solutions should start at the household level (Schertenleib, 2001).

Effective sanitation is not just about providing an appropriate sanitary installation. The combination of a sanitation system, hygiene and clean water prevent exposure to pathogens thereby preventing disease and death. Without a toilet system as the primary barrier, the environment can be exposed to pathogens i.e., hands, foods, objects, soil and water are contaminated. But effective secondary barriers are needed to prevent the continued transmission of pathogens, i.e., hygiene practices such as handwashing, careful food handling, keeping the living and cooking areas clean, and protecting drinking and bathing water. All these issues are implicated at the household level and need to be included in an improved sanitation program (Esrey, 1996).

3.2 Ecological Sanitation in PICs

A number of projects will be described in this section where the theory of the Circular System of Resource Management at a household level was explored in practice, quite some time before this particular theory was articulated. Key features of the projects are examined in some detail because the process of implementation revealed some useful lessons in the promotion of community-based responsibility for improved sanitation and pollution control in PICs. However, as the projects lasted for several years, and involved many aspects of community life, the description represents only a summary of these complicated political and socio-cultural events.

It has been estimated that approximately seven per cent of the population in the 14 PICs participating in the IWP have access to reticulated sewerage systems, and some of those communities with centralised systems have sewers but no treatment of effluent prior to discharge (SOPAC, 1999). The remainder use pit latrines, flush septic tanks, pour flush latrines, over-water latrines, the bush or the beach. There is evidence of pollution from these systems and practices (Dillon, 1997), so attempts have been made to develop an on-site toilet for PIC conditions that does not pollute water supplies nor use precious water for transport or treatment of human excreta. The composting toilet is an above-ground *dry* or *waterless* sanitation system that has been explored as an alternative.

Composting toilets first appeared in Scandanavia in the 1930s in rocky areas where it was not possible to install pits or septic tanks. Since then they have been used in Europe, India, Asia, the Americas, New Zealand and Australia. There are many versions of on-site and commercial off-the-shelf waterless toilets available (Del Porto and Steinfield, 2000). They vary in cost depending on design complexity, materials used, and the cost of local labour to construct them. In rural Guatemala, waterless toilets were being built by householders for approximately $US90 (*Pers. comm*., Roman, 1996) and in urban El Salvador the Tecpan desiccating latrine was built by a contractor for $US164 with a solar heater and pre-fabricated plastic toilet seat (Esrey *et al*., 1998). In Australia, owner-built Composting Toilets (CTs) have been constructed for $US200. In PICs the cost of site-built CTs including superstructure have ranged from $US1000 to $US2500. This can be reduced as the designs and experience evolve to suit local conditions.

Once installed there is usually no cost to operate the toilet, but there are ongoing maintenance requirements which require regular commitment, in particular the addition of a carbonaceous material such as dry leaves, untreated softwood shavings or coconut fibre to balance the nitrogen in human excreta and provide aeration. The type of carbon-based bulking agent that can be used depends on what is locally available and easy to collect. In desiccating toilets, ash is added as a drying medium and urine is usually diverted before it reaches the decomposition chamber. Any type of organic material can be used for personal cleaning, and dropped in the toilet, which is important in PICs, as it eliminates the need for buying commercial toilet paper (Winter 1995; *Pers. comm*., Timon 1994).

The decomposition process produces a soil like humus or compost, which can be used as a fertiliser, once enough time has passed to allow the destruction of disease causing organisms or pathogens. The nature of those organisms depends on the enteric diseases extant in the toilet users, but the usual practice is to allow the *fallow* period to exceed the viability of the most persistent organism that might be in the community. The compost needs to be emptied from the end-product chamber of the CT every six months to two years depending on the size of the chamber and usage. This task is less onerous than moving a pit toilet around the house compound, and a lot less difficult than de-sludging a septic tank.

The main obstacle with introduction and maintenance of composting toilets is that they are relatively unknown, and require some change in toilet usage and habits. These very personal attitudes, which are ingrained at an early age, are difficult to modify and require time and patience and persuasive incentives. As a Kiribati community health officer remarked "*it took us 20 years to get used to the flush toilet, at first we didn't like it for a lot of reasons*" (*Pers. comm*., Karawaiti, 1999).

Although flush toilets are now often preferred, their promotion and acceptance has not been based on a public health advantage, in comparison with other systems. As a research study in 1980 concluded;

It is important to note that a latrine properly located, properly constructed, and properly maintained will meet all public health requirements for the sanitary disposal of human *waste*, whatever the design, be it a simple vault or borehole, one with a complex water seal, or a multi-vault unit. No one design is better than another so far as public health is concerned; selection of one design over another is determined by a composite of cultural, aesthetic, social and technical factors. The principal objective of a conventional water flush system is to provide a higher level of convenience, not better health (World Bank, 1980).

While Western educated interveners may be inspired by the notion of better excreta management systems improving the health of the users, it has been observed that family health is rarely given as a reason to install a toilet (Van Wijk, 1994). In many cases *prestige, convenience, comfort, safety, privacy, and economic benefits (e.g., alternative fertiliser) are the most common reasons for desiring a latrine* (Jenkins, 1999).

Universally, attitudes towards human excreta are similar to attitudes towards diet. The beliefs and preferences regarding both these essential physical processes are the result of cultural norms, which may explain why modifying a tradition of human *waste* management is as difficult as modifying a traditional diet (Pickford, 1995; Warner, 1996).

Cultural norms have their own logic which need to be understood, especially if change is desirable. For example, the tradition of using the beach, which has become a public health problem in some areas in PICs, had its obvious attractions in sparse settlements (Taulima, 1994). The custom provides a pleasant environment for defecation, maybe an occasion, en route, for social contact or a break from the domestic scene, allows for quick removal of excreta by the tide or crabs, avoids the pollution of groundwater that in-ground toilet systems have introduced, requires no maintenance, costs nothing, and feeds the fish (Winter, 1995; Saitala and Paelate, 1996; ADB, 2000; SOPAC, 2001). To compete with these perceived attributes or any other existing cultural preferences, a new type of toilet, such as the CT, has to have relevant and practical advantages, which need to be clearly and repeatedly demonstrated and directly experienced. Even then, widespread acceptance is likely to take many years.

3.2.1 Composting Toilets on Kiritimati

There have been a number of composting toilet trials in PICs (Rappaport, 1995; Del Porto and Steinfield, 2000), but one of the earliest where multiple units were involved was conducted on Kiritimati, in Kiribati, where a population of approximately 3500 people were living in four villages. Kiritimati, (pronounced Christmas in English) one of the largest atolls in the world, had often been considered as a possible location for re-settlement to ease the problems of over-population on Tarawa. However the availability of fresh water would limit the population increase that could be sustained on Kiritimati (Falkland, 1985).

In the early 1980s a study of the island's water resources led to a plan to upgrade the reticulated water supply and improve sanitation (Falkland, 1984). This raised the question of what kind of toilets would be suitable for an environment with low rainfall, shallow groundwater and infertile porous soils. Some houses already had pour-flush septic tanks or pits. Installing more pit latrines and septic tanks in settlements located on a freshwater lens was no longer considered an appropriate strategy (UNESCO, 1991; TSP, undated). Although the local government would have preferred septic tank installation, there was reluctance by the donor (AusAID) to fund infrastructure to increase the community's access to fresh water and then to have much of it used for toilet flushing, which in turn would reduce supply for other essential needs, could pollute the water source, and thereby threaten public health. It was decided to trial a composting toilet (CT) as a possible alternative (AIDAB, 1993).

In 1994 an AusAid funded composting toilet trial was commenced with a brief introductory program and the first generation of toilets were officially trialed for 10 months, and the second for four months. It was part of the Kiritimati Water and Sanitiation Project (KWASP). The composting toilet design that was used initially was pre-fabricated in Australia, as required by the contract, and transported to the island to be assembled on-site. The pre-fabricated toilet was presented as a work- in-progress to introduce the concept, which could then be adapted, where possible, to suit local preferences. There were many logistical and planning problems during the project that partly related to the geographical and political isolation of Kiritimati, and partly to the short trial period. The education process evolved in response to circumstances as they arose, and was a steep learning curve for all concerned. Some aspects of the process and the lessons learned are discussed as follows.

Participants should be keen to be involved and make some contribution

The participants in the first phase of the trial were all public servants living in Government houses in London and Banana, and were selected by the Government of Kiribati (GOK) mainly because they were living in houses that needed to be provided with a toilet. The participants had little sense of ownership of the system as it was not their choice to have a CT, they did not own the house or land and most would return to Tarawa at the end of their three-four assignment on Kiritimati. However, despite the fact that they would have preferred a flush toilet like the other government employees, the participants did fully co-operate in the project and monitor their usage and response to the systems as requested by the project team, and some were appreciative of the advantages over time.

The one positive aspect of the trial being conducted on government property was that there was no land-use issue to be resolved within an extended family, which could be an obstacle to a government sponsored trial on private land. It was hoped that, if accepted, the dry system might be used on Tarawa where there was an even more pressing need for a toilet system that did not use limited water supply for flushing and did not discharge effluent into water bodies. However, testing a system in one context does not necessarily mean it will be acceptable or unacceptable in another, even within the same country. Many complex factors affect successful technology transfer.

Gender equity

Apart from the in-put of the three expatriate advisers, on a three-four monthly basis, the project was conducted by the local health inspector and the community education officer, both women. The expatriate project director was also female and this predominance of women in the project allowed for easy communication with the female householders. It was an encouraging role model for the I-Kiribati girls to see women running a technical project (*Pers. comm*., Tim, 1994). In the past, water and sanitation projects have often been conducted by ex-patriate male engineers who usually worked with local men to implement the project. Women, who are often responsible for water and sanitation issues in the home, were rarely involved in the process. However as the trial progressed it became apparent that the low-tech community-

based project was sometimes dismissed as *just womens' business*, and that it was also important that local men were included in promotion and implementation of the system to allow equitable community response.

Locally built is locally owned

It was obvious that a locally built system was more appropriate to avoid ongoing dependence on imports and to give the users of the system the opportunity to contribute to design, and build the toilets themselves. Also the fittings on the pre-fabricated design were too intricate and not robust enough for Kiritimati maintenance conditions. It was intended from the beginning of the trial that the CT design was an evolving process based on the response of the users, while still maintaining the integrity of an effective treatment system.

The second phase involved construction of three toilets from local materials in the squatter's village of Tabakea (tenure was not legitimate but was unofficially recognised by the GOK). The positive aspects of this phase were that the users of the system were involved in collection of materials and construction of the toilet at their own home site, and as these householders intended to remain on Kiritmati, there was an increased interest in the system and a desire to make it work in the long term. The *squatters* also appreciated being provided with a toilet and it gave some security and status to be (however reluctantly) included in a joint government/donor project.

What can make the message interesting?

The message of the CT project was: *we are working together for healthy families, clean environment, fertile gardens, and pure water*, in Kiribatese and English. This theme was developed as cyclical motif with the help of local poets and artists, and conveyed using several media, with varying degrees of success as illustrated below.

Avoid passive meetings

- Early in the project, meetings were held in each of the church *Maneabas* (central meeting house) where the system and its purpose was explained by the I-Kiribati team members and questions were invited. These meetings were not that well attended and the audience appeared quite bored with yet another lesson about how they should think about the environment, a concept not easily understood in Kiribati (Saito, 1997).

Song and dance

- Two of the toilets were installed at schools and a song was composed with the children about the dry toilet, the water cycle and the use of compost to make healthy gardens for healthy communities. The teachers then choreographed a descriptive dance to accompany the children singing and this performance was filmed. For many months the *toilet song* was heard being whistled and sung around the villages.

New types of toilet should be attractive and prestigious

- The amateur video was further scripted and shot with the I-Kiribati project team, to include significant GOK personnel giving their support for the trial, the health inspector testing groundwater for pollution, and a sequence showing a similar CTs elegantly installed in modern urban and rural homes in Australia. This was important as most community members considered the flush toilet as a desirable status symbol and suspected that the composting toilet was the same as the low-status pit latrine (*Pers. comm.*, Iotia, 1994). In general, Western inspired high-tech, high-cost waterborne sewerage systems are seen as superior and this attitude is not exclusive to PIC communities (Japan Sewage Works Association, 1991). To counteract this prejudice, alternative systems should be physically attractive, and where affordable, use prestigious products (Van de Korput, 1995).

Cross-cultural competition attracts attention

- The video concluded with a song and dance routine by Australian comics singing the praises of a dry sanitation system. The film, which was produced in Australia in Kiribatese and English, was shown at the maneabas and schools and seemed to arouse more interest in the project than the previous verbal presentations. Much time was spent discussing the comparative singing and dancing talents of the I-Kiribati and Australian performers.

  The video allowed the I-Kiribati project team to conduct their ongoing education program at schools and in various community groups in an entertaining manner and without having to continuously repeat the message themselves. They both had many other public health related duties to perform on the island. The need for a functioning VCR was the only limitation, but this was usually able too be borrowed for a screening (based on previous experience, a VCR was not provided by the project, as it was a very desirable item for private entertainment).

- Posters were prepared with the theme of the project in the local language. They were handed out throughout the villages but did not appear on many walls so obviously were not valued, or perhaps there were too many posters from other projects, all urging changed behaviour for fear of dire consequences.

Don't give everything away - people value what they pay for

- After the disinterested response to the posters, it was then decided to try and sell the project T-shirts to raise prize money for a gardening competition, rather than give them away for free. To the project team's surprise, all 300 T-shirts were sold for $AUD 8 within half a day of going on offer. This indicates people value what they pay for. When residents appeared at church the following Sunday wearing their toilet T-shirts, a message was received from the priest asking the project team to please ensure in future that project T-shirts had a collar.

Link with other beneficial and non-controversial programs

- The health inspector was conducting a gardening program to encourage people to eat fresh vegetables especially to reduce night blindness (*Pers. comm.*, Karawaiti 1994). Apart from the cultivation of babai pits, the I-Kiribati are not traditionally vegetable gardeners so this required much encouragement in the poor soil conditions. The CT project was linked into this promotion of integrated home compound management by providing vegetable seeds to residents and awarding substantial prizes for the best gardens. It was explained that the decomposed mixture of leaves and excreta in the toilets could create a useful fertiliser, as the soil in Kiribati lacks, structure, clay and organic matter. Water saved from using a dry sanitation system instead of a flush toilet could be used to water the gardens, and greywater re-use was also encouraged. When the compost from the toilets was ready to be emptied, after rigorous biological testing to ensure pathogen destruction, it could be used on flower gardens and around fruit trees, (although some people used it on vegetable gardens, despite being cautioned by expatriate public health personnel not to do so). The enthusiastic application of the leafy humus was a significant breakthrough, as most participants were convinced that the toilet would not convert excreta to something useful and inoffensive. The inspection of the compost led to the first requests from other residents for a CT.

Seeing is believing

- To convince people that there was a connection between flush toilets and polluted groundwater, a strong vegetable dye was poured into a toilet and the pink colour later appeared in a nearby well. Only the residents who lived around the well witnessed this, which caused some shock, the events were filmed and included in the educational video. Everyone does not necessarily accept the *germ theory* of disease and it is difficult for people to believe that there is some danger if they cannot see it. Some community members have other explanations for sickness, including overeating at feasts, sorcery, exposure to wind and sun, and negative thoughts (*Pers. comm.*, Tim, 1995; Hausia, 1998; Ake, 1999).

Did the education process work?

All these activities ensured that probably everyone on the island had heard about the CT project and had some idea of why it was happening. At the end of the trial, AusAID personnel conducted an extensive appraisal of the project, covering technical, socio-cultural and biological issues. With the assistance of local workers, they surveyed all four villages, covering approximately 85 per cent of all households on the island, and established that half the population had seen the video. It was also reported that 82 per cent of those surveyed would use a composting toilet if it was freely provided, even though they would have to close their flush toilet permanently (if they had one), and 49 per cent wanted the CT because it would protect the fresh water. Others were interested in saving money on water bills (8 per cent), saving money on toilet paper, construction materials, maintenance of cisterns etc. (8 per cent), using the compost as fertiliser (16 per cent), or because they didn't have any toilet (9 per cent). The negative responses (10 per cent) which mainly came from upper-status residents, focused on a distaste for human *waste*, fear of flies and smells, conviction the CT *would not work*, and a definite preference for flush toilets as a modern convenience (AusAID, 1995).

Direct experience is usually necessary

However, given the issues of taboo and privacy around defecation, only the extended families of the trial participants would have known what it was actually like to use and maintain a composting toilet, what the compost looked like, and whether the CT was a tolerable substitute for the pour-flush or pit latrines. The retired head of the public utilities division and respected community leader, who lived permanently in the *squatter* village, began to build his own CT based on the project design. He had a septic flush system (with two toilets), which he had become reluctant to use because he accepted that it was polluting his well water (*Pers. comm*; Keeba 1995). This is possibly the only definite indication of successful technology transfer in the trial project.

Avoid contradicting or confusing the message

In addition, the overall conservation and public health message was contradicted by the ongoing installation of flush toilets at the schools, and later at the homes of some of the CT trial participants. The children at the schools saw the teachers go to use a flush toilet while they had to use the CT or continue to use the beach. The question was asked by some: *so if it is true, and the groundwater needs protecting from human waste, why is there an alternative program concurrently installing more flush toilets?* (*Pers. comm.*, Tim, 1995). It was common knowledge that the septic tanks

and pit latrines were purposefully installed to reach into the shallow groundwater to allow liquids to disperse. This contradictory message is similar to what occurred in a solid*waste* management program in Samoa where school children diligently separated materials in their rubbish and then witnessed it all being thrown into the back of the garbage truck (A-N-D, 2000).

Further confusion occurred when the suggestion was made to GOK personnel during the trial assessment that one of the villages should be moved off the main lens to protect the groundwater (AusAID, 1995). While this may have been a good idea in principle, the timing was unfortunate as it diffused the promotion of an above-ground waterless toilet, and caused ongoing practical and political complications (OPVC, 2002). It is difficult enough to introduce a new type of toilet without associating the trial with a strategy such as the relocation of an entire village.

Despite these limitations, AusAID personnel considered the pilot trial enough of a success to include the CT as an extended trial, in the five year Water Supply and Sanitation Project for the island. However, the pilot trial was terminated at the end of 1995 and for almost two years there was no further external or government support for the users of the system or the local team members. This was seen by some of the community as further diminishing of the message and purpose of the pilot trial (*Pers. comm*., Karawaiti 1996).

In 1998, a WHO/SOPAC funded research project visited Kiritimati to see what had happened to the toilets and to conduct ongoing biological monitoring of the compost for pathogen destruction and fertiliser value. Surprisingly, four of the nine domestic toilets were still being consistently used and maintained and the other five were being used occasionally. Some of the CT structures had suffered from lack of maintenance and inappropriate construction materials and were falling apart. Two households, which had recently been provided with flush toilets continued to use their CT when there was no water, or if there were many visitors, Berry, (1998).

Maintain momentum, consistency and ongoing feedback

When the extended project began, with new expatriate advisers, and new CT designs to choose from, it was considered necessary to re-inform the public of the purpose of the CTs and this was initially an embarrassment for the local team members (*Pers. comm*., Karawaiti). It was partly necessary because of the transient government population (public servants usually spent three years on Kiritimati) but mainly because the original message of the CTs had been lost to the wider community and negative attitudes had replaced the earlier tentative acceptance of the system.

The trial design was adapted where possible to accommodate complaints and feedback. One hundred and fifty CTs were installed over 18 months with completion of construction in December 2001. This extension would mean that more people would have personal experience of the system. However the installation of flush toilets in government houses with or without CTs continued to proceed, and some senior GOK personnel felt that the CTs should only be installed *where they are really needed, or demanded but not at places were flush toilets were also available* (AusAID, 2000). The project funded an I-Kiribati woman and a man as full time Community Liaison Officers who made regular visits to the CT households and conducted community meetings, supported by regular radio programs. At the time of writing this review, the extended CT project had not been officially assessed (*Pers. comm*., Garcia, 2002) however the contractors have reported an increasing number of requests for the CT. No construction contribution is required from government householders, and private householders on the *waiting list* are unwilling to contribute to installation costs.

The scale of this trial of CTs allows wider management issues to be explored, such as the inclusion of CTs in the standard maintenance and plumbing repair programs for government housing, (OPVC, 2002).

3.2.2 The Organic Toilet in Tonga

Following the trial in Kiribati, a trial of CTs was undertaken in Tonga (1997-1999), as part of an AusAID funded project to institutionally develop the Tonga Water Board (Falkland, 1995; Crennan and Benke, 1996; Crennan, 1999). In the town of Pangai-Hihifo in Ha'apai, reticulated water was sourced from under a farming area outside the town. Over the years, this groundwater had become increasingly saline and the Tonga Water Board planned to re-locate to a new source and install infiltration galleries into the lens of sweet water under Panagai- Hihifo. Many people had private wells into this valuable catchment, and this is why the village had originally been settled there. However, the water was polluted from septic tanks, pit latrines and domestic animals (Tapealava, 1996; IHP/UNESCO, 2001). Once again, it was considered important to develop a toilet system that did not discharge into the lens and did not use precious water for flushing.

One to one discussions

In this trial, construction of the toilets was preceded by a large community meeting and small gender segregated group discussions, and then a 'customer survey' of 10 per cent of the town's household's (population approximately 3500 people). Discussions of two to three hours were conducted by an expatriate adviser with each household, covering issues of water use and sanitation practice. All households surveyed had a toilet and many households had both a flush toilet and a pit latrine. Most households had access to a rainwater tank and reticulated water, some also had a private well. A translator from the Tonga Water Board was involved initially but this was found to be more of a

hindrance than a help. In a small community, people did not like talking about personal issues in front of someone they know, and once alone they were willing to attempt basic English without embarrassment. An experienced social scientist from another island could have performed the same task and have the advantage of fluency in the local language. It was suggested, however, that some people may talk more freely to a *pa'alangi* about sanitation practices because there would not be the fear of transgressing taboos, or stimulating gossip (*Pers. comm*., Kaifoto, 1997).

Volunteer participants make a financial commitment

The idea of a compost toilet was introduced at the end of the discussion, and photographs were shown of CTs in Kiribati, Australia and Europe. Residents were offered the possibility of becoming participants in the trial if it interested them. However, it would cost them 100 pa'anga (approx $US50), in advance, to contribute toward materials. There was opportunity for 13 households to participate and this offer was taken up by a cross section of households that varied in economic and educational circumstances. For some families, raising the $T100 was slow and difficult, for others it was just inconvenient. The participants were genuine volunteers and ownership was much increased by the financial commitment.

One CT was installed at a Catholic school and one at a free Church of Tonga compound, also on a volunteer basis and requiring a financial commitment. The school staff volunteered because they had recently hosted an annual church conference and had been horrified by the consumption of water and blockages in their flush toilets. They also had ongoing water loss from cisterns leaking due to mineral deposits jamming the flushing mechanism. These continuous slow cistern leaks are common in the PICs where groundwater is used for flushing toilets, and they result in much*waste*d water and extra loading on septic tanks, discharge areas and receiving waters.

Saving money is a powerful incentive

The Deputy Head Master was also the science teacher and he specialised in organic farming. Although Tongan soil is fertile, unlike Kiribati soils, he could still see a potential use for the compost from the toilets (*Pers. comm*., Hausia, 1997). In Tonga the community pays for reticulated water and it was reported that nearly half the school's infrastructure budget was consumed in paying for water for the flush toilets. Herein lies the strong motivation to use a dry system, i.e., to save money on water bills. There had been some reluctance to include a school in this trial after the counterproductive exposure in Kiritimati schools, but having found an advocate for the system among the teachers, this school installation proved to be very productive in conveying the message to the community, in a number of ways.

Community participation in research

The composting toilet trial was linked to a UNESCO/SOPAC/IHP funded groundwater pollution study further discussed in Section 3.3. The project aims were to establish more comprehensive evidence of the rate and direction of flow of groundwater, the degree of groundwater pollution in the village context, and where pollution was coming from. The overarching question was whether or not there is a safe distance in a village context for the siting of wells and sanitation facilities in relation to each other. This aimed to review the standard criteria that had been imported to the Pacific that 30m was a safe distance between a water supply source such as a well and a source of pollution such as a toilet. That standard had been based on European soils and groundwater characteristics, and had not been adapted to local conditions since its introduction to the Pacific in the 1960s (Dillon, 1997).

The significance in linking the two projects in terms of community participation was that the second stage of the groundwater pollution study was conducted in the Catholic school grounds, and the children constructed the site and assisted with monitoring of the experiment. The older boys dug the holes down to the groundwater for the monitoring bores (or piezometers), and in return their school fees for one term were paid, ensuring that their parents heard about the project. The whole school witnessed the application of dye tracers into the central piezometer and later observed the pale appearance of the dye in water samples taken from further afield which indicated the direction and rate of flow the groundwater. Prior to this demonstration, the children and most of the teachers did not understand the movement of the groundwater, much less that it was capable of carrying pollutants between various sites.

For many months the children regularly collected samples from the piezometers, under the supervision of the science teacher, before final tests were conducted. Samples were also taken from groundwater around the large septic tank which showed that the concentration of pollution in the groundwater closest to the tank was very high and gradually diluted away from the tank. These experiments demonstrated that in a densely populated village area where neighbouring in-ground toilets are located close to each other, pollution may be widespread. Rather than closing private wells to avoid the polluted water, an alternative solution was to use a *dry* above-ground toilet such as the CT instead of the pit latrines and flush toilets. This allows households to keep their independent access to well water and increases motivation to protect the groundwater as a community asset.

Integrated maintenance

The trial CT at the school was used and maintained by three classes of boys, and four flush toilets were closed at the suggestion of the Deputy-Principal. At first there was some shyness but the children quickly adapted and

consistently used the CT and named it the *Organic Toilet*. The usual daily practice of sweeping the grounds supplied dry leaves to put in the toilet with each use, to provide the necessary carbon/ nitrogen balance. The basic biology of the decomposition in the toilets was explained to the children and compared to their compost heap and organic garden. After 12 months of the trial, the head mistress requested another composting toilet for the girls to use, but it was not part of the trail to provide further toilets. The parents and teachers then raised funds to build a second CT based on the design of the trial toilet but with cheaper materials and some changes to suit their preferences. The school was delighted to report that their water bill dropped from 70 pa'anga a month to 20 pa'anga a month (approximately $US35 to $US10). The domestic trial participants who had flush toilets also reported savings in water bills (Crennan, 1999).

Because the CT is installed above ground, the height of the buildings can be an initial obstacle to some people. It was a contentious issue for the I-Kiribati, and to a lesser degree for the Tongan trial participants. However it was resolved in Tonga by constructing the toilet closer to the house which allowed for inconspicuous access. There remains the difficulty of access for the disabled but a ramp can be provided instead of stairs. Once the Tongan trial participants had realised that the toilet did not smell, they reported that they wished they had decided to have the building attached to the house so it was convenient to use the toilet at night.

Demonstrate cross-sectoral support and co-operation

An amateur educational video in Tongan language was shot during the trial and circulated when the trial was completed. The video was scripted and produced with the assistance of CT trial participants: the teachers and children at the Catholic school and various staff of the Tonga Water Board, the Ministry of Health and the Ministry of Lands Survey and Natural Resources. The involvement of this cross section of government departments and the community conveyed the message that this was a community issue that required a partnership solution. The process of production of the video was as important as the outcome especially for those who contributed to its development.

Demonstrate a holistic approach

The video was introduced by the national Head of the Tonga Water Board and presented the following activities:

- Sampling of private wells and testing the samples for pollution in a laboratory; the installation of infiltration galleries for the new groundwater supply;
- Tonga Water Board staff repairing leaks and installing water meters;
- The ground water pollution study at the Catholic school;
- The uses of rainwater, tank water, and reticulated water;
- Demonstration of CT maintenance by domestic trial participants, including adding the bulking agent and removing compost from the end-product chamber;
- Demonstration of related hygiene issues especially washing hands after using toilet;
- Australian householders emptying compost from their CT and digging it into their garden;
- Biological testing of the compost and the results;
- Interviews with family members from Tongan CT households on their views about the toilet; and
- Demonstration at coastal households of marine protection provided by a CT in place of a flush toilet or pit latrine.

Family members from the CT trial households volunteered to act in the video, particularly in the scenes demonstrating use of water around the home, and the vulnerability of groundwater to pollution from domestic animals, in-ground rubbish pits, and poorly maintained wells. AusAID personnel ordered one hundred copies of the video and distributed it to all government departments and schools in Tonga (*Pers. comm.*, Bleakley, 1999).

Regular radio programs were broadcast across Tonga describing the progress of the trial. The information provided was very general and circumspect to avoid transgressing taboos related to public discussion of personal matters such as hygiene and sanitation. However there were reports of people hearing about the program in outer villages and islands of Tonga. As there are often many educational programs on the radio, information needs to be presented in an entertaining way to catch the listener's attention.

Stimulate local economy

The organic toilets were constructed by local builders in Pangai-Hihifo, and although this presented some logistical and quality-control problems at the time, the experience has created ongoing business opportunities for the builders involved. For the trial, fibreglass pedestals or toilet seats were manufactured in Australia and imported to Tonga. Once a mould can be made, this also allows for the local fibreglass company to mass produce pedestals for future extension. The design and appearance of the toilet pedestal is a significant feature in terms of acceptance. When

a CT was built at another school in Ha'apai after the trial, the donor insisted on a concrete seat because it could be made on-site. The concrete seats were used with pit toilets and have negative associations, and the teachers politely protested without success (*Pers. comm*., Hunter, 1999). It is important to accommodate user's preferences for fittings where possible.

Technology transfer

From October 1999 to November 2001, forty one organic toilets were built on the small island of 'Ata'ata off the coast of Nuku'ualofa at the request of the community. The 'Ata'ata town officer had visited the CT trial in Ha'apai in 1998 when he had heard about the project on the radio and through relatives. CT project personnel had then visited 'Ata'ata at his request to discuss the system with the community, and a submission had subsequently been made to the government for assistance to provide all the households with the Organic toilet.

Materials for twenty of the CTs were funded by AusAID and twenty four by Canada fund. Each household contributed 250 pa'anga (approx $US125). The cost of the toilets including shipping was approx. $US550. Installation of the new CTs was supervised by the town officer and personnel from the Central Planning Department, and construction was undertaken by the 'Ata'ata community. The fibreglass seats were manufactured locally by a Nuku'ualofa company. Educational material developed during the CT trial was used to prepare householders for maintenance of the system, but the system was constructed from observation, rather than through use of technical drawings from the trial. It is reported that there has been no complaints from the community regarding use and maintenance of the system, and there is a sustainable supply of dry leaves on the island for use as bulking agent. Applications for organic toilets have been submitted to Central Planning from communities in Vava'u, and are being considered (*Pers. comm*., Leha, 2002).

3.2.3 The Atollette in Tarawa

FSP-Kiribati in Tarawa have been trialing a combination CT/Ventilated Pit Latrine design for some years, initially at their office compound and later at a number of church compounds and outer island schools. In the first version, designed for FSP by an external adviser, the decomposition chambers, which have no plenum floor, were installed below ground level to try and reduce the height of the building. In the shallow groundwater conditions of Tarawa, this meant the chamber flooded in the rainy season, particularly at high tide. This design fault creates a very negative impression of the new type of toilet, which will be communicated widely, and can set back technology transfer by many years. There were also difficulties removing the end-product because the material had to be lifted up out of the chamber (*Pers. comm*., Smedly, 1999). An improved version has recently been designed and constructed at FSP and other locations, in co-operation with Kiribati Housing Corporation (KHC), and funded by ADB as a model for the SAPHE project (Refer Section 4.5). It is reported to be working well (*Pers. comm*., Jenkins, 2002) and the first version at FSP office compound has been closed.

Design considerations

Although the CT is a work-in-progress, which is always open to improvement and innovation, design variations should be advised by local people with ongoing experience in the daily use and maintenance of the system in local conditions. This includes emptying the compost and alternating the batches, that is, at least one full cycle of the treatment process, and should include a wet and dry season. An integrated CT pilot project is recommended in Annex III and IV, and the *design choice should be informed by indigenous users with extended practical experience, in consultation with advisers experienced in the design and trialing of a variety of systems*. The design should not be changed because of immediate negative reactions if the changes may threaten treatment process or make maintenance physically difficult or unhygienic.

Even with the strong reaction in Kiritimati to a raised toilet structure, householders who had a CT installed, eventually became accustomed to the height of the building, and even found it advantageous in the rainy season. (The original CTs buildings were even more conspicuous than necessary, because they were erected in an exposed area, a considerable distance from other household buildings). After almost two years of refusing to use the CT because of the height of the building a male member of a trial household reported: "*one day I just went up the steps and into the toilet and then thought, this is OK, and from then on I used the CT*" (*Pers. Comm*., Taukaban, 1998).

The composting chambers are installed above ground level to prevent contamination of groundwater, and to allow easy removal of the compost. Although the chambers themselves can be somewhat reduced in height, or the superstructure can be designed to conceal the height, the above-ground treatment system is integral to the environmental protection that the CT offers and this needs to be repeatedly explained and demonstrated to users.

It is useful to keep in mind that simply the requirement to change toilet habits can, in itself, be a sufficient obstacle to acceptance of any new system. It is important to allow ample time for adjustment, reaction and feedback, and then base any modifications that seem necessary on a thorough consultation with experienced users.

Toilet Cost and Value

The following observations have been made by the contractors working on the CT component of the SAPHE project (Coffeys, 2001) (Refer Section 4.5):

- While every effort has been made to design a toilet that can be built to an acceptable standard at the lowest possible cost, the estimated $Aus850 is still considered by many to be too high for wide acceptance. A revolving fund will be provided under the SAPHE Project, with a flat 1 per cent *soft* rate of interest. As the funding originates from a loan, rather than from grant or bilateral assistance, it is understood that the disbursements must be recouped to allow eventual repayment of the Loan. However, the cost burden could well be too high for a large number of the needy households that clearly require subsidisation if they are to obtain an adequate toilet. An innovative approach will need to be carefully considered by the Managing Contractor.
- A safe, private, comfortable toilet is now seen by most islanders in Tarawa as a *public good*, as understanding of the need to protect the environment and environmental health increases through awareness and education campaigns. However, a toilet is not yet seen by many as a *merit good* that enhances social standing, property value, or potential rental income. Land is generally inherited *family land* so property values are of little consequence. Where land is sub-leased, a proliferation of household toilets on the sub-let portions could actually be seen to detract from the overall (non-monetary) value of the land parcel.

3.2.4 Workers' Composting Toilet in Tuvalu

As part of the Tuvalu *Waste* Management Project (discussed in Section 4.2) a double batch CT was built in 2000 at the project workshop. The toilet was constructed by local carpenters from materials procured at the local store, and is for the use of the 15 local project workers. The toilet was erected on the site of an old toilet block and cost approximately $A3000 ($US1500 in February 2002) including outhouse. The project team designed the toilet after reading reports and looking at videos from other CT projects in the Pacific.

Dry leaves are used for bulking agent in the toilet. The CT has been used for 18 months, and the bins have been alternated a couple of times. It was reported that the workers have accepted using the CT as it has a porcelain pedestal similar to the flush toilet. The Project Manager considered that it would be much harder for government bureaucrats who were accustomed to western style living to accept the CT. Many of the workers also seemed to appreciate the water saving advantage of the CT given the scarcity of water in Funafuti. Some of the workers wanted to install a CT in their home, but the project team thought that it would not be good for it to appear that the project workers were receiving extra benefits. Two commercial units (Rotaloo and Natureloo) were purchased for the project but because of issues related to site approvals they have remained on the island unassembled and future plans for their installation are uncertain. Another smaller batch composting toilet has been constructed from locally procured materials at the land fill site (*Pers. comm.*, Boase 2002).

3.2.5 Composting Toilets in FSM, Fiji and Palau

Since 1992 a number of different CT designs from the US-based Sustainable Strategies have been trialled in FSM, Fiji and Palau (Del Porto and Steinfield, 2000). These systems did not receive an extended introduction or ongoing monitoring from the contractors after installation, apart from an occasional communication every couple of years. Although there have been some problems with maintenance, the toilets have been relatively well sustained given these circumstances.

Kosrae, FSM

Sustainable Strategies was first retained by Greenpeace in late 1992. A workshop to install a large-capacity Vera Carousel biological toilet was initiated on the island of Kosrae, FSM, at the home of the Chief of Sanitation. It has been used regularly by his family of five, with occasional visitors, since January 1993.

Yap, FSM

Also in 1992, a version of the Carousel toilet made in Australia was installed at the Yap Institute of Natural Science, It has been used by the Institute's staff of three, and by several members of the director's family, who live in an adjacent house.

Yap and Pohnpei, FSM

Following the success of these demonstrations, Sustainable Strategies designed a site-built composting toilet using concrete, heavy nets and other locally available materials (Soltran 2). These units were piloted on the island of Yap and Pohnpei through a project begun in 1994. Subsequently, the FSM government agreed to the construction of up to 40 additional units on Pohnpei with funds left over from a rural sanitation program. The implementation approach was for the health agency to provide funds for materials and plans to anyone who wanted to build the CT. Several systems have been built independently, but no recent reports are available on numbers (*Pers. comm.*, Steinfield, 2002).

During the CT project, a *Waste*water Garden for the treatment of greywater from a washing machine was installed at a private home. This aerobic evapo-transpiration bed, which used a variety of local plant species, was reported by the owners to be successfully preventing any *waste* water discharge from clothes washing. More recently, several of these gardens, integrated with site-built composting toilets have been built to provide zero-discharge treatment for preschool centres in Yap.

Fiji

In December of 1996, Sustainable Strategies conducted a workshop in Fiji, sponsored by the South Pacific Commission, in which the two-chambered concrete-and-fish-net Soltran 2 was constructed. The workshop was held both in the classrooms of the Fiji School of Medicine and in the Vatuyalewa/Tovata settlement in Nasinu.

The Fiji School of Medicine has a three-year program for the education and training of students preparing for careers as public health and environment inspectors. The third-year class and other visiting Health Inspectors participated directly in the lecture and construction workshop. In addition the members of the Vatuyalewa/Tovata settlement also participated at all levels of the program.

A flexible integrated composting toilet and greywater system was developed for a small Fiji island resort that required flush toilets. This system has since been built worldwide, and it was recently improved for an ecotourism resort in Belize. The designers recommend minor improvements before it is extended in PICs (*Pers. comm*., Steinfield, 2002).

Palau

In December, 1996 the Koror State government of the Republic of Palau retained Sustainable Strategies to provide technology transfer assistance in developing the production capacity to manufacture the Carousels on Palau. The first phase of the project involved design and installation of seven sanitary facilities or *comfort stations* with multiple CTs for use on Rock Island which is popular with tourists. Five of the facilities have a capacity of about 75-100 persons per day and two with 25-50 persons per day. Park staff report that the CTs have been functioning effectively. The second phase ie local production of further Carousels has not yet occurred, although training was provided (*Pers. comm.*, Steinfield, 2002).

3.3 Groundwater Pollution Research and Training in Tonga

In addition to providing evidence of groundwater pollution from sanitation facilities, the UNESCO/SOPAC groundwater pollution study, referred to in Section.3.2.2, indicated how to more fully utilise a research process to increase community awareness (IHP, 2001). Certain difficulties arose in the first phase of the study, which provided a number of lessons in the planning and management of a cross-cultural, multi-disciplinary project of this nature. In addition, reluctant and polite feedback from Tongan team members, after the initial fieldwork was completed, revealed common frustrations that need to be taken into account in counterpart training programs. The second phase of the study was adjusted to ease those frustrations. Although this study was initially focused on educating government employees, these people are also community members and their training will personally and professionally influence and inform public opinion and understanding. The concerns that needed to be accommodated include the following issues:

- *Selection of Location*: The dye tracing experiments were initially conducted in a public oval and the unprotected site was partially vandalised which affected the results of the study and diminished its importance and relevance in the eyes of the community.

  Response: as previously mentioned in Section 3.2.2, the experiment was re-located to the school grounds and some tasks in the experiment handed over to the teachers and children.

- *Method of training and communication*: In the first study period each of the tasks was performed, usually alone, by a team member already skilled in that particular field. As there was insufficient liaison between the team members as a group, there was little understanding of the roles of the other team members, and minimal comprehension of the process and benefits of a multi-disciplinary study. These limitations were somewhat exacerbated by late arrivals and early departures of team members, participants accommodated in different locations and the short duration of the fieldwork. Some of the individual tasks were quite time consuming which reduced the opportunity for group interaction.

  Response: most study activities in the second phase were undertaken as a group with each member leading the others in activities that related to his or her expertise. As the team members came from the Ministry of Health, the Ministry of Lands, Survey and Natural Resources and the Tonga Water Board, this collaboration was in itself educational for the team members, and the community who shared in their work.

- *Inaccessible monitoring techniques*: The first tracing experiment using Rhodamine-WT was set up by the expatriate project leader but required collection of samples by Tongan counterparts. This particular tracer was not visible to the naked eye and required sensitive equipment to be detected. Testing of most of the samples was conducted in Australia by the project leader. Consequently the Tongan team members did not learn the skills related to the methodology, or directly experience the logic and outcome of the experiments, which is

particularly important in an oral society. Reports detailing experimental results are not necessarily thoroughly read, or believed. Visual demonstration of cause and effect is essential if perceptions are to change.

Response: in the second phase, a tracer was used that could be tested in the Tonga Water Board laboratory and team members were trained to use equipment provided by the study. The process was filmed and included in the educational video with an explanation by the Science teacher from the Catholic school. The project report was written as joint effort with each member responsible for a certain section, and all members responsible for overall presentation (Crennan et al., 1998). Tongan team members have presented results from the studies at international conferences (Fatai, 1999).

A similar process of counterpart responsibility for ongoing conduct of research was incorporated into a groundwater re-charge study in Kiribati (White et al., 1999). This method of on-the-job training is more effective than passive workshops where trainees are expected to absorb and retain considerable amounts of information delivered over an intensive one or two week course. It is also useful to remember that these courses are usually in English, which is the second language of PIC participants.

- *Timing of the study*: The week chosen for the initial in-depth study coincided with the final preparations for the annual conference of the Wesleyan church, the largest congregation in Tonga, which was being held in Pangai-Hihifo that year. This resulted in late arrivals of some team members due to inability to secure seats on the flights to Lifuka. In addition community members and government personnel were preoccupied with conference preparations and were, therefore, not as receptive to the study as they may have been.

  Response: Although it is often difficult to avoid or predict local events and preoccupations, major annual gatherings of this nature can be noted and circumvented with a little prior investigation, especially when the fieldwork is of such a short duration. Some flexibility was introduced to allow for unexpected events such as funerals. In general, the transfer of most of the responsibility for the conduct of the study to local counterparts and community members reduced the regular demand for inflexible project schedules related to input of expatriate advisers.

3.4 Social mobilisation for Sanitation in Sri Lanka and Vanuatu

Social mobilisation has been described as a process of bringing together all feasible and practical inter-sectoral allies to raise people's awareness of and demand for a particular development program, to assist in the delivery of resources and services and to strengthen community participation for sustainability and self reliance (Dahal, 1994).

Two examples from island countries are provided here where this process has been developed and refined over time, as it further demonstrates the long-term multi-disciplinary approach that is necessary to achieve improved sanitation and pollution control. In a sense, developing an appropriate technology that may offer some environmental protection is only 20 per cent of the task. The process of implementation and sustained ownership of the program is 80 per cent of the challenge. The programs summarised here have attempted this process across many communities on a nationwide basis, and over an extended timeframe.

3.4.1 Community Mobilisation in Sri Lanka

The Sarvodaya Shramadana Movement (SSM) of Sri Lanka is the largest non-governmental organization (NGO) in the country and is also the main NGO working in water and sanitation sector in Sri Lanka. The methods and techniques developed by Sarvodaya in building community awareness, ensuring community participation and sustaining community management of integrated community water supply and sanitation schemes has been applied in hundreds of Sri Lankan villages.

Based on its extensive field experience Sarvodaya has developed a five-stage model of village community development, and water and sanitation related activities are initiated in the Third Stage of village development. The *First Stage* is that of psychological infrastructure building. It begins with a village level discussion about local needs and organizing self-help activities. Villages enter the *Second Stage* of social infrastructure building when they have formed one or more community groups of farmers, mothers, children, youth and elders.

The *Third Stage* of the Sarvodaya development process is critical. At this stage the village is organized to satisfy its own basic needs, and water and sanitation related programmes are initiated. Community water and sanitation needs are satisfied through the construction of gravity water supply schemes, hand dug shallow wells and low-cost latrines. In addition the village Sarvodaya groups are brought together and institutionalised as a legally incorporated body (the Sarvodaya Shramadana Society or SSS) which is entitled to open its own bank account, obtain loans and start economic activities with support from District level and National Level Sarvodaya structures. Villages in the *Fourth Stage* are expected to become self financing in their Sarvodaya activity and they assist neighbouring villages in their *Fifth Stage*.

A close contact is maintained between these societies by a full-time Sarvodaya worker known as the Gramadana Worker. Gramadana means *sharing of resources at the level of villagers on a voluntary basis*. Several clusters of such

villagers are organized around Sarvodaya Divisional Centres, and several divisional centres around District Centres which correspond to the government administrative units.

The decision-making process involved in a typical Sarvodaya Rural Technical Services (SRTS) water project is as follows:

- Firstly, a formal request seeking assistance for the need for improved water and sanitation is submitted to the Sarvodaya District Coordinator by the officials of the SSS through the Gramadana Worker;
- On receiving the request the District Coordinator will assess the availability of funding and hand it over to the SRTS technician for further action. The technician will visit the village with the Gramadana Worker and the members of the society and have a preliminary participatory survey to check the technical feasibility of the project. This survey will lead to discussions with the SSS to decide the technology and options which will be selected for the project. If the project is technically feasible, SSS will start the mobilization and educational activities with the assistance of the Gramadana Worker; and
- In the mean time the SRTS technician will prepare the necessary plans and the cost estimates for the approval of the Sarvodaya head office. The financial input provided by Sarvodaya will compliment what ever the villagers themselves can contribute. This ensures village self-reliance and self-confidence. All critical decisions as to the choice of technology, levels of service, and location of facilities are taken by the community, in addition to their cash, material and labour contributions.

As soon as the head office approves the project, the funds are released to enable the SRTS technician to start the construction work on a *shramadana* (donating manual labour) basis. With the commencement of the construction work, the SRTS technician will train two village youths who have been selected by the SSS as Caretakers for the maintenance of the project. While SRTS contributes financially and technically, the society will provide the available raw materials at village level and the unskilled labour required. On completion of the project, the scheme operation and maintenance (O and M) will be formally taken over by the village society and trained caretakers will look after the project under the guidance of the SSS. O&M will be the sole responsibility of the SSS but if there is any technical problem which goes beyond the capability of the caretakers the SSS can still contact the SRTS technicians for assistance.

During construction phase, an accompanying hygiene education activity is implemented through the pre-school and other social programmes initiated by Sarvodaya in the village. Women are involved through mothers' groups and are represented in the village SSS. Thus, Sarvodaya's holistic approach addresses both technical and social issues related to community water supply and sanitation while the activities that are carried out during the succeeding stages of village development directly address the root causes of chronic ill-health, i.e., poverty and powerlessness. In addition, Sarvodaya demonstrates *that water and sanitation needs can be satisfied through an integrated community development approach which recognizes amongst other considerations, the spiritual values cherished* by the people (Ariyaratne and Jayaweera, (1994).

3.4.2 Community Mobilisation in Vanuatu

The aim of the ten year Vanuatu Rural Sanitation project which began in 1988 was to reduce the high incidences of diarrhoea, and deaths from diarrhoea, in children under five, by improving sanitation for 75 per cent of the rural population. More than 25 per cent of the population had no toilet and the remainder had pit latrines which needed upgrading.

The following behaviour changes were advocated:

1. Proper disposal of faeces of young children;
2. Handwashing before eating and after using a toilet;
3. Use of latrines; and
4. Use of plenty of clean water.

The project, which employed 33 village sanitarians to facilitate implementation, incorporated the following approach referred to as a *Complete Whole*:

- Promotion of an appropriate technology at the current level of development;
- Enough time allocated to prepare the community for the acceptance of the project;

  Local elites eg chiefs, church leaders and school teachers are mobilised before the project starts. Patience, and flexibility, and a lot of it, is required during the community organisation phase and results in sustained participation;
- Communities are provided with 'Informed Choices' in terms of designs. Thus, the design contradictions are reduced. The family contributes 50 per cent of the cost of the latrine, including construction; and

- Social marketing and mobilisation is used to motivate use of the services and change personal hygiene behaviour. The impact on health is assessed through monitoring incidence of disease before and after availability of latrine, Dahal. (1994).

3.5 *Wet* Sanitation Systems

This section will briefly refer to management of sanitation installations where water is used to transport *waste*, otherwise referred to as waterborne systems. While on-site *dry* toilets may be advisable for certain vulnerable conditions in PICs, introduction is likely to be slow. In the meantime, sanitation systems that do mix *waste* with water are currently widely used in PICs, and this practice is likely to continue.

3.5.1 Sludge Management and Resource Recovery

In addition to the discharge of effluent, waterborne systems also produce sludges (or bio-solids) which have potential for beneficial reuse. This includes sludges from centralised sewage treatment plants and also solids from septic tanks (septage). In order to work efficiently, septic tanks need to be emptied every two to five years depending on usage. Surveys in PICs have indicated that some households do not recall ever emptying their septic tank, and many people do not actually understand how they work (AusAID 1995; SWA 1997; *Pers. comm.*; Dworsky 2002). Lack of maintenance of the septic tank is common, and not just in PICs.

There is currently a local government program in Australia to train householders to take better care of their septic tank systems and attendance is compulsory, on threat of being fined (Lovell 2000). In many countries, septic tanks are only emptied when users choose to call upon the emptying service (if there is one) or are forced to do so because of odours and/or their in-house drainage system becomes blocked due to excessive solids build-up within the septic tank. Consequently, septic tank emptying can be a very irregular event, resulting in inadequate retention time in the tank, excessive solids carry-over into trenches and drains, inundation, pollution and related health risks

When tanks are emptied there is the issue of what to do with the sludge Septage disposal is a widespread problem throughout PICs. A common practice where a tanker removal service is not available is to dig a pit for the septage beside the septic tank. This allows the septage to leach directly to groundwater. When the sludge is collected it is often dumped in landfill also presenting leachate problems. Literature reviews indicate that faecal sludge disposal is an unresolved problem in many developing countries, that is, the sludges are dumped untreated at the shortest possible distance from the house-site, be it on open ground, into drainage ditches, into water courses, or into the sea. It is reported that there are only a few places where septage and nightsoil are properly treated in treatment plants specifically designed for this purpose e. G. in Ghana and Indonesia. In some countries (e. G. in Botswana, Tanzania, South Africa), faecal sludges are added to the urban *waste* water stream for co-treatment in '*waste*' water treatment plants, generally *waste* stabilisation ponds (WSP). These may easily become overloaded, Strauss, Larmie and Heinss, (1998).

The fact that faecal sludges are usually disposed of untreated is mainly due to a lack of treatment and resource recovery options which have been adapted to the socio-economic conditions of developing and newly industrialising countries. The treatment technology should be based on locally available and serviceable material and equipment that are simple to operate. In Colonia, Yap, anaerobically digested sludge from an Imhoff treatment plant was dried on sand beds. The dried sludge was used for fertiliser and was reported to be in high demand, Chowdhury, (2001). In Nuku'a'lofa, Tonga, septage from local septic tanks was dewatered on drying beds and some farmers collected it for use as a fertiliser, although this facility has since deteriorated, JICA, (2001).

In American Samoa, a local resident, returning from years in the U. S, brought with him a small tank and pump system, and established a business pumping out septic systems. He empties his truck load at the centralised sewage treatment plant where a septage discharge area has been established. The septage is processed along with the incoming sewage from the gravity sludge pump, and becomes part of the digested sludge which is dried. The dried sludge is mixed with cinders in about a 50-50 mix, and the community utilise it for fill or gardens. It is reported that it "*disappears, faster than it is accumulated, and people utilise it for fill or gardens or yard"* (*Pers. comm*., Dworsky, 2002).

There is potential to improve septage management at the village level through a pilot project developing a methodology for treatment which ensures adequate protection of public health. This would require a treatment process such as aerobic drying/composting to destroy pathogens in the sludge, a co-operative effort between householders, a village committee and institutional support from public health and other relevant authorities who were trained to undertake monitoring. Many of the social issues discussed in the sanitation trials in Section 3.2 would also need to be addressed in a community sludge composting project.

Co-composting of septage appears to be a viable option. *Co-composting* usually refers to the combined composting of faecal or *waste* water treatment sludges with household or municipal compostable (organic) refuse. It is both a traditional process and a fairly recent*discovery* which has been tested in a number countries (Larmie, 1994). It can be extended to include the joint composting of sludges with other organic material such as sawdust, wood chips, bark,

slaughterhouse or food processing *waste*. Co-composting can also include animal faeces. In Majuro, Marshall Islands, sludge from pig pens is co-composted with green *waste* and then used as a fertiliser on Taiwanese market gardens (*Pers. obs.*, Crennan, 2001).

The material added to the sludge should enhance bulking for adequate air passage and create a 20/1 to 30/1 Carbon/Nitrogen (C/N) ratio for optimum composting. This is similar to the process that operates in the composting toilets described in Section 3.2. C/N ratios in faecal sludges range from about two in fresh faeces to around 6/1 to 15/1 in septage. The moisture contents of the mixture to be composted should amount to 40-50 per cent. In China, India, Malaya, Singapore, and Nigeria, co-composting has been practised for several decades. Nightsoil is co-composted with either refuse and/or other organic/bulking material. The mixing ratios amount to 1/5 to 1/10 (sludge to added material) on a wet weight basis if undewatered sludge is used. With dewatered sludge or with wood chips, the faecal sludge proportions can be increased to as much as 1/1.5 (Scott 1952; Shuval *et al*., 1981; Obeng and Wright 1987).

In Rini near Grahamstown, South Africa, a co-composting unit has been treating municipal refuse and bucket latrine sludge from a community of 100,000 people (La Trobe and Ross, 1992). The nightsoil is pre-settled and then windrowed with the unsieved refuse for a period of three weeks. The regular windrow temperatures reach 55 °C. The Council for Scientific and Industrial Research of South Africa has been conducting pilot investigations on the co-composting of latrine sludges with municipal solid *waste*. If municipal *wastes* are co-composted with faecal sludges, heavy metals would need to be monitored, as they may accumulate in the compost and in compost-treated soils (Strauss, Larmie and Heinss, 1998). Effective co-composting of sludge with organic household *waste* is probably sufficiently challenging in PIC conditions, given the social and cultural concerns about handling human excreta. The addition of general municipal refuse may create too many unwanted complications. However these programs indicate what can be achieved with co-composting.

For the last decade there have been a variety of pilot studies conducted in developing countries, which provided low-cost low-tech sludge management, resource recovery, and improved pollution control, and these studies would be a useful reference in any similar PIC program (Koottatep *et al*., 2001; Mara and Pearson, 1992; Xanthoulis and Strauss, 1991; WHO, 1989).

3.5.2 *Waste* Water Management and Resource Recovery

In addition to the bio-solids that result from waterborne sanitation systems, there is the *waste* water itself that requires treatment. Individual on-site waterborne sanitation systems such as septic tanks are usually the responsibility of the householder or landholder. Reticulated or *off-site* systems include municipal sewerage systems, which are commonly the responsibility of local government, or small-scale treatment plants which are sometimes operated by the private sector to service cluster dwellings such as resorts. In some PICs small-scale *waste* water treatment plants are also used at institutions such as hospitals. A project was undertaken by SOPAC to develop guidelines for the selection of appropriate small scale *waste* water treatment plants for use in the Pacific Region. To improve environmental protection in certain circumstances, it was suggested that a small scale *waste* water treatment plant could be funded and implemented at the village level, if maintenance capability and responsibility, and land use issues, were resolved (SOPAC, 1999).

While municipal sewerage plants are the responsibility of government agencies, lack of funds for ongoing costs including electricity, and limited availability of skilled personnel can result in inadequate maintenance and operation. This is an outcome of conventional technologies from developed countries being implemented without due consideration of local capabilities and constraints, and there are many examples of failed systems throughout PICs. Power outages can further contribute to difficulties with sewerage systems, as electricity in PICs is generated from oil or diesel fired power stations which also suffer from regular operational problems.

Of those systems which are operating, some actually present health hazards to the communities they service because of operational difficulties. For example, on Ebeye Island in the Marshall Islands, a reticulated saltwater sewerage system is reported to have incidents of backwash where sewage surcharges through manhole covers. After heavy rains, standing water in the streets can contain reconstituted dry sewage, and children, in particular, are exposed to infection as they play in the pools of storm water. The sewerage system includes oxidation ponds for secondary treatment and discharge via deepwater outfall into the lagoon. Some residents who live near the oxidation ponds complain of *waste* water being sprayed out of the ponds during high winds. The lagoon is extensively used for bathing, swimming and fishing, and the construction of a causeway has reduced tidal flushing, resulting in increased pollution from the sewage discharge (SOPAC, 2001). These hidden exposures to sewerage effluent can be more threatening than obvious risks such as the potential for contamination from defecation on beaches, where people are careful to avoid contact with excreta.

When *waste* is transported away from its source the opportunity for individual responsibility for management usually decreases, however it is possible for communities to work together to reduce pollution loadings from reticulated sewage systems and other *waste* waters. This is being demonstrated by community-based activities in Cuvu, South Western Viti Levu in Fiji, a coastal district consisting of eight villages with a population of approximately 2500-3000. Two

inter-related projects are being conducted at Tikina Cuvu as a collaboration between the community, a tourist resort and NGOs, and is co-ordinated by the Foundation for the Peoples of the South Pacific (FSP-Fiji). Both projects address the issue of land-based pollutants and their impact on marine and freshwater environments, and adopt a *grass roots* rather than a *top-down* approach to environmental sanitation and resource management. A significant feature of the project is the process itself, which seeks to empower communities to better understand and solve their own problems.

> The Wai Bulabula project provides communities with ways of treating *waste*s naturally, before they get into the marine or stream environment, using simple technologies and plants that remove *waste*s while at the same time providing useful products (Robinson, 2001).

The Wai Bulabula (Living Waters) Project, initially funded for two years (1999-2001) by The Darwin Initiative for the Survival of Species, is a land-based program focusing on improving treatment of *waste* waters (e.g. sewerage, fertilisers, silt, and sludge), which enter the mangrove and freshwater environment. This strategy aims to restore the coral reef, the mangroves and stream health. The environmental restoration is undertaken through soil conservation, rubbish removal, improved sanitation, artificial wetlands, mangrove replanting, and composting solid *waste*. The project intends to develop a *waste* treatment model using natural systems and accessible technologies that can be used by communities.

The Shangri-la Resort and FSP-Fiji have co-operated in the construction of artificial wetlands, using local plant species, on Yanuca Island. It is expected that this system will treat '*waste*' waters generated by the Resort to a higher quality level than is currently available with existing technologies in Fiji. It is intended that the system developed at the Resort will help to rehabilitate the surroundings of Yanuca, and will serve as a demonstration of Wai Bulabula technologies that can be duplicated in the rest of Fiji, both at other resorts and in the wider community (Robinson, 2001).

The Coral Gardens Initiative is a marine based program initially funded by Conservation International U.S. and supported by the Shangri-la Resort, which assists communities and local leaders to develop and implement their own marine resource management plans. The program conducted at Tikina in Cuvu in collaboration with the Wai Bulabula project, focuses on restoring the reef by removing crown of thorns starfish, replanting coral, establishing *tabu* areas, and protecting coral from harvesting. This involves training traditional owners to restore the reef for their own use, and protect it from abuse and monitor changes. This program will be discussed in more detail in Section 4.2.

4. Integrated Waste Management and Resource Recovery: or everything is connected to everything else

4.1. Introduction

In Section three, activities were discussed that focused on improved sanitation and pollution control. This section will further examine strategies to minimise *waste* that have been undertaken at the community level in PICs and elsewhere, with an additional focus on solid waste. This includes strategies aimed at *waste* avoidance/prevention, re-use, recycling, and re-processing.

In an ideal world, it is preferable to have a holistic or synergistic approach to managing the bi-products of consumption. This would involve identification of the types, quantities, sources, pathways, and final disposal of wastes, including sewerage, stormwater, solid and hazardous *wastes*, and treating all inputs and outputs as part of a municipal ecosystem. This, of course, would involve ongoing co-operation across sectors and government agencies, and partnership with communities, which is not often achieved in developed countries, and rarely experienced in PICs.

In most developed and developing countries there are often separate agencies or organisations responsible for potable water supply, sewerage disposal, removal of sludge from on-site sanitation, storm water drainage, and solid *waste* collection and disposal. This approach tends to ignore the unavoidable inter-relationships between these services, and the efficiency gains that can be achieved if they are provided as part of an overall coherent strategy. For example, there can be a detrimental impact from inadequate management of solid *waste* on the operation of storm drainage systems, because open drains are then used as receptacles for solid *waste*. Similarly, unsanitary conditions can result from the flooding of on-site and off-site *waste* and sanitation facilities as a result of inadequate storm water drainage. Furthermore, inappropriate disposal of water, after it has been used, can result in ponding of greywater or sewage, which creates an ideal environment for disease vectors and can destroy whatever health benefits were anticipated through the supply of potable water.

There are rare cases where water supply and sewage disposal are the responsibility of the same organisation, and this usually results in a more coordinated approach to water supply and sewage disposal investments. However, such combined organisations typically focus on piped systems for water supply and waste disposal, and have little or no concern for on-site sanitation systems, which predominate in most developing countries, and particularly in PICs. Equally, solid waste removal is rarely the responsibility of a water and sanitation organisation, and even more rarely is it the responsibility of the institution in charge of building and operating storm water drainage systems, if such systems exist. In fact, storm water drainage systems are usually not *operated* in any normal sense. Much to the delight of rats

and other disease carriers, the accumulation of debris and solid *waste* is not addressed until flooding occurs in the rainy season (and sometimes not even then).

If *waste* is dealt with at source or on-site, many of these organisational difficulties are reduced. In an effort to contribute toward the creation of a healthy municipal ecosystem this Section will examine the community-based strategies which have made some attempt to deal with all the human and environmental factors which affect the system. In most cases local government or other agencies are involved, or need to be involved, to a greater or lesser degree, and this involvement will be briefly referred to. Given that personnel in government organisations and sector agencies are also members of *the community*, socio-cultural factors which influence *waste* management apply universally.

A number of programs have been selected from across the region, and elsewhere, which have attempted an integrated approach to a range of *waste* minimisation and pollution control issues. As the projects have many components, particular activities will be described in more detail which illustrate *waste* minimisation strategies that could have wider application in PICs. Background conditions are summarised to indicate why the programs were undertaken, and to provide examples of typical challenges faced in PICs. Practical experiences from community-based initiatives demonstrate what is achievable and what can be improved. As socio-economic and environmental conditions vary across the region, this is not to suggest that initiatives that have *worked* in one community, will necessarily work in another, but some general useful lessons might be learnt from these experiences.

4.2 Coral Gardens/Wai Bulabula Restoration in Fiji

As mentioned in Section 3.5.2, a community-based program to reduce loadings of liquid and solid waste on the marine and freshwater environment has been undertaken at Tikina Cuvu in Fiji since mid-2000. Tikina Cuvu was selected for the Wai Bulbula (Living Waters) project after consultation with local communities established that there was support for the project, and financial and logistical assistance was offered by the Fijian Shangri-La Resort. A second FSP co-ordinated project, the Coral Gardens Initiative is also located at Tikina Cuvu. Although the two projects are distinct, both programs are working together to empower local communities to reverse the decline of coral reefs and nearshore waters, and to increase benefits to the community, such as food and income from fish sales and tourism.

4.2.1 Background Conditions

In Civu district, the coastal hydrology has changed due to the construction of the Yanuca causeway/bridge in the 1960s, with over 100,000 cubic meters of sand deposited in the channel, resulting in severe beach erosion of the main Cuvu Bay beaches at the Shangri-La Resort. Deforestation and hillside burning and farming has contributed to erosion and the flooding of Cuvu Bay and reefs with muddy fresh water. Many of the cane farms are directly abutting streams with no buffer of trees (required by law). There has been a decline in coastal coconut forests due to demand for old trees by the *Pacific Green* coconut furniture factory, and to stray cattle killing coconut seedlings, which has resulted in further beach erosion in many villages, in part related to poorly constructed seawalls and partly to the removal of coastal trees.

Draining of freshwater wetlands and filling-in of mangrove forests at the mouth of Voua and Cuvu streams allows rainwater and nutrients to run directly onto the reefs. Further degradation of the natual filter has been caused by *Rhizopora* mangroves being stripped to make traditional paint for tapa cloth, and mangroves cut down for firewood. Nutrient run-off from piggery *wastes*, sewage, and agriculture is feeding *Sargassum* and other seaweeds on the reef which are smothering the coral, and contributing to an infestation of coral killing crown of thorns starfish. The infestation is linked to ecological imbalances caused by overfishing, especially of herbivorous fish and urchins, and nitrification of inshore waters.

The primary method of rubbish disposal in the eight villages of the district was directly into the sea. There was an unofficial rubbish dump on Cuvu Bay from Newtown's shops and homes, with the main Sigatoka town dump upwind of Yadua village and likely to be causing health problems due to dioxin released from daily burning.

There had been severe overfishing due to population increases, and desperation fishing due to widespread lay-offs subsequent to the May 2000 coup. Habitat decline had occurred as a result of destructive fishing methods and the use of plant (*duva*) poison on both the reefs and in the streams.

A number of recent climatic events had contributed to further reef degradation. Coral bleaching had occurred due to unusually high temperatures over the past two summers, and record *tidal* waves (in March and July 2001) had destroyed most of the remaining branching corals on the reefs, also wiping out the initial coral transplanting and restoration experiments.

4.2.2 Process and Outcomes

A summary of progress and solutions implemented under the project to date (February 2002) are provided below.

The Tikina Council set up the Cuvu District Environment committee and a working party through which the Wai Bulabula and Coral Gardens Initiative projects are co-ordinated. The co-ordinating committee is comprised of landowners, government departments, NGOs and FSP-Fiji, and regular meetings have been held for the past two years

Two-day environmental awareness workshops using Participatory Learning and Action (PLA) techniques were conducted in the eight coastal villages of Cuvu which allowed people to air their environmental concerns and stimulated interest and wider participation of the community. The program is structured to function through *80 per cent community contribution and 20% input from a team of facilitators or guides* (Robinson, 2001). The workshops were followed by four three-day management planning workshops. State-of-the-environment books were produced for the district and for each village.

An Environmental Management Plan was adopted by the Tikina Environment Committee and approved on July 4th, 2001 by the High Chief and Tikina Council.

Following the community consultation process, the Cuvu Bay unofficial rubbish dump has been closed and cleaned up by the community and made into a picnic area. Disposal of rubbish into the sea has ceased in all eight villages in the Tikina district.

Rubbish is now taken to the dump at Sigatoka or it is burnt or buried in house compounds. Composting and vermiculture trials have been part of the Wai Bulabula project and there are plans to apply the results of the trials to waste management in the villages. *Waste* minimisation, composting, and watershed management workshops are planned to further reduce coastal pollution, unwise burning, and erosion.

The village communities undertook Crown of Thorns starfish removal and approximately 4,000 starfish were removed from specific areas, representing an estimated 70-80 per cent of what was present on the Tikina reefs, and 99 per cent of what was on the reef in the Yanuca (resort) area.

Four no-fishing *tabu* marine protected areas (MPAs) have been established in the management plan, for an initial three-year period, three on reefs and one in the Navuevu mangrove. Boundaries of MPAs have been marked with buoys and stakes. A monitoring regime has begun of baseline fisheries data and reef mapping involving USP students and local village youths. Increased fish have begun to reduce algal overgrowth on the reefs within the protected reef areas. *Tridacna* clam, spider conch, and *trochus* brood-stock have been secured for restocking within the MPAs for accelerated recovery of these severely overfished species, and restocking has begun (1700 *Trochus*, 200 giant *chitons* thus far). There has been a ban on fishing with poisons and small mesh nets in the Tikina.

Construction of two fish aggregating devices (FADs) have been completed by the Fisheries Department, for deployment in the Tikina, to reduce pressure on reef resources by providing alternate fish sources for the communities and commercial fisherpeople. A pilot coral aquaculture farm has begun in Yanuca Channel at Cuvu village, to demonstrate a potential sustainable replacement for coral harvesting to the nearby Tikinas of the Coral Coast that are involved in the trades.

The partnership with the Shangri-la Resort has resulted in the following activities (*Pers. comm.*, Bowden-Kirbyn, 2002):

- The sewage works has been rebuilt and improved at the Shangri-La Resort based on FSP's recommendations. Based on Wai Bulabula trials, a constructed wetland system was completed in January 2002 and planted with Water Hyacinths (*Eichhornia crassipes*) to strip nutrients from treated waste water. The system has three large ponds connected by attractive waterfalls and a flowing stream, and fish have been stocked to control the breeding of mosquitoes, tropical wetland plants, including economically useful and ornamental plants, that were tested for tolerance in high nutrient waters, are floating on rafts in the *waste* water holding ponds;
- All the food scraps generated by the resort are now used for animal feed;
- Plastic bags are no longer used in the waste baskets in the guest rooms (hundreds saved per day);
- The shells and gravel raked off the swimming beaches no longer go to the landfill, and are now used to build a gravel beach in an area of erosion;
- Mulching of drift algae and leaves and twigs from the garden is planned, with investigations on how to include coconut leaves without damaging mulcher blades;
- Hyacinth is harvested weekly from the resort wetland and will be composted, and used for pig food. SPACHEE (South Pacific Action Committee for Human Ecology and Environment, refer Section.6.5) is teaching women from the villages how to use Hyacinth for weaving (Ecowoman, 2000);
- Based on advice from FSP and a hydrological study carried out by USP Department of Geography, the resort is implementing recommended coastal rehabilitation as resources permit (e.g., restoring the channel opening to its former location, and deepening Yanuca channel by dredging);
- The potential for elevating one of the *tabu* sites to the status of *Yanuca Marine Park*, permanently closed to fishing, has been proposed, and extra funding from the Shangri-La Resort has been obtained for this purpose.

FSP is acting as a "broker" between communities and the resort, ensuring that resource-owning communities benefit more from the presence of tourist activities in the area;

- To absorb nutrients leaking onto reef flats from polluted groundwater, 3,000 hybrid dwarf coconut seedlings have been planted in the coastal villages, and nutrient sampling and water quality monitoring of the coastal waters has begun. The dwarf species was selected because it does not cause a threat during hurricanes, which is a risk associated with taller trees. OISCA International is facilitating an extensive mangrove planting and channel deepening effort at the Yadua stream mouth and the work will soon expand to the mangrove conservation area at Navuevu;
- Fertilizer experiments have been undertaken to identify an economic use for pest species (sea weeds and COT). This included field trials in community gardens, and chemical analyses by the Fiji Department of Agriculture; and
- The Cuvu Environment Committee has submitted a formal request to the Fiji Government for assistance in overcoming problems beyond the resources of the communities to remedy, including replacing the Yanuca Island bridge/causeway, which is presently blocking tidal flow through the channel.

Lessons Learned

A program of this magnitude and complexity requires a long lead time. The *comprehension period* can take at least one to two years before communities fully commit themselves and understand and digest concepts. Donor agencies need to be informed how traditional systems work to enable them to adjust their funding mechanisms to provide some support over a longer period. Often funding periods end when communities have just begun to actively participate, which can defeat efforts toward sustainability.

It is important to clarify with external consultants the cost and time that will be involved in technical assistance so that the local counterparts can ensure the budget also allows for necessary community activities. Where possible technical assistance should be sourced locally to reduce costs, and technical skills and activities should be transferred to community members as soon as feasible (*Pers. comm*., Lucas, 2002).

Ongoing commitment from the community requires incentives and direct involvement. During the project this has been achieved by:

- Village *clean-up* competitions;
- Participation in marine restoration projects;
- Training workshops to develop environmental and management skills and knowledge;
- Developing a village theatre troupe to perform in schools and workshops on environmental themes;
- Participation in field trials and other project research;
- Ensuring youth have an opportunity for input to decision-making through PLA and theatre activities; and
- Incorporating traditional practices such as: working in harmony with local protocols eg. the establishment of an environmental committee through district council and endorsement from chief and leaders; building on the concept of Vanua, ie., identity of indigenous communities, and planting local species around or near toilets, septic tanks and drains which feed on nutrients from *waste* thereby helping to reduce eutrophication.

Attention should be given to addressing conflicts which are commonly experienced when resources are communally owned. This includes anticipating potential conflicts such as disputes over water connection and drainage, and dealing with existing conflicts such as disputed ownership of land and fishing boundaries.

It is crucial to establish a working relationship with the communities built on trust and confidence, and to avoid creating unrealistic expectations about outcomes from the project. Creating a community/private sector/local government partnership is mutually beneficial, and it is important to have the widest possible collaboration of stakeholders (Robinson, 2001; Bowden-Kirby, 2002).

4.3 Waste Management in Tuvalu

The Waste Management Programme in Tuvalu supports a number of interconnected activities. These include the AusAID funded Waste Management Project (WMP), the SPREP funded Solid Waste Education Awareness Programme (SWEAP) and the government-supported waste reduction programme. These activities are headed by a Tuvaluan Project Co-ordinator, who oversees implementation of all waste-related activities. The WMP was preceded by government deliberations and input from a number of donor agencies and NGOs over several years, including ADB, JICA, SPREP and SOPAC, which surveyed waste production and its environmental impact, and identified the need for community

involvement in waste management (AusAID 1999; SPREP 1999). The WMP began in 2000 and is planned for completion in mid 2002.

4.3.1 Background Conditions

Conditions in Tuvalu prior to the WMP were described as follows:

> Disposal of solid waste is a major problem in Tuvalu where there is no room or infrastructure for conventional means of disposal, and recycling may not be economically feasible. A range of liquid wastes pollute fresh water systems, aquifers and groundwater lenses and enclosed coastal waters. The threat to water quality, particularly in atoll islands, poses a major environmental risk;
>
> The growing population in Funafuti has placed increasing pressure on the local environment and has also created a potential public health problem. At the present time there is no formal waste disposal system and no regulation of what materials are dumped into Borrow Pits, creating the potential for harmful substances to seep into the environment, particularly the lagoon and surrounding seas, and affecting marine life;
>
> The deteriorating environment is increasingly affecting the health of local residents, and unsightly rubbish and poor sanitation harms tourism and its associated economic benefits. In order to maintain visitors' perceptions of Tuvalu's pristine marine and terrestial environments, and to address increasing health concerns, there is an urgent need to address solid and liquid waste practices before they degenerate further (AusAID, 1999).

4.3.2 Project Goals

The project outputs prescribed in the AusAID WMP design document included the following:

- Development of an effective collection and disposal system for Funafuti;
- A system for separating wastes at household level will be designed and programs initiated. Household bins to be provided to enable wastes to be properly separated.
- A pilot solid waste composting program will be conducted to determine viability and acceptability by the community, to determine the viability of composting as an appropriate means of disposing of green waste (kitchen waste, coconut husks, papers and leaves etc), and 50 households will be selected for a trial program. This will include the implementation of an education program, the procurement of shredders and the construction of compost facilities. Women's groups have been pioneering the composting programme and they will be invited to continue this role. Composting is not traditionally practiced. Apart from those used as pig food, green materials are seen as *waste* rather than a valuable resource to be used for supporting soil fertility. Coconut products are difficult to shred indicating that a shredder will be required;
- Encourage and provide alternatives for Tuvaluans to re-use consumer items and include an Annual Clean-up Day;
- Pilot projects to up-grade septic tanks and trial composting toilets with performance monitored and community acceptance assessed. Septage disposal addressed;
- Three model piggeries will be developed; and
- A storage site provided for hazardous and special wastes.

The budget for the project was approximately $A2 million of which $A1.2 million was spent on equipment.

4.3.3 Process and Outcomes

Solid *waste* characterisation studies (using Australian *waste* characterisation guidelines) were conducted by the Project Team in which 3.5 tonnes of garbage was examined including putrescent '*waste*' such as rotting breadfruit and nappies. It was found that up to 70 per cent of the *waste* was organic. Therefore the composting project became a pivotal part of the strategy to reduce waste going to the landfill. Previously organic waste (including branches and trees) was collected on the monthly garbage collections.

The original plan to have a pilot composting project in 50 households was integrated into the household*waste* separation activities and has been underway since September 2000. A condition for receiving a new set of plastic wheeli-bins (provided by the project) is to sign up to the project and agree to separate waste. A regular, reliable collection service with dedicated vehicles was initially funded as part of the project but has now been taken over by the Tuvaluan government. Currently the collection service is provided free of charge to the householder. It remains to be seen how the service will be funded in the longer term. The original 50 households involved in the composting trial was expanded to 120 and then to 250 households. In February 2002 it was reported that the composting activities are being further expanded to a total 400 households due to community interest (*Pers. comm*., Boase, 2002).

In the past programs, residents had been provided with 44 gallon drums as *waste* receptacles, free of charge, by the council. According to council workers the 44 gallon drums were too heavy to handle. The open drums were also affected by rain and caused problems with flies and vermin. Later, in a 1996 ADB project, four hundred 120 litre wheelie bins were made available to public at $A15/bin. Only 131 out of 300 households covered by the Funafuti Town Council had purchased a wheelie-bin at the time of a study conducted for SPREP in 1999 (SPREP, SKM Tuvalu 2000). In any case, it was reported that the wheelie-bins that were purchased were sometimes not used for collecting *waste*, but more often as water containers. The WMP system of providing rubbish receptacles attempted to avoid the mistakes of the past (*Pers. comm*., Boase, 2002).

Community Education and Awareness

The SWEAP project (approx. $US7,500) focused on public education regarding *waste* management and held community training workshops on source separation and the production and management of compost. Brochures, posters and newsletters were produced in the Tuvaluan language and the expatriate advisers from the WMP attended meetings and workshops intermittently. The Tuvaluan Association of NGOs (TANGO) was also invited by the project to talk to various groups through their *Kitchen and Water Catchment Improvement Project* (which includes a component on diversifying food sources through enhancement of kitchen gardens) and other awareness raising activities. Project counterparts speak at various TANGO activities and technical advice has been provided to TANGO members on composting processes.

Tuvalu enrolled in the Clean up the World Campaign and there have been three Clean-up Days since the project began. Approximately 600 tonnes of garbage has been collected on each Clean-up Day or approximately 2000 tonnes of garbage has been collected since the campaigns were initiated in addition to 80-90 car bodies. The community organised the transport to carry out the clean-ups. Competitions were arranged with prize money awarded on the amount of rubbish collected. This worked well partly because there are nine communities living in Funafuti from different islands so the usual competitive spirit was further stimulated.

Institutional Support and Training

In order to achieve effective separation of *waste* and provide a quality service, there are separate pick-up days. There are two green *waste* pick-ups per week, one for putrescent *waste* and one for non-putrescent organic *waste*. Additional to this there is a solid refuse pick-up.

Once collected, the organic waste is transported to a central composting centre where it is spread on a rack and staff remove non-biodegradable items such as plastic bags and cans. Then a shredder (costing $US10,000) shreds brown and green organic matter separately, which is then re-mixed in a measured ratio with pig manure in the starter slurry to seed the windrows. Tuvaluan counterparts were trained to operate and maintain machinery, to understand the principles of composting (e.g., the importance of the carbon/nitrogen ration) and to operate a windrow composting system. This training was intensive with Tuvaluan workers from a range of backgrounds trained on a one-to-one basis for three to six months. There are a total of 15 Tuvaluan field workers and three staff members working on the project. While training was expensive and time consuming, it has been reported that this kind of investment was seen as essential for the long-term sustainability of the new systems.

One of the women counterparts had a diploma in science. Once she understood how to put the formula together and the operating rules and parameters (e.g., temperature, checked with probes and moisture and C/N ratio) and the Tuvaluan workers had observed the process over a three to six month period, the centre became self-sustaining. Piles of compost at different stages of maturation were numbered and compost was tested for toxicity. When the community observed that the organic matter which they had put in their wheeli-bins had produced friable compost, they began to purchase it at a low price and the overall composting strategy gained acceptance.

After six to seven months, the Agriculture Department became involved in the project and showed people what and how to grow plants in the compost. In the meantime, project staff were taking compost home to test on their own gardens. To date there does not appear to be an increase in gardening activities by Tuvaluan communities, but this could be a focus for further encouragement, so that the compost is fully utilised. It is reported that most of the compost is collected by the Samoan population who live in Funafuti, for their gardens.

In response to queries about the sustainability of a community program dependent on machinery, the project manager reported that as part of the project, a workshop has been assembled at the composting centre in an old hangar. The workshop has the tools to properly maintain the equipment including a welder. A trained mechanic and two trained workers (who attended maintenance courses in Australia as part of the project) are part of the maintenance team. A maintenance regime has been established where each piece of machinery is serviced for half a day out of every five days. An appropriate technologist was also engaged during the project establishment period to ensure technologies and methodologies could survive beyond the project. Currently the shredder handles the collected daily organic matter in one day. The balance of the *waste* material goes to the land fill. It is considered that the composting enterprise has potential as a community business (*Pers. comm.*, Boase, 2002). Refer to Section.5.5 for a description of a non-mechanised community composting enterprise.

Cans

The contents of most beer cans are consumed at the hotel and bar in Funafuti which are separate establishments at either end of the island and do not enter the domestic *waste* system. The bar and hotel are owned by the community and revenues raised return to the Town Council. A can re-cycling system, Cancare, which is operated by Matagigali Bar with some help from USAID, was reported to be functioning at low efficiency when the WMP began work on Tuvalu. Cans also littered the lagoon areas of Fogafale. The payback for cans is insufficient to encourage people to collect them. Although Cancare was not included in the WMP, can recycling did regenerate to some extent without direct intervention by the project team, other than conducting maintenance on Cancare's crushing machine and supplying some equipment. The WMP also provided more drop-off points for cans to be collected. It was reported that there was poor quality control when separating and cleaning aluminium cans and this is affecting the price received for crushed cans in Australia. Cancare re-cycles about two container loads every year to Australia. It receives $8000 for each container load and pays a discount rate of $800 instead of $3000 due to the support of a local shipping agent.

Disposable Diapers

An industrial drop off bin (1100 litre) has been provided in a central location for used disposable diapers. The bin is taken to the landfill everyday for emptying. It is reported that most people now deliver the used diapers to the bin rather than putting them in the lagoon. However, while there may be a reduction of diapers going into the lagoon, they are now going to the landfill. Incineration is being considered as an alternative but the use of disposable diapers needs to be discouraged in Tuvalu and other PICs, ideally supported by a restriction on imports (Refer Sections 4.4.3 and 5.6.1). An innovative pilot project on this controversial subject would be most useful.

Hazardous Waste

A hazardous *waste* depot or store has been established in Funafuti as part of the Waste Management Project. Hazardous *waste* is separated and stored there until it can be shipped overseas for treatment and disposal in a suitable facility. This export operation would need to be undertaken in compliance with the requirements of the Waigani Convention to which Tuvalu is a party (SPREP, Burns*et al*., 2000). Since the WMP, hazardous*waste* no longer goes into the landfill, and the community deliver specified *wastes* to the store. It is intended that used oil (e.g., from power stations) that is delivered to the store will be repatriated to Fiji. There is a problem with repatriation since ships for oil pick-up do not visit the smaller island nations, including Tuvalu. A storage tank was delivered to Tuvalu some years ago by BP with the intention of storing*waste* oil for repatriation but it has not been utilised. Misuse of treated timber can also present a health threat, e.g., community members were buying scrap treated pine from a sawmill to smoke fish. All these issues are a matter of raising community awareness of the dangers of exposure to hazardous materials (Refer Sections.5.6.3 and 6.5).

As elsewhere in the Pacific, used batteries are an environmental and public health concern. In Tuvalu, lead from car and boat batteries is often re-used in fishing as sinkers. The use of lead in fishing can result in lead fumes as battery casing is burnt, and also acid can be spilt on the skin. Acid can be neutralised with lime or seawater. Batteries are delivered to the hazardous '*waste*' store by the community and are picked up by project staff wherever they are seen during *waste* collection. The WMP aims to export batteries in container loads to a battery re-cycler after removing the acid. Household batteries are collected at drop-off points and sealed in drums filled with concrete before landfilling. This is a recently introduced operation, and many small torch batteries are still seen on the ground around the villages.

Hospital *waste* such as dressings and placenta is now being incinerated in a small diesel powered incinerator which was installed as part of the project.

Piggery

A prefabricated modular piggery has been designed as a model communal facility, although it has not yet been constructed and delivered. The plan is for the communal piggery to accommodate up to 100 pigs. The facility would be constructed away from the village on a pre-cast concrete base (100m from the village was suggested as being close enough for owners to easily walk to the piggery and feed their pigs). Villagers would be able to rent a bay for their pigs. A *waste* water system will be incorporated into the piggery. This will be a matter for intensive community consultation.

Borrow Pits

There has been limited success with cleaning up the Borrow Pits which were the customary dump or *waste* disposal site. There are ten major pits and these were the result of the construction of the airfield in the 1940s, and are porous and subject to tidal movement (Saitala and Paelate, 1996). There is apparently a lack of motivation from the squatter settlement dwellers as well as the government to take responsibility for the condition of the Borrow Pits because they are on private land. However the WMP has leased one of the pits for 'clean' landfill and rehabilitated it. During one of the Clean-up days 50 members of the community attempted to clear out some of the other pits, but much more time and energy is required to address the problem effectively (*Pers. comm*., Boase, 2002).

Sanitation

Apart from the composting toilet pilot described in Section.3.2.4, other strategies to improve sanitation had not been undertaken at the time of writing (February 2002). These planned activities included septic tank up-grades, pilots to trial mounded effluent drain-fields, and small bore reticulated effluent collection with disposal to a common mounded drainfield.

4.4 Village Beautification in Tonga

The Tonga Environmental Planning and Management Strengthening Project (TEMPP) undertaken between 1997 and 2001 was primarily a national capacity building program covering a wide range of environmental concerns. However, among other outcomes, the project provided stimulus for a very practical *waste* management initiative at a village level which will be described at Section.4.2.3, as an example of what can be achieved within existing community-based organisations. This initiative is of particular interest because it commenced at the end of the TEMPP project and is being maintained and funded by the community.

4.4.1 Background Conditions

The status of *waste* management on Tongatapu included the following conditions.

Policy and Planning

The government of Tonga did not have a formal *waste* management policy. There was limited legislation and few regulations relating to the control of *waste* management activities, and a lack/or ineffective enforcement of laws where laws do exist such as the anti-littering/dumping law. Previous planning for solid *waste* management in Tonga, including Nuku'alofa, has been fragmented and ineffective, with few programs and recommendations being implemented (Dever, 1999).

Waste generation

Approximately 100 tonnes of *waste* was being disposed of each week at the Tukutonga dump site on Tongatapu (equates to 5200 tonnes per year). Composition of *waste* at the dump was estimated as follows (SPREP: SKM-Tonga, 2000):

- Mixed domestic: 24 per cent
- Paper and cardboard: 20 per cent
- Organics: 20 per cent
- Metals: 20 per cent
- Construction: 8 per cent.

Waste storage and handling

There are no guidelines for on-site storage and handling of *waste*. Few households own or use garbage bins. Some households place their *waste* in bags on elevated stands or in large metal drums. However, most solid *waste* is placed out on the kerbside for collection in bags and/or open piles, and is available to roaming pigs and dogs. Solid *waste* generated at institutional, commercial and industrial premises is stored in a variety of manners including the use of a range of containers such as large metal drums and some mobile garbage bins (Dever, 1999).

Waste Collection and Disposal

A solid *waste* collection service is provided by the Ministry of Health (MoH), but the extent of the service is limited as the MoH has only one *waste* collection truck. Approximately 20 per cent of the households in Nuku'alofa and the surrounding villages utilise the *waste* collection service, however, according to the MoH many other households wish to utilise the service. The fees for the collection service range from $T0.50 ($US.025) for residential household to $2.00 per month for an industrial premise or large store. The '*waste*' collection service is subsidised by the government of Tonga, with the income generated only covering approximately 25 per cent of the costs of running the service. Privatisation of the waste collection service has been considered by MoH.

Littering and indiscriminate dumping of solid *waste* is prevalent in Nuku'alofa and in villages around the Fanga'kakau lagoon. Generally, the littering and dumping occurs on unoccupied and public land, on the fringe of the urban area and away from villages. The MoH has had one street sweeper who is responsible for cleaning the main street water front. There were few other public litterbins in Nuku'lolfa or the village surrounding the lagoon. Most of the domestic *waste* generated in Nuku'alofa is managed on-site by burning. This includes all combustible household *waste* such as paper, plastic, cardboard and yard *waste*. Usually, kitchen food *waste* is fed to family pigs and dogs. Non-combustible '*waste*' such as old car parts and white goods are occasionally taken to the Tukutonga Waste Disposal site or dumped on unoccupied land nearby. The disposal of such large items is a serious problem on Tongatapu and the island is littered with remnant vehicles and other large metal scrap.

Some villagers take their own *waste* to the Tukutonga dump site and some dump their '*waste*' on vacant land at the edge of town. Most *waste* generated at institutional, commercial and industrial premises in Nuku'alofa is either collected by the MoH or taken direct by the owners to the Tukutonga *waste* disposal site.

The MoH operates the dump site at Tukutonga, approximately five kilometers east of the Nuku'alofa town centre, and immediately west of Tukutonga village. The *waste* disposal site is located in a mangrove area, although residential development is occurring to the south of the site at the village of Popua. Due to a lack of funds and access to suitable equipment the *waste* is irregularly compacted and rarely covered. Access to the site is generally difficult, particularly in wet weather despite the reasonably good access road. This is due to the practice of dumping*waste* on the access road. The operation incorporates no environmental controls to prevent water pollution (by leachate) or prevent local nuisance such as fires, smoke, dust, flies, and vermin. In 1996, WHO provided funding and successfully improved the operation of the *waste* disposal site. However, upon expiration of the funding, the '*waste*' disposal operation has deteriorated (Dever, 1999).

4.4.2 Project Goals for TEMPP

The TEMPP objective was to contribute to Tonga's National Development Plan through capacity building support for the implementation of five components:

1. Strategic Management Planning;
2. Environmental Planning;
3. Environmental Management;
4. Information and Community Participation;and
5. Project management.

One focus for the planning process was to develop an Integrated Waste Minimisation and Management Strategy for Tonga which was *environmentally sound, acceptable to the public, cost effective, dependent on proven technology and capable of early implementation to prevent, control and manage pollution and waste* (Dever, 1999).

To develop the strategy the following stakeholders were involved in consultation: Ministry of Lands, Survey and Natural Resources (MLSNR), EPACS, TEMPP, Ministry of Health, Ministry of Works, Tonga Water Board, Central Planning, Labour, Commerce & Industries, AusAID, NZ High Commission and NGOs: Tonga Trust (TT); Aloua Ma'a Tonga (AMT); and Langafonua 'A Fafine Tonga.

It was decided, after much consultation with government and NGOs that the following issues should be covered by the Waste Management Plan:

- The establishment of a new sanitary landfill waste disposal site or Waste Management Facility (WMF). The WMF is scheduled for 2002-03 to be built at the old Tapuhia quarry in Vaiini , funded by AusAID. The provision of adequate equipment and training to operate the WMF and to up-grade the collection service;
- The closure and rehabilitation of present the dump. This will be undertaken when the WMF is completed and will be funded by NZDOA;
- Development of appropriate waste minimisation and recycling programs to reduce the amount of waste disposed at the landfill, thus extending the life of new WMF;
- Education and training programs to emphasise the importance of waste minimisation and resource recovery;
- The development of appropriate mechanisms for funding waste management activities; and
- Attention given to the increasing importation of products and materials which require management and disposal in Tonga, particularly non recyclable materials and old vehicles, Dever, (1999).

4.4.3 Process and Outcomes

As part of the education and training program the following three NGOs were involved in the TEMPP Project:

- Tonga Community Development Trust, (TT);
- Aloua Ma'a Tonga (AMT); and
- Langa Fonua 'A Fafine Tonga (National Council of Women).

Although these organisation were involved in different activities, the TEMPP process somewhat strengthened the links between them. Previously there had not been common channels of communication amongst these three NGOs or other NGOs operating in Tonga (Marsh 2001) and this co-operation needs to be further encouraged to maximise resources and ensure activities achieve comprehensive exposure and support.

These three organisations were involved in a variety of awareness raising activities:

- Tonga drama competition through Awareness Community Theatre (ACT);
- Pesticide Awareness program;
- Implementing and overseeing the building of fence pens for domestically raised pigs;
- The impact of TEMP educational activities;
- Producing newsletters including "Tokangaekina OFanga Uta Mo Fangakakau";
- Monitoring (Lagoon Watch) and radio programs;
- Organising the mass collection of empty drink cans to sell to the recycling centre for the purpose of donating these funds to charity; and
- Working with women to produce TV programs which raise awareness of women's development and environment issues in Tonga, including discouraging the use of disposable diapers.

TEMPP provided training to various NGO personnel and government staff, including the Communication, Project and Media Officer at Langafonua 'A Fafine Tonga who attended training in Australia with personnel from the Ministry of Health, Tonga Water Board and Agriculture. The project officer spent two months attending a number of courses including a university conducted Environment Impact Assessment workshop, and a Resource and Recovery Education Course run by the Beverage Industry Environment Council. She also had a work placement at a Shire Council Environment Unit (*Pers. comm.*, Vi, 2002). Inspired by her training the project officer undertook initiatives that were independent of TEMPP and commenced at the conclusion of the project in September 2001. These initiatives which indicate a sustained outcome from TEMPP training and awareness raising activities are described below.

Waste minimisation and village beautification

In addition to her official duties, the project officer decided to apply her experience in Australia in her home village of Havelu, which is part of Nuku 'alofa, as she is a member of the Havelu Women in Development and Beautification Committee. She initiated this enterprise as a community member rather than in her roll as project officer for Langa Fonua. Havelu is adjacent to the lagoon and includes Vaiola, the main public hospital in Tonga. People travel from all over Tonga to visit the hospital, and both the lagoon foreshore and the hospital precinct were heavily littered, as well as the residential streets. As is common in PICs, people often do not feel any responsibility for land outside their home compound, and especially outside their home village.

A description of the process of village mobilisation is provided here as it is a low cost/no cost community-based strategy that could be applied in any similar village context in Tonga, or elsewhere in PICs.

From feedback from some of the community they were not aware much of the environment.*All they care about was to keep Tonga clean for the tourist*. It's true, when I went out to one Primary School for my radio program I asked the kids: Why do we need a clean environment? All they said was: for the tourist. *For the tourist, but not for ourselves!* Even I used to think like that but I know more now. I started off with the Havelu community so that other communities might see our new idea and copy it. I held a consultation with the Town Officer, the Committee and some men who where interested to listen, and told them about the new idea how to minimize some littering problems (*Pers. comm*., Vi, 2002).

A survey was conducted by sub-committee members from each section of the village to establish what kind of litter was being scattered around Havelu. In the meantime funding was sought to support the waste minimisation program.

> "I wrote a letter to all the private businesses in Havelu, with the signature of the Town Officer and I signed in for the Chairlady as she was away at the time, and distributed it to the private business. In the letter I asked for sponsors to contribute into the Committee's Environmental Programme and Beautification (*Pers. comm*., Vi, 2002).
>
> Some businesses did not respond but the following contributions were made:
>
> - Tupulekina Technology Ltd. (Fua 'o e Fonua store) contributed two drums;
> - Tui International (they import the popular E2 soft drink) donated $100.00 pa'anga;
> - Zuvva Holding Company Ltd donated $200.00 pa'anga;
> - 'Esiaola Furniture Showroom donated paint;
> - South Pac Sales Painting Ltd donated paint;
> - BP oil donated 18 drums; and
> - Pac Sales Ltd donated paint."

The local mechanic expressed regret that he could not afford to make a financial contribution. He was advised that he could help by fixing the drums with lids and painting them different colours, six drums were painted red with instructions written in Tongan *for aluminum cans only*; six were painted green *for plastic and glass bottles*; and six drums were painted yellow for *rubbish only* such as *plastic bags.* In mid September 2001, the drums were placed outside the hospital, near the lagoon, next to a vegetable market, in front of the town officer's residence, and outside the house of the mechanic who painted the drums.

Havelu village, with a population of 500 is divided into four main areas, each with between five and eleven *blocks.* Altogether the Havelu community consists of 31 blocks each with their own chairperson, secretary and treasurer, and all belong to the Havelu Women in Development Committee (HWDC) which consists of a Chairperson, the town officer, Deputy Chairperson, Secretary and Deputy, Treasurer and Deputy and Advisory Members (i.e. chairperson, secretary, treasurer of each block). Similar Women in Development and church-based village committees exist throughout Tonga and have been functioning for many decades, and involve men, women and youth.

The HWDC hold a meeting twice a month and block representatives are expected to attend. If they cannot attend, they send a proxy. The representatives report on their own activities such as beautification and clean up. During recent meetings, most of the issues raised by leaders of each group had been related to problems with littering. For the purposes of the waste characterisation survey they were asked to find out what type of rubbish was being littered in their area. They returned to their group to consult with the residents and reported back at the next HWDC meeting, three weeks later, and it was reported that the litter was comprised predominantly of peanut packages, twisties packages, cigarette butts, aluminium cans, plastic, plastic bottles, and used diapers.

Rubbish drums that had been placed by the main waterfront in Nuku'alofa during TEMPP activities had been used by passersby to dump their own rubbish, so the Havelu drums were placed near responsible households who kept watch that the drums were used only for communal litter. *Waste* watch was generally encouraged in the community;

One of the locals told me he was on his way home when he saw a foreign shop owner walk over with a full knitted package which we use for picking up rubbish, and dump it in the red drums that collect the plastic and glass bottle. The package was full of sea food shells and some unbelievable food scraps which were already rotten. He told me that he went to confront the shop keeper with the bag, but he pretended he didn't even know what the local was talking about (*Pers. comm*., Vi, 2002).

It took some time and repetition of the message for people to get used to the system and start picking up litter and putting it in the drums. Participants in a weekly HASH run helped set an example by collecting litter as they ran around the village.

When the drums are full, the contents are sorted and sent to various destinations.

- Cans are taken to the one recycling business in Tonga, which ships the crushed cans overseas, and money received is used for beautification of Havelu.
- Plastic bottles are emptied at least twice a week and have to go to the dump because there is no recycling strategy available.

  As for the plastic bottles, it is too much and it only increases the unnecessary solid waste in the Kingdom. I had an idea to collect the plastic bottles in Havelu and put them to one side and ask the public to come and take what they needed and try to broadcast a television program and ask the public: How are we going to battle against this unnecessary solid *waste* in Tonga. How did it get to Tonga? How can we ship it out of Tonga? How can we make those people see what they have done for their business benefit but not the environment? Another good example is the Royal Beer Factory in Tonga, they produced the plastic bottle for the Zingo soft drink and sell it, but don't recycle it (*Pers. comm*., Vi, 2002).

  The only thing that would make the Coca Cola Business in Tonga do their job properly is to educate the people and encourage them to participate in public and make them see how important it is to be aware of what is right and what is not right. If the people don't care the government won't care. If it is something important to the people then the government would act on it. If only there is someone who really cares enough and has courage to lead the way (*Pers. comm*., Vi, 2002).

- Glass Bottles such as Ikale and Royal Beer go to the factory and receive ten cents a bottle. Some are sold back to the community by the Committee for one cent and the remainder go the dump.

Funds from recycling were used to contribute to other aspects of village beautification. During the TEMPP project a section of the lagoon foreshore had been fenced off and the WID committee decide to improve the beach area by:

... establishing a park for children and also a small *faleTonga* (traditional hut) for people who will use it for picnics and resting. Since it's already fenced by the Lagoon Watch Project, it will be easier for the community to maintain it and look after it. It will be locked in the night time and open in the day time. No drinking will be allowed in that area. There's also a board established at the beach front for posters and environmental issues. The park is established to

promote environment friendly and awareness for Havelu Community, since it's also next to the Lagoon. Traditional plants will be planted in the area. If the park is established with equipment for children or schools to use it, there will be payment at the door for admittance so that the Community could be able to maintain the clean up and future improvement (*Pers. comm*., Vi, 2002).

To further engender civic pride a second project is proposed:

Since we have someone in the organisation (*Langa Fonua*) who knows how to weave thin wire into a hanging basket, we could ask her to come to Havelu to conduct a workshop on weaving that type of hanging basket so that we could put the pot plants with teardrop plants in the hanging basket and hang it on the electric pole (five meters away from the ground). This would be for all the electric poles in Havelu. I was thinking of looking for funding to buy the wire for the hanging basket and the teardrop plants. When all is ready, a meeting will be held with other leadership in the community to ask them to invite all their groups to come to the weaving of the plant hanging baskets for the electric poles. When its complete then they'll be responsible for hanging them on electric poles in their area (*Pers. comm*., Vi, 2002).

Disposable Diapers

Two urban centres, Nuku'alofa (Tonga) and Honiara (Solomon Islands) were covered in *waste* characterisation surveys discussed in Section.2.6. The studies showed that over a five year period there was a 96 per cent increase in the generation of paper-based waste and this was attributed to the introduction of disposable diapers.

As part of her duties at Langa Fonua, the Project Officer has been involved in education and awareness raising regarding the waste management and pollution concerns associated with disposable diapers;

During my awareness talk with the communities, one of the members said that he's tired of picking up the diapers that are discarded on his areas and also dogs dragging it from other places to his area. During our awareness talk I left out a teddy bear with nappies and a diaper. I asked a volunteer to please put one of those two on the teddy bear. Of course the one who complains just walked up and put on the diaper on, but not the nappy. I guess the main thing is to emphasise the message of the awareness talk: REDUCE, REUSE AND AVOID. To be realistic, it will be hard to stop using the diapers (*Pers. comm*., Vi 2002).

As previously suggested, an imaginative pilot project which draws on the experiences of local educators such as the project officer and addresses all the issues around diaper use, including the labour saving benefits for women, could be a useful component of the IWP.

4.5 SAPHE and KEEP in South Tarawa

In 2000 the Sanitation, Public Health, and Environment Improvement Project (SAPHE) began in South Tarawa, which aims to improve the development potential of Kiribati and the health and well-being of its people through a sustained program of improvement in water supply, sanitation, solid *waste* disposal, and environment conservation. SAPHE was preceded by many investigations and recommendations including the Sanitation and Public Health Project (ADB, 1996).

The total project cost is $US12.8 million, with the ADB funding a $US10.24 million equivalent concessional loan and the Government of Kirbati (GOK) funding the balance. The ADB loan will come from the Bank's Asian Development Fund (ADF) which means it is interest-free and repayable over 40 years, including a grace period of ten years. The loan is primarily focused on infrastructure improvements such as repairing the existing reticulated water supply system, reviving the salt water sewerage system and undertaking sanitary landfill works.

The loan will fund toilet infrastructure for public housing through the Kiribati Housing Corporation (KHC). Construction of appropriate on-site sanitation for those not serviced by the sewerage system, will also be financed under the Loan. However funding will be available under an on-lending scheme, that is, households can borrow money to build their composting toilet or other on-site sanitary installation. It was agreed between ADB and GOK that on-lending terms to KHC and private householders would be moderate (*Pers. comm*., Moala, 2002).

The ADB is also providing two technical assistance grants, totalling $US1.5 million, for the Management and Financial Advisory Services for Restructuring the Public Utilities Board and for Community Development and Participation Initiatives (CDPDI).

The community education component of the CDPDI is known as the South Tarawa Community Education and Awareness Project which is implemented by FSP-Kiribati, in partnership with Coffey International, and in co-operation with the Kiribati Housing Corporation (KHC). The CDPDI addresses community water supply such as wells and rainwater tanks, environmental sanitation and public health, and this is linked to the pre-existing Kiribati Environmental Education Program (KEEP) conducted by FSP-Kiribati. Activities include community consultation, designing materials for use in education and awareness and consultation activities, trialing compost toilet designs and conducting CT construction workshops, strengthening the capacity of project staff and counterparts from relevant agencies and

organisations in community development and participation skills. The CDPDI mainly focuses on the communities in South Tarawa that will not be serviced by the reticulated water and sewerage systems, i.e., 70 per cent of the population.

4.5.1 Background Conditions

South Tarawa is comprised of a string of islets joined by causeways and, in some cases, accretion and land reclamation. The population of South Tarawa in 1999 was estimated at 30,000 and growing at 3.1 per cent per annum (MFEP, 1999; Webb, 1996). Inward migration has increased the population of the islets to a level that may be approaching, or exceeding, the carrying capacity of this small area of land. In 1996 the population density of South Tarawa was 1,799 persons per square kilometre, and in Betio it was 6,735 persons per square kilometre (Jones, 1996). Only 25 per cent of the population originate from South Tarawa, as their 'home island' and have associated rights of tenure. The remainder have migrated from the outer islands. There are many socio-economic, resource management and land use complications created by widespread squatter settlements.

Over the centuries, the I-Kiribati have developed a wealth of knowledge about their environment, especially regarding the reef and marine resources. These natural assets have been sustained through customary fishing regulations, marine resource ownership/tenure systems, clan taboos, demographic and technical factors which have limited exploitation. As a result of social and economic changes, many of these sustaining mechanisms have broken down, and the environment now faces severe threats (Saito, 1997).

Freshwater sources are rainwater and subterranean groundwater lenses. There was also a desalination plant in operation. The average rainfall in Tarawa is 1,550mm with long drought periods. Groundwater contamination ranges from mild contamination from faecal wastes to heavy contamination with sewage, and possibly hydrocarbons. Depletion, expressed as the occurrence of saline intrusion, is occurring as a result of a combination of increasing demand and severe drought years in 1995-96 and 1998-99.

Resources, such as firewood and useful trees, are also being depleted by over use, minimal regeneration and expansion of housing and infrastructure to meet the pressures of an increasing population. Denudation of the more sparsely populated islets of North Tarawa is accelerating to meet the demands for firewood, bush poles and roofing thatch in South Tarawa.

The major piped water supply system is in poor repair, but even when rehabilitated it will be able to provide only a finite and relatively limited level of service, insufficient for the daily needs of the entire population of South Tarawa. Complementary use of harvested rainwater is presently unable to meet the gap in demand for a number of reasons including: unsuitable roofing (including thatch) on a large proportion of houses, inadequate enforcement of the few regulations concerning the provision of rainwater catchment systems on suitable buildings, and the vagaries of an equatorial climate. Up to 80 per cent of the population relies to some extent on dug wells tapping the shallow fresh water reserve.

Disposal of human and animal excreta is problematic. Defecation along the beach protects the shallow groundwater to some extent, but increases the risk of contamination of shellfish and some fish species as well as direct infection during immersion in the water. The salt water flush sewer system provides limited service, but the effluent is discharged untreated to the reef. Some inappropriate forms of household sanitation are being promoted, including pour flush water seal toilets and septic tanks, both of which increase the risk of contamination of the fresh water reserves.

An outbreak of diarrhoeal disease, eventually confirmed as *cryptosporidiosis*, throughout Betio and South Tarawa in mid-2000 highlighted deficiencies in sanitation and hygiene. At least 1,000 cases were reported, of which about three-quarters were under the age of five years, and there were some deaths. This is a disease spread through the faecal-oral route of infection from domestic animals and symptomless human carriers as well as from those with diarrhoea. The infective cysts of this organism are difficult to destroy by most disinfection methods, and can survive for significant periods in moist soil and in water.

The practice of allowing pigs to range freely around housing and near pointsources of water could represent one infection path and inadequate food hygiene could be another. With wells and piped water collection points often unprotected from external contamination, and insufficient coverage by safe working toilets, further outbreaks are possible. Cleanliness, good food hygiene and the boiling of drinking water could interrupt the cycle of infection and transmission. There is already a reported shortage of firewood, so the boiling of water may well be the first safe practice to be abandoned. All water sources need protection from direct and indirect contamination, and community awareness and health education campaigns are required to increase standards of water and food hygiene, and for moves towards the removal of domestic animals from residential areas (Coffeys, 2000).

Communities on South Tarawa dispose of their household*waste* by burning, dumping it in the house compound, using the collection services, and dumping on the beach, in the sea, and in drains. The Betio Town Council (BTC) and the Teinainano Urban Council (TUC) collect waste from all types of premises, providing the appropriate fees are paid. Charges in the two Councils are generally similar. The TUC charges Government Ministries $A600/year, private businesses $A400/year, stores $A50/year, and civil servants living in Government quarters $A1.85 per fortnight. For BTC, households

pay $A17/ year for a local (thatch etc.) house, $A29/ year annum for permanent (concrete block, fibro etc.) houses. The total annual income of TUC is about $A300,000 per annum of which '*waste*' management service fees account for about 25 per cent.

Approximately one-third of all households on South Tarawa are Housing Corporation (KHC) tenants whose fees are deducted from their wages by their employer, the government. Of the remainder, approximately one third pay fees and one third do not contribute. Probably the major reasons for not paying fees are inability to afford the fees, and lack of Council collection service in some areas, due to poor vehicular access and insufficient collection vehicles. There are few households with rubbish containers. Some households, government houses and private businesses use 44-gallon drums as refuse receptacles. The drums are difficult for the *waste* collectors to handle, and without covers, are open to vermin, dogs, flies and mosquitoes.

Households without rubbish bins leave rubbish at recognised collection spots on the roadside and Council employees use rakes, shovels, their hands and plastic sheets to load it onto the trailers pulled by tractors. The rubbish piles are subject to scavenging by dogs, pigs and chickens. It has been estimated that the councils collect 4500 tonnes of *waste* per year, or 75 per cent of the amount generated. At present there are half a dozen unattended council operated solid *waste* dump sites, most of which are simple open dumps and are typically on the foreshore, with some doubling as land reclamation projects. The dumps are often on fire and refuse is washed into the lagoon, into the sea and onto beaches.

Since a substantial amount of *wastes* are not collected, the villages and beaches are littered with rubbish, which creates health problems and degrades the environment. Wrecked or useless vehicles, oil drums, shipping containers, and other industrial *wastes* are often left where they were last used (MFCP 1999; A-N-D 2000; Jones, 1995; ADB, 1996; GOK, 1993).

Medical *wastes*, needles and syringes are put in small containers or boxes with dressings, clothes, etc., to be burnt on site or buried in the hospital grounds or on other islands. Infectious medical waste is burnt in a 200 litre drum at the hospital and the ashes are taken to a landfill. In 2000 the hospital had two waste incinerators, which were often not functioning (A-N-D, 2000; Burns *et. al*., 2000).

At present there is no proper system to deal with used batteries. It is estimated that Kiribati imports more than 1 million small batteries per annum. In addition there are millions of batteries that have already been used and discarded all over the country. Batteries make up 0.8 per cent by weight of the household waste and can be seen in significant quantities around the landfills. According to the locals, this problem is more prominent in the outer islands where there is no electric power, A-N-D, (2000).

In addition to solid waste the island is also littered with scrap metals such as derelict vehicles, mechanical equipment and World War II relics.

The traditional pit, or modified pit system of cultivation in Kiribati (*Pulaka*) also provides a repository for some green (and solid) *waste*. A form of composting is practiced in this system where rotting coconut trunks, chopped green leaves, *pandanus* and coconut leaves are mixed with soil (Berry, 2000). This tradition may partly explain why the baseline survey conducted in South Tarawa in 2000 (A-N-D, 2000) indicated that 90 per cent of people on South Tarawa are favourably disposed towards the idea of making compost. At the same time, the survey also indicated that 33 per cent of the respondents thought that it is acceptable to dispose of waste into the lagoon, the sea, or coastal areas. Responses to the survey suggested that people had a poor understanding of hazardous *waste*, *waste* as a resource, and the adverse effects of uncontrolled *waste* (especially the economic and environmental effects).

According to community surveys, the perception regarding *waste* on South Tarawa is related to the concept of social conscience and collective responsibility (A-N-D, 2000). *Waste* becomes a problem if a person's home or yard is littered, but if any other place is littered, it is not a problem, and cleaning up after others is not expected (ADB, 1996). The types of waste that are of particular concern are plastics, cans/tins and glass and the social effects of uncontrolled waste disposal (bad odour, bad appearance, etc.), littering and illegal disposal, and specific pollutants such as disposable diapers. On South Tarawa, survey respondents have placed emphasis on legislation and enforcement, and on improving services and facilities, with minimum emphasis on awareness and education.

4.5.2 Goals of the SAPHE Project

The GOK through the Ministry of Finance and Economic Planning (MFEP) described the desired outcomes, or Terms of Reference for SAPHE as follows (MFEP, 1999):

- Improvements to water storage and delivery including, pilot projects to remove hydrogen sulphide from lens water; designing expansion components of infiltration galleries, water retaining structures, reservoirs, pipelines, water treatment plants and metering facilities. Determine sustainable extraction rates of fresh water from lenses at Buota and Bonriki;

- Improvement to reticulated sewerage system: household connections, sewers, sewerage pump stations, ancillary water and sewerage system reticulation structures, design and costing of rehabilitation, extension or reconstruction work on existing sea outfalls;
- Implementation of waste management including design of four fenced solid waste landfills and solid waste facilities and equipment including shredders, composting operations and design, procurement of hospital incinerator and assess the need to make provision at landfill sites for composting and recycling areas;
- Provide technical advice, and liase with the Ministry of Environment and Social Devleopment (MESD) regarding the toilet trials and house water tank trials to be undertaken as part of the Community Development and Participation component of the Project;
- Assist Kiribati Housing Corporation (KHC) in the design and supervision of minor works (sic) associated with the project, including ferro-cement rain tanks, composting toilet and pit latrine construction;
- Review designs for composting and sealed toilets to be constructed by the KHC, including design prepared under the AusAID Kiritimati Island Project and the toilet design used in the FSP pilot and other appropraite toilet designs, and prepare designs of composting and sealed toilets to be used by local self-help groups;
- Development of programs for a public awareness and education campaign through councils, churches, NGOs, MoH, aimed at promoting awareness of the targets and objectives of the project; of the interrelationships between sanitation practices, water quality and health; and of the benefits of improved sanitation and water conservation practices;
- Prepare plans for Councils to promote volume reduction of solid *wastes*, including a public relations program to promote composting of organic waste. Prepare a program for removal of large car bodies, remnants of earthmoving and construction machinery, batteries, other assorted metals for recycling or disposal, after cleaning, in deep ocean water;
- Assess aluminium can recycling initiatives, review economics and prepare reports on desirability and profitability of these initiatives;
- Assess the extent to which wastes are recycled on-site by households and others, prepare recommendations for expanding on-site recycling and on-site protection of human and animal *wastes* to minimise water pollution and health hazards; and
- Review present manual *waste* collection system and low-cost options for improvement. Review overall operations of the Solid Waste management service, its effectiveness and cost-effectiveness etc., and prepare a manual on Solid Waste Management operations including overall operations, *waste* recycling on-site and at the disposal site, and collection and disposal site operations (MFEP, 1999).

4.5.3 Process and Concerns Regarding SAPHE

It is reported that CDPDI activities have been undertaken over the last twelve months by the contractors in co-operation with FSP-Kiribati and KHC, including assessment and design of community sanitation and water facilities, and the next phase begins in early 2002 (*Pers. comm*., Drew, 2002).

However, some of the planned activities of the SAPHE project have been slow to eventuate, and concerns have been raised in consultation with MESD personnel and others about the limited focus of SAPHE, as follows.

The Loan project focuses heavily on the delivery of material amenities and facilities. It lacks emphasis on social planning and community consultation. *People need to be brought to the centre stage of developments*. The town councils require the same attention to build capacity, as the public utilities. To change the existing attitude and practices with respect to sanitation and *waste* disposal, simple, practical and viable alternatives will need to be found. The technology infrastructures that will be created during the life of the project, including the centralised systems, should be environmentally friendly and technologically appropriate (easily managed by local people, A-N-D, 2000).

Improving existing centralised systems will not solve the problem. A large section of the population is not covered by the existing sewerage system. Addressing the needs of 70 per cent of the population is referred to as minor works in the GOK Terms of Reference (Refer Section 4.5.2) and it is feared that these communities will continue to engage in practices that will pollute the environment and threaten public health. Their ongoing practices could also influence the behaviour of others. There has been strong community interest in the workshops for construction of composting toilets. Further CT construction workshops are planned, but there needs to be a mechanism that will assist the wider community to obtain a toilet. There is a danger that the interest to be charged for the proposed revolving fund under the SAPHE Loan Project will be too high to allow those families most in need from applying (Coffeys, 2001).

It was suggested that equal attention should be paid to *waste* disposal facilities for the animals. Pigs are common even in the most urbanised areas of South Tarawa. Pigpens are of a range of ingenious constructions utilising discarded materials of many kinds. Most are close to houses, for ease of disposal of food scraps and for security. *Waste* collects on the sand, and is likely to contaminate the groundwater at times of rain. Where the pens are on the higher

dunes, the depth of dry sand between the surface and the aquifer will provide some filtration, but in other locations the depth to groundwater is likely to be only of the order of 500mm to 1m. With a population of pigs that could be equal to a significant percentage of the human population, and with the humans using the beach for defecation, the pigs must be making a significant contribution to the current levels of faecal contamination of the aquifer and to nutrient concentrations in the groundwater (Coffeys, 2000).

4.5.4 Kiribati Environmental Education Programme (KEEP) and links with SAPHE

The Kiribati Environmental Education Programme (KEEP) which began in 1996, and which is now linked to SAPHE-CDPDI activities, is implemented by FSP-Kiribati in co-operation with the Environment Unit of the Kiribati Ministry of Environment and Social Development (MESD).

The overarching goal of KEEP is to improve the environmental management of the people of South Tarawa. It is intended that the overall goal of KEEP will be realised by the following objectives:

- Increasing public knowledge and understanding about behaviours that are helpful or harmful to the environment.
- Increasing the range and frequency of environmentally friendly behaviours of the general public and specific interest groups, KEEP, (2001).

Part of the programme focuses on solid *waste* management and environmental awareness and education

Solid Waste Management

Since its inception, KEEP has been funded by AusAID, British DFID, NZODA and SPREP and a number of *waste* management activities have been initiated under the program. These include *waste* awareness and education, utilisation of bio-degradables through composting organic material, trialing composting toilets, and the Bikenibeu Pilot Project on Solid Waste Management. The Bikenibeu Pilot Project was commenced in 1999 in partnership with the community of West Bikenibeu, MESD and the town council, and was partly funded by Canada Fund. The objective of the Project was to involve the community in setting up a system for *waste* collection and included the provision of strategically placed bins for *waste* segregation (A-N-D, 2000). There was an improvement in conditions while the project was being funded, but in early 2001 an inventory of bins was conducted and found that 28 were missing, 46 were in poor condition and only 14 were still useable. The stands that supported the bins also went missing or became dilapidated (KEEP, 2002; KEEP, 2001a; KEEP, 2001b). The bins were not replaced by the council.

FSP-Kiribati conducts regular workshops which are attended by the public on *waste* management and recycling, and they produce regular radio programs discussing environmental and *waste* management issues. Homes are also visited to promote reusing of glass bottles, and composting of paper *waste* and organic matter for the garden which has been successful where land is available to establish gardens. There is no local method of recycling plastics available, however there are a number of private sector can recycling services (Refer Section.5.2).

FSP are currently working on a proposal with Voluntary Services Overseas (VSO) to have a volunteer conduct research into the feasibility of a plastic recycling facility in Tarawa. Options to be explored include:

- Recycling of plastics to make simple building materials (similar to those that are used for park benches and retaining walls in Australian National Parks);
- Bailing of suitable plastics to use as infill for sea wall construction;
- Transporting plastics to a recycling depot overseas; and
- The introduction of a deposit scheme on plastic bottles so that they are collected and returned to the shops.

It is reported that limited success had been achieved in mobilising communities to change their solid *waste* management practices in regard to non-organic materials. In general, people expect the government to solve the *rubbish problem.* It is considered that there is limited value in teaching people about recycling, unless bins are available, payment of a modest collection fee is enforced, an effective collection service is provided, and designated *waste* disposal sites are properly maintained (*Pers. comm.*, Jenkins, 2002).

KEEP/SAPHE-CDPDI joint activities

Joint KEEP/SAPHE-CDPDI workshops have been conducted during 2000-2001 in which presentations are made on water conservation, the water cycle and solid *waste* and water management. Inadequate *waste* management is related to the effect of leachates and chemicals on the quality of the ground water, which most people use for drinking. The community is usually more receptive to water related concerns, than to the promotion of changes in *waste* management activities. Also included are presentations from the SAPHE Steering Committee members on the Kiribati Housing loans, (ADB on-loan) regarding the water tank pilot project and composting toilets. The workshops often conclude with a drama performance on a related topic

Gardening and home composting

Gardening and related home composting activities have been well accepted by the community, where sufficient land is available to create gardens. This is one aspect where people are receptive to the idea of waste separation and re-processing, through diverting organic material to composting and mulching. An organic demonstration garden has been established in the FSP office compound as part of KEEP and other activities. The garden is used for seed trials, workshops, school visits and work experience. FSP supplies government departments and communities with seeds and seedlings adapted to Atoll conditions, and sales from seeds provide sufficient income to enable the Seed Centre to be partly financially self-sufficient.

The Pacific Regional Agricultural Program (PRAP) under the Division of Agriculture in South Tarawa is also involved in the research of crops for atoll conditions and training and extension work. Plants from the PRAP nursery are distributed. throughout Tarawa and the outer islands. Vegetable crops were grown in North Tarawa in mulch pits with shade shelters built over them. Families reported that they taught themselves to grow plants and make compost from an FSP publication (*'Mixed Gardening on a Coral Atoll: A Guide for Kiribati'* by Carolyn Peduzzi). They sold their produce at the Bairiki market after transporting it by canoe which involved a two to three hour journey across the lagoon (*Pers. comm*., Kamauti, 1999; *Pers. obs.*, Berry, 1999). There was a South Tarawa vegetable growers cooperative with 20 members, however it was reported that they don't eat the vegetables themselves but keep them for sale (*Pers. comm*., Natake, 1999).

These activities indicate that there is potential for sustained practice of separation and reprocessing of green waste in Tarawa, which may provide a foundation for more extensive recycling of other materials.

4.6 Community Focus for Water and Sanitation in Papua New Guinea

This section provides a brief summary of a large-scale program that commenced in 2002. It is of interest to IWP as it has been developed out of the experience of many previous programs, which failed to meet their objectives. The design of the program provides relevant information on lessons learnt and strategies that may address past shortcomings. Low-cost technology and a community focus are being promoted and this indicates a significant shift toward a more integrated approach to resource management and pollution control, within a substantial multi-sector infrastructure program. This is a validation of the IWP emphasis on community mobilisation, and the development of the program in PNG could be a useful reference point for similar large-scale schemes in the Region.

The Asian Development Bank (ADB) is a major funding agency in the water supply and sanitation sector in PNG with various investment and Technical Assistance projects implemented in the last 15 years. As a result, some important lessons have been learned with respect to both sustainable sector development in general, and timely project implementation in particular. Lessons relating to sector-wide development, point to the following constraints:

(i) Inadequate sector coordination, funding, and medium-and long-term planning;

(ii) Inadequate capacities of main sector agencies, especially the Waterboard;

(iii) Insufficient funding for the operation and maintenance of water supply and sanitation systems;

(iv) Insufficient attention to low-cost options for both water supply and sanitation for the poor;

(v) Ineffective implementation of the overall sector regulatory functions of the Waterboard; and

(vi) Limited implementation of community-based programs, and awareness and health education activities.

Most centralised water supply and sewerage systems in PNG have suffered from operation and management deficiencies, lack of planned upgrading, and failure to replace obsolete equipment. Another cause of project implementation delays and cost overruns relates to land ownership, land-lease disputes, and compensation. Based on ADB and Waterboard experience, land acquired and leased, particularly from customary landowners, may become a compensation issue with each new generation every 15 to 20 years. One solution is to minimize customary land involvement whenever possible. Where this is not possible, land could be accessed through joint ventures or other convenient arrangements with the traditional landowners (ADB, 2000).

Similarly, rural water supply facilities often break down only a few months after installation. They continue to be in a state of disrepair due to the absence of repair and maintenance programs in the beneficiary communities and relevant Government agencies. This was one of the lessons learned from the European Union funded rural water supply programs. In 1996, an ADB-funded Water Supply and Sanitation Sector Study recommended a community-based approach that could lead to sustainable water supply and sanitation projects. The approach enhances participation through community awareness and health/hygiene education. Unfortunately, subsequent sector projects have not followed the recommendation.

The low sanitation coverage for both urban and rural areas in PNG is a major sector issue that needs to be resolved. Promoting sanitation and hygiene education is difficult due to the limited staff and financial resources of most rural local governments, the long distances to the villages, and the highly varied conditions in PNG. In the urban areas, the high cost of reticulated systems due to low population densities and rugged terrain makes it difficult to expand

coverage for these systems. Services also suffer from inadequate maintenance. It was concluded that on-site sanitation using low-cost technologies may be the only viable and affordable solution for many urban areas, especially for the low-income households in the urban fringe areas and settlements.

In the light of these experiences, the ADB prepared a feasibility study for a project called the Provincial Towns Water Supply and Sanitation Project (PPTA) to provide adequate water supplies and sanitation arrangements in provincial towns, and improve governance in the water supply sector as well as strengthening capacities of the Waterboard. The Project is estimated to cost $US23.3 million equivalent of which $US13.2 million is the foreign currency cost and $US10.1 million equivalent is the local currency cost. The ADB loan will amount to Special Drawing Rights 11,985,000 ($US15,300,000 equivalent) from the Asian Development Fund (ADF) with a term of 32 years, including an 8-year grace period, with an interest charge of 1 percent per annum during the grace period and 1.5 percent per annum thereafter (ADB, 2000).

4.6.1 Background Conditions

Papua New Guinea's total population in 1996 was estimated at 4.5 million, most of whom live a subsistence lifestyle in the rural areas without access to basic services such as potable water, adequate sanitation, and electricity. PNG also has a wide linguistic and cultural diversity. A semi-subsistence sector provides livelihood for 85 per cent of the population. Low life expectancy, high infant mortality rate, poor adult literacy, combines with low per capita income to make PNG's human development level the lowest in ADB's Pacific developing member countries (PDMCs). Health indicators show a high incidence of waterborne intestinal diseases, particularly diarrhoea and typhoid, which are directly attributable to unsafe drinking water supplies and poor sanitation conditions.

About 16 per cent of PNG's urban population is categorised as poor. They are squatters in informal settlements, the unemployed and under-employed, and low-income groups burdened by large households. The urban poor are most vulnerable because they have fewer resources with which to change their circumstances. The time consumed in searching for water diverts the poor from other productive tasks. Searching for alternative sources of water during the dry season has a high negative impact on their already low productivity.

PNG towns are typically small, consisting of 500 to 1,000 households, with the urban population as a whole not growing rapidly. Port Moresby and Lae are exceptions, with populations in excess of 100,000. Some urban centers have water supplies and only a few have adequate sanitation services. The small size of the towns and low urban population density combined with the low average *per capita* income of the urban residents limit the scope for providing and sustaining reticulated water supply and sanitation services on a cost recovery basis.

Sanitation, a culturally sensitive issue in the country, is less developed than water supply. The Waterboard, Eda Ranu, operates sewerage systems in Alotau, Kimbe, Kundiawa, Lae, Mt. Hagen, Popondetta, and Rabaul, collecting sewage through a reticulation system. Levels of treatment vary, and operation and maintenance problems are frequently encountered with the treatment plants. Eda Ranu provides the only other reticulated sewerage system. The town councils in Madang and Wewak operate a pan collection system, where household toilet waste is collected twice weekly and discarded in waterways, some with basic treatment. Pan systems pose significant health hazards and are not well regarded by the town councils and household members. Urban households not connected to a sewerage system, especially in small towns, commonly use septic tanks, pit latrines and waterways, and the surrounding bushland continues to be used in many cases. Rural householders generally defecate in the bush. Sanitation coverage in 1996 was estimated at 20 per cent of the total urban population. There were no estimates of rural coverage.

Although the National Water Supply and Sewerage (NWSS) Act established the Waterboard in 1986 with broad powers to regulate all water supply and sanitation systems, the sector remains highly fragmented. The Office of Conservation and Environment (OCE) is responsible for administering the Environmental and Contaminants Act. The Department of Planning and Monitoring (DPM) is responsible for planning development, formulating the national budget, and sector policy issues including water and sanitation. Prior to the enactment of the Organic Law in 1996, the Department of Health (DOH) through its provincial offices carried out programs promoting health and sanitation in the rural areas, including providing water supplies at the village level. Since 1996, the direct responsibilities of DOH have been devolved to the provincial governments.

4.6.2 Goals of the PPTA

The *Provincial Towns Water Supply and Sanitation Project* (PPTA) will provide piped water supplies, sewerage and sewage treatment (new or upgrading of existing systems and expanding coverage) to six selected provincial towns, capacity building for the PNG Waterboard, and support for selected sector policy measures.

Of particular relevance to this review is the inclusion of an on-site sanitation component designed with the intention of collaborating with communities and local-level government institutions at all phases of project planning and implementation. The Low-Cost Sanitation-Community Awareness and Health Education (LCS-CAHE) component of the project will be implemented to provide affordable options for on-site sanitation, and a community awareness and health education program for low-income households.

The LCS-CAHE program is funded by the JFPR (Japanese Fund for Poverty Reduction) in a grant of $US1.74 million, and is linked to the main project (PPTA). The LCS-CAHE program is not targeted for cost recovery, and the LCS-CAHE program will be operated and maintained by the urban authorities of the selected provincial towns

The LCS-CAHE program will include two major activities;

(i) Low-cost sanitation (LCS) to provide low-income groups and the urban poor with easy access to low-cost basic sanitation facilities such as VIP, pour flush and composting toilets and;

(ii) Community awareness and health education (CAHE) to build awareness and improve health education for the communities. The CAHE program activities will be implemented in selected urban and peri-urban settlements where unhealthy *'waste'* disposal systems (e.g., bucket system and simple pit latrines) exist and where a reticulated sewerage system would be too expensive. Implementation of the LCS program activities will start in selected settlements in Lae and Madang where 2,400 ventilated improved pit latrines (VIPLs) will be installed. During the second phase of implementation, an additional 1,800 VIPLs will be installed in selected urban and peri-urban settlements in Alotau, Mt. Hagen, and Wewak.

The LCS sub-program will build on interventions that are part of the CAHE sub-program. Household surveys in the targeted project communities, and field investigations, have confirmed a very low level of understanding of water and sanitation-related issues, particularly the linkages between water, sanitation, personal hygiene, and good health. The health awareness campaigns under the CAHE sub-program will educate people in appropriate toilet use and maintenance, and provide information on the health and sanitation linkages. As women are primarily responsible for maintaining household sanitation conditions, a special project focus will be on existing women's groups and the formation of new groups to help achieve positive behavioural changes in sanitation practices (ADB, 2000; ADB, 2001a).

During project preparation, a needs analysis was conducted in the field and it was found that about 8,620 poor households in the urban settlements of the provincial project towns needed improved sanitation. The program will construct low-cost sanitation facilities for the most needy 4,200 households (36,000 people), about half of the total potential demand. It will provide funds for construction costs, and the households will share through in-kind contributions such as materials and labour. The LCS will be implemented over three years with an initial 18 months pilot-testing period in poor urban communities in Lae and Madang. During this *learn-as-you-go* phase, workable, socially sensitive, and cost-effective approaches to LCS-CAHE interventions will be developed, providing a model for building a community sense of ownership and involvement. The situation will be replicated more extensively in all provincial towns during the remaining 18 months of the implementation period. The total duration of the project will be 36 months, with start-up expected in April 2002 and completion in April 2004 (ADB, 2000; *Pers. comm*., Ponzi, 2002).

4.7 Community Management of Public Waste Facilities in the Congo

The program described here has been included in this review as it demonstrates the potential for waste minimisation and pollution control on public land through enterprising community management of public facilities and services.

In the Democratic Republic of Congo (DOC), in Africa, a USAID funded project is using creative methods to address water sanitation and solid waste challenges, including alternative delivery mechanisms such as public-private partnerships (PPPs) and community partnerships. Through these partnership arrangements, the USAID/DCR strategy aims to maximise income-generating potential and to decentralise power to the community and household levels. The construction of infrastructure such as cisterns, taps and latrines in the targeted areas increased access to potable drinking water and clean sanitation facilities. However, increasing access is necessarily complemented by emphasising community participation through capacity building, and behaviour change through hygiene education. Through these strategies the projects have maximised the potential for achieving sustainability and creating consumer demand, which are two key determinants in successful sanitation and *waste* management programs.

4.7.1 Background Conditions

Some urban areas in the Democratic Republic of Congo (DRC) are in crisis due to rapid growth, chaotic settlement, and poor management of public affairs. These conditions have led to serious degradation of the urban environment, decaying infrastructure, and deterioration of public health. Rapid population growth in urban areas has made it necessary for some Congolese communities to inhabit poorly drained wetlands, which are prone to flooding. Garbage and household waste accumulates among the dwellings. There is no regular service available for *waste* removal or to transport garbage to the few dump sites that exist. In communes or neighbourhoods where there are no latrines, open canals and open spaces are used for excretion. *Waste* water canals overflow with sludge and human excrement from household and public latrines which have not been emptied, and the *waste* drains into markets, streets, and roadsides. In response to these conditions, USAID/DRC Urban Environmental Health Program, with support from the Regional Urban Development Office (RUDO) in Pretoria, South Africa, and the Environmental Health Project (EHP) in Washington developed an Urban Environmental Health Strategy in June 2000. USAID/DRC then committed funds to support the implementation of three urban environmental health pilot projects aimed at preventing infectious diseases.

4.7.2 Goals, Process and Outcomes of the Pilot Projects

Two of the pilot projects focused on increased sanitation facility use, improved hygiene practice, improved *waste* water management and drainage, and enhanced community capacity to identify and satisfy their own needs for improved sanitation and solid *waste* management.

Environmental Health Pilot Project in Barumbu, Kinshasa

The goal of this project was to reduce the incidence of diarrhoeal diseases in the targeted area by working with the community to eliminate the various vectors found in the environment. The program was designed to identify and test creative solutions and alternative techniques to address environmental health problems in the project area.

The Barumbu *waste* management project created four income generating activities:

- A solid *waste* collection system using push cars or 'chariots'. The chariots are 10-12 feet long with a flat base and metal pipes (where available) for support. They are fitted with two truck tires and are pushed (or pulled) by one person or by a number of people if the load is very heavy;
- One composting centre providing high quality compost to the surrounding market garden;
- Four pit latrines built in Epolo Market where users pay 20 Congolese Francs (the equivalent of a few American cents) to receive access to a latrine and soap and water to wash one's hands; and
- MAPET (Manual Pit Latrine Emptying Technology) services for human *waste* treatment.

With the mobilisation of nine solid *waste* collection chariots, the International Rescue Committee (IRC) has been able to secure over 130 paying customers in the district, and has reduced the amount of domestic solid*waste* which clogs drainage canals and increases flooding. They are also using the solid '*waste*' to produce compost, although the development of a viable market outlet remains to be established. It is reported that project benefits appear sustainable as evidenced by the impressive receipts collected to date and the management organisation that is in place. As the community is middle class in economic status, payment for services is progressing well, and affordability for latrine and solid *waste* collection does not appear to be an impediment. The project was completed in December, 2001 (*Pers. comm*., Kutuka, 2002; *Pers. comm*., McGahey, 2002; McGahey, 2001; Roark, 2001).

Water and Sanitation in the Public Markets of Kinshasa

The goal of this project was to reduce public health hazards by improving sanitary conditions and hygiene behaviour change in seven of the larger markets in Kinshasa (Gambela, Matete, Selembai, Bayaka, Ngaba, Bandal, and Lufungula). These markets were different from Epolo Market in that they are significantly larger, and the city authorities are more closely involved in decision-making regarding their use.

Key components of the project implemented by Action Against Hunger - USA (ACF) included;

- Water/Sanitation Committee (WSC) management capacity building;
- Baseline studies to establish data and measure impacts;
- Construction of public latrines in the seven selected public market of Kinshasa, and construction of water distribution points at the sanitation units, and promotion of hygiene behaviour changes.

The project achieved the following:

- Nine new latrine units have been constructed in seven selected public markets of Kinshasa. The latrines are ventilated pit latrines (VIPs);
- Eighteen water tanks have been built in the sanitation units;
- Eleven drinking water points have been built and eight are equipped with a drinking water reservoir tanks. Some of the market latrines were also equipped with showers at the request of the market community;
- The market drainage system has been improved; and
- Seven local committees have been trained in the management of the sanitation and water facilities.

One of the latrine units opened by Action Against Hunger (ACF) is attracting an average of 1,200 paying customers per day to a hygienic facility that is also serving as an educational platform for widespread hygiene improvement. As in the Epolo market within the IRC project, users pay 20 Congolese Francs and receive toilet paper, and soap to wash their hands. It is reported that latrine users are enthusiastic about its cleanliness and seem willing to pay for the service, despite being very sceptical about the program at the outset. The management group is earning a profit and appears well on its way to sustaining the operation as a micro-enterprise.

The pilot project was completed in August, 2001. The pilot is of particular interest because of the improvement of sanitary conditions and hygiene behaviour in the markets, especially the provision of acceptable public toilets, private sector contribution to construction and management of latrines, and the involvement of vendors, restraunt owners, customers, and market managers in the enterprise.

Lessons learned during the pilot projects

Hygiene behaviour change

- Training and equipping of community animators (*sensibiliseurs*) is crucial to the accomplishment of hygiene behaviour change;
- Comprehensive baseline surveys focused on targeted behaviours are important for planning Information/ Education/Consultation programs and training, as well as for documenting health and environmental impacts;
- All community members can be mobilised as educators, not just community animators; and
- Multiple means of communication should be used in implementing behaviour change activities

Strengthening of local partners

- Sufficient time must be set aside at the beginning of implementation to understand and train local implementation partners including government and community-based organisations;
- All local partners should be brought together under an umbrella organisation rather than conducting all activities with a single local partner; and
- Comprehensive market sanitation projects should be understood and implemented following the same steps as comprehensive community development projects.

Sustainability of interventions

- One year is too short a time period to accomplish both interventions and their long-term sustainability;
- Income can be generated by community-based *waste* management;
- In income generating projects related to infrastructure management, a targeted amount of funds should be set aside to cover recurrent capital costs; and
- In income generating projects in Congo, strong efforts should be made to ensure that collected fees retain their value over time.

Program design

- Proposals must be written based upon a thorough understanding of the situation in the field.
- A formal start-up workshop bringing together all stakeholders is beneficial in project implementation (McGahey, 2001; Roark, 2001; *Pers. comm*., Kutuka, 2002; *Pers. comm*., McGahey, 2002; Source Water and Sanitation Weekly, 2002).

4.8 Niue Water Supply and *Waste* Management Project

In 1997 a Water Supply and Waste Management (NWSWMP) project began in Niue.

Niue is the largest and highest coral atoll in the world with a land area of 259 sq km. Between 1992-1997 there was a decrease in the population on Niue from 2543 (1992) to 2100 (1997), and in 2000, the population was estimated at 1,900. Water supply is available to each household, either from the main supply or from individual rainwater tanks. However Niueans have become almost entirely dependent on the groundwater lenses for their water supply, the main water system being supplied by pumping water from the lenses in the eastern side of the island and then gravity feeding it to the western side (Nomachi, 1993). Water was considered fit for human consumption in 1991 based on testing conducted by the Department of Health, although elevated levels of coliforms were detected in some boreholes throughout the island (UNCED, 1991). The 1991 UNCED report also highlighted concerns related to lens contamination from a weedicide commonly used on Niue and other common agricultural products. The report also noted the high background radiation levels detected in fresh groundwater (UNCED, 1991).

Water quality is now being threatened however by:

- An inefficient sewerage system;
- Proximity of livestock farms to bores;
- Use of fertiliser and other agricultural chemicals;
- Deforestation and the loss of soil cover; and
- Inefficient solid waste disposal system, UNCHS Habitat, (1998).

Each of the 12 villages on Niue have their own dump sites and manage their own rubbish disposal, except for Alofi which has a daily collection of solid waste which is then dumped near the airport. There has been no effective means of disposing of hospital *waste*. The practice has been to burn it in areas beside the hospitals. Similar problems exist in disposing of large industrial *waste* such as refrigerators and old motor vehicles.

There is no centralised sewerage system on the island. All households and commercial establishments use concrete septic tanks or water-sealed latrines for sanitation although there are also some pit toilets still used. It is the intention to convert gradually to septic tanks. *Gastroenteritis* still ranks among the ten leading causes of morbidity, and the incidence of both acute and chronic respiratory diseases is very high. Vector borne diseases have occurred on Niue with devastating results (Jackson, 2000; UNCHS: Habitat, 1998).

4.8.1 Goals of the NWSWMP

Funded by AusAID from 1997 to1999, the aim of the Niue Water Supply and Waste Management Project was to build effective partnerships, promote effective governance, provide essential infrastructure, and maximise environmental sustainability. The amount committed to the project was $A715,000. In a practical sense, the objectives were to upgrade water supply and waste management operations, to assist in informing the Niue communities about the potential dangers associated with poor household sanitation, excessive water consumption, and waste production, and to provide project management to ensure project outcomes.

4.8.2 Process and Outcomes

The main activities conducted during the project were:

- Lens model development and calibration;
- Upgrading of water supply system (reduction of losses *via* leak detection, and improvements to village water supply systems);
- Improved consumer knowledge of their water supply; and
- Improved consumer knowledge of waste management.

Some of the objectives for the water supply component of the project were fulfilled and a program of community information activities was commenced. However, the demand management, waste minimisation and improved household sanitation programs were terminated early because of a breakdown in communications between the Australian Managing Contractor (AMC), the Pacific Technical Assistance Facility (PACTAF) adviser and the Niue counterparts. Although *waste* stream characteristics were assessed and a *waste* management strategy plan was developed for Niue, surveys to quantify the proportions of various *waste* types were not carried out. Recommendations for restructuring of *waste* management responsibilities were rejected by the government of Niue. This also contributed to the decision to terminate the project.

Phase One: Lessons learned

The following lessons were learned from the first phase of the NWSWMP:

- Project designs should not include funding patterns that result in inadequate technical assistance. The feasibility assessment of projects needs to assess the amount of technical assistance required and whether the time allocated is sufficient both in terms of total amount and frequency of visits.
- Counterpart agency commitment to the project should be considered in areas additional to funding. If a project is likely to involve significant institutional change some consideration should be given to the commitment of counterpart agencies to make the necessary changes.
- Non-counterpart agency commitment to the project may be important if they have a specific function in government which may impact on project implementation. In the case of the Niue project, the Department of Lands had the responsibility for survey but required payment. No allowance had been made by the project to pay for the Niue government to undertake project work, so the surveys were not completed (AusAID, 1999).

Phase Two: Waste Management Plan (WMP)

Since the Waste Management component of the NWSWMP was not completed, AusAID decided to appoint a *waste* management adviser for 12 months to complete the *'waste'* management project and formulate a Waste Management Plan (WMP) for Niue under the PACTAF program. The position commenced in May 2000. The Plan was overseen by a Waste Management Working Group on a voluntary basis.

The Waste Management Plan was developed following community input and consultation. A *waste* stream analysis provided baseline data of the volume and characteristics of the *waste* produced by the community. The action plan recommended by the Waste Management Adviser included the following:

- Clean-up of Tafalalo Waste Tip including covering and sealing of exposed '*waste*' and the creation of a small face for controlling dumping;
- Village dumps clean-up including cover and sealing of exposed *waste* and the creation of a small area for controlled dumping;
- A Waste Management Planning Process to provide for community consultation and involvement in the development of a Waste Management Plan;
- Waste management education and promotion of the strategies contained in the WMP;
- Vehicle wrecks and appliance clean-up to reduce vermin harbourage and potential environmental degradation;
- Supply of *waste* containers of appropriate size to all occupied premises on Niue and to supply mechanical wheeli-bin lifting arms to the *waste* collection truck;
- Supply recycling crates to all Niue households for kerbside collection of recyclables;
- *Waste* oil collection facility to protect water lens from contamination;
- Septic *waste* facility such as simple impervious drying beds and an effluent collection system such as small impervious lagoons where anaerobic decomposition of suspended matter and evaporation would take place. Dried sludge could be used for composting;
- Provision of secure containers to store disused chemicals until disposal is provided;
- Supply of a HACH water treatment laboratory; and
- Funding for miscellaneous community*waste* management proposals such as: vermiculture to deal with organic *waste* disposal; development of cottage paper product manufacturing (cards etc.) from recycled paper; green waste shredding and composting trials, and a small pilot recycling sorting and bailing plant (AusAID, 2001).

Other suggestions made by the Waste Management Adviser:

- The collection and packing of plastic, tin and cardboard and shipping to NZ recycling companies;
- Bacteriological, chemical, pesticide testing undertaken on a regular basis to protect health and build a historical database; and
- The establishment of an Environment Unit, Wolfe, (2001).

Outcomes from the WMP

AusAID provided $NZ44,000 to fund four activities from the Waste Management Plan:

- Clean-up of outlying village tip sites ($NZ13,200);
- Waste Management Education and Awareness ($NZ18,600);
- Clean-up of main tip at Alofi ($NZ10,980); and
- Planning and office administration ($NZ2000) (Foreign Affairs and Trade 2001).

Recent reports confirm that Waste Management workshops have been conducted to bring together government departments, village representatives and other stakeholders, to exchange concerns about waste management. AusAID has also funded a septic tank construction project and legislation has been enacted requiring replacement of defective septic tanks. All new dwellings are now required to install approved septic tanks. A variety of public awareness campaigns and Waste Management promotions have been undertaken including Tidy Village competitions, and participatory waste management education in schools. *Waste* containers have also been supplied to all premises and the clean-up of Tafalalo Waste Dump has been completed (*Pers. comm*., Sanson, 2002; *Pers. comm*., Sharp, 2002).

5. Partnerships

5.1 Introduction

This section will further examine the interdependent relationships that can enable communities to take responsibility for minimising*waste*, recovering resources and reducing pollution. These relationships involve partnerships with government and the private sector, and non-government organisations. In Sections Three and Four, some of the programs discussed included ventures where these partnerships were operating. This Section will focus on resource recovery in the private sector in PICs and elsewhere, and suggests support that can be offered by PIC governments to facilitate local operations.

In order to accomplish waste reduction and pollution control objectives, it is productive to encourage the creation of joint ventures and other types of relationships between businesses and community-based organisations. Local governments need little or no additional authority to develop creative strategies for dealing with waste. Rather

than trying to persuade communities to act, the challenge is to offer more attractive alternatives to conventional approaches such as landfilling, incineration, or relinquishing control of a potential resource. By building alliances, resources can be shared, communities can be empowered and employed, money can be saved and people and systems can compliment each other to reach a common goal.

5.2 Recycling Initiatives

Communities can participate in *waste* separation schemes, but there is a need for partnership with agencies that can reprocess materials which cannot be re-used or recycled within the community. There are a number of relatively successful recycling operations in PICs, which will be briefly described in this Section. These ventures are managing to function even though they often operate in a less than supportive regulatory and legislative environment. This indicates that it is possible to implement even more effective *'waste'* reduction strategies under an encouraging stewardship. Supportive measures that can be undertaken by governments are discussed in Section 5.7.

Fiji

An active program has been in place in Fiji for recycling paper, metal and plastics (UNEP, 1999) and some of these commercial operations are described below.

In 2002 approximately 70 per cent of Coca Cola's soft drinks (the largest manufacturers of soft drinks in the Region) were marketed using recyclable PET bottles. There are other companies in Fiji which use PET bottles for beverages and other products such as fats and oils, natural waters, honey, sweeteners, juices, salad dressings, and household cleaners.

Of the companies using PET bottles in Fiji to market their products, Coca Cola is the only company which has put in place a program to recycle their bottles. *Mission Pacific* is the PET recycling project initiated by Coca Cola. The company was paying collectors 68 cents per kilogram of PET bottles (or two cents per 500ml bottle and four cents for two litre bottle) in addition to providing free collection bags and transport. To make up one kilo, it is necessary to collect about 33 small bottles or 18, 2-litre bottles. One bag full of bottles is about 40 kilograms and that was worth $30. A family of four regular collectors could make about $200 per week. The bottles are crushed, baled and shipped to the Coca Cola PET Reformation Plant, in Preston, Sydney. It is claimed that the recovery rate of used bottles is much higher than the 18 per cent average for other countries (A-N-D, 2000; SPREP SKM-Fiji, 2000). However, it was also argued that this scheme could be improved.

The return system for PET bottles appears to be working as it has been reported that low income families do collect them and there has been a noticeable decline in plastic bottles littering the landscape (*Pers. comm.*, Drysdale, 2002). However, the Chief Executive of the Fiji Visitors Bureau noted that after stormy weather one can see a 'carpet of coke bottles and grass' floating off the coast to Suva (the stormy weather dislodges plankton, which gets enmeshed with floating coke bottles) (A-N-D, 2000).

A beer bottle refund recycling scheme operates successfully at Carlton Brewery in Suva. Beer bottles are used six to ten times, and the brewery has negotiated with Australia to take broken coloured glass via *waste* Recyclers Fiji (SPREP SKM-Fiji, 2000).

A number of other recycling businesses operate in Fiji including Waste Recyclers (Fiji) Ltd., Scrap Metal (Fiji) Ltd., IA Traders (scrap metal) and Waste Care Fiji. Items recycled include paper, cardboard, ferrous and non-ferrous metals, plastic, copper, brass, aluminium, lead, radiators, batteries, cooling systems, cars, transformers, cables and wires, aluminium cans, air conditioners, hot water systems and stainless steel.

In 2000, Waste Recyclers (Fiji) Ltd. paid 30 cents to $2.00 per kilogram of metal. The Company also collects Coca Cola crates and beer crates and sends them overseas for recycling. In 2000, Scrap Metal (Fiji) Ltd paid $1.80 per kilogram for copper, $1.00 per kilogram for brass, $2.00 per kilogram for aluminium and from 40 cents to $2 per battery depending upon size. It was reported in 2000 that Waste Recyclers (Fiji) annual income was approximately $550,000 (A-N-D, 2000; SPREP SKM-Fiji, 2000).

Kiribati

Despite the impost on exported items, including crushed cans, in Kiribati, there are two private can recycling businesses operating in South Tarawa, although it is reported that they are having little impact on reducing cans littering the environment (*Pers. comm.*, Jenkins, 2002; *Pers. comm.*, Drew, 2002). There appears to be not enough incentive for children to recover the cans for recycling. One of the businesses (Moel Trading Company) was not functioning for a period in 2001 due to operational difficulties and broken machinery (*Pers. comm.*, Drew, 2002) but is now back in operation (*Pers. comm.*, Jenkins, 2002).

According to the latest figures available (2000), both of the can recycling businesses were offering $A0.35/ kilogram for aluminium cans. Although can recycling is a sideline to the main businesses, in 2000 both enterprises were able to collect enough cans for crushing and export to make a reasonable profit. Cans are shipped to Sims Metal in

Brisbane or to any buyer who offers the best price. International Recyclers in Australia acts as a middleman in the aluminium can transactions.

Mary's Enterprises at Bairiki uses a hand operated hydraulic press (*Pers. obs.*, Berry, 1999) where cans are compressed into small pellets. The Ministry of Environment was providing wire-mesh baskets in 2000, which were used to collect empty cans. The baskets are placed at strategic points: outside shops, supermarkets, eating places, schools, and around public offices. In 2000, Mary's Enterprises had five baskets in Betio, six in Bairiki and three in Bikenibeu. Once a week or whenever the baskets are full, the cans are emptied into a truck and brought to the crush yard. The pellets are then stacked into containers and shipped to Australia. One hundred and twenty five cans weigh about 3 kilos when crushed. A container of crushed cans is about ten tonnes. In 2000, a tonne of crushed cans returned between $1000 to $1300 free on board (FOB). Freight, handling, and port charges came to approximately $800 per container. Considering the export rate of one container every six months and expenses involved (cost of cans, truck, labour, repayment for crusher, etc), aluminium can recycling is a profitable business. However, Mary's Enterprises mostly uses family labour and spare time to run the operations (A-N-D, 2000; SPREP SKM-Kiribati, 2000; *Pers. obs.*, Berry, 1999).

Moel Trading Company at Betio has a diversified business related to ferrous metal recycling, footwear, video library, computers, and landscaping. It also successfully exports aluminium cans to Australia. The can and ferrous metals export recycling business is called Cancare. Metals collected and exported include brass, copper and lead.

Tarawa Cancare exports about two to three containers of crushed cans per year. The business has a motorised hydraulic press arrangement and large wire netting cages for the cans. In 2000, the estimated profit of the can recycling business was about $10,000 to $11,000 per container load. The major capital cost is the cost of a crusher which was valued at approximately $40,000 (A-N-D, 2000; *Pers. comm*., Drew, 2002).

Tonga

Royal Beer brewery recycles beer bottles and pays 10 cents per bottle returned to the factory or to any of its agent's outlets. As a result there are very few beer bottles seen lying around and they are perceived to be a valuable commodity (SPREP SKM-Tonga, 2000; *Pers. comm*., Vi, 2002).

Aluminium cans are being collected at the dump site by scavengers who sell them to a small recycling business run by a local business person in Sopu who was paying approximately $T5/1000 cans or $T6/1.5m^3 of cans in 2000. About 12 x 1.5m^3 bags of cans are collected per month. Some other metal items are collected in small quantities for recycling. For example copper is collected and recycled at Atenisi University, where T20cents /kilogram is paid for scrap copper.

Some NGOs and village committees are collecting cans and using the funds for charity or village beautification. Since the TEMPP project there is more awareness for the need for recycling operations for a range of materials in the '*waste* stream. While there are still very few recycling initiatives in Tonga, there is community pressure on Coca-Cola to provide recycling of PET bottles (*Pers. comm*., Vi, 2002) and interest in other '*waste*' reduction strategies. See Section 4.4.3 and Section 5.6.1.

Vanuatu

There is a beer bottle recycling scheme at the Vanuatu Brewery which operates successfully because they pay 10 *vatu* refund for each bottle returned, which is sufficient incentive. About 92-94 per cent of bottles are returned.

Scrap metal recycling is carried out by a local business for most non-ferrous metals including copper, aluminium, brass, zinc, lead and stainless steel. The business is a 'backyard' operation, under the registered name of Vanuatu Recyclers. Metals are collected by school children from hotels and landfill, and are then crushed or stripped and packed into a container for shipping to Tools and Ingots in Brisbane. About two containers or 32 tonnes of metal is shipped per year. Concern was expressed by the business owner that many hotels do not take part in the segregation and collection of cans. There is no ferrous metals collection at present in Vanuatu.

Waste oil recycling is available through Mobil who ships the oil to Fiji for burning in furnaces. However at present this is only carried out in a partnership arrangement with Unelco's waste oil operation (SPREP SKM-Vanuatu 2000).

Papua New Guinea

In Papua New Guinea there are about eight companies involved in the recycling of scrap metal such as aluminium cans, copper, brass, other aluminium, lead, stainless steel, hot water systems, batteries, radiators and all other non-ferrous scrap metals. From the presence of people scavenging at the landfill, it is obvious that a majority of the locals are aware of the values of these materials. It was suggested (in 2000) that a regional directory for companies involved in recycling should be developed. This would be a useful way of making the public aware of the recycling opportunities in their country.

The National Capital District Commission initiated a campaign in 1999, for the collection of plastics at a rate of 20t (cents) per bag. This campaign appears to have been successful, however, the common practice of trench disposal is not environmentally acceptable. It was recommended that the relevant authority should investigate the possibility of sending the collected plastic to Australia or New Zealand for recycling. Coca-Cola Amatil Ltd (Papua New Guinea) indicated that a PET bottle recycling company was to commence operation in PNG in December 1999. The representatives of the company also expressed intentions to provide monetary incentives for the return of PET bottles as practiced in Fiji (SPREP SKM-NG 2000). A recent update on this was not available.

Niue

Niue has a well organized system of aluminum can recycling (UNEP 1999). In Alofi, next to the Catholic church, the Mokeni family (Aluminium Can Collectors) collects and crushes cans for shipping to recycling factories overseas. Five cents is paid for each empty can. It was reported that:

> ... the Can Man is still in operation at five cents per empty can. The Catholic Church here is still the main operator, however, the program is on a temporary break with the death of the collector just recently. It is a successful venture and has kept our roads very clean and good for our health too, depriving those mosquitoes of breeding places! (*Pers. comm*., Morris-Tafatu, 2002).

Cook Islands

Approximately five million aluminium cans are imported into Rarotonga each year. A retired Catholic priest, Father Glover, who has worked in the Pacific Islands for many years, formed the Catholic Church Committee for the Environment (CCCE) after retiring on Rarotonga. Father Glover ran a successful aluminium can and glass recycling project on Niue before coming to Raratonga, which is still operating (see Niue above). The CCCE bought the island's only aluminium can recycling business.

As part of the business, the CCCE bought the 40 can collection bins that were installed around the island. Father Glover then sold his car to buy a small truck and in a short time had increased the number of bins to 140. The committee's next purchase was a can crushing machine bought with a grant from SPREP and AusAID.

Father Glover and his local workers, known as the *Can Crushers* are reported to be a familiar sight as they drive around Rarotonga in their little yellow truck. Stopping at hotels, cafes, local stores and sporting clubs, they fill the wire cage with cans, glass and PET bottles. They sell all glass bottles and a few PET bottles to a local soft drink factory where the workers wash and refill them with local fruit drinks. The final stop is the depot where the aluminium cans are crushed and stacked ready to ship to New Zealand where they are recycled into new cans.

The *Can Crushers* divide the profit from their sales amongst schools who take part in the program. Any school which has a recycling bin and whose students bring in cans, *can share in the success of all who work for a cleaner environment*.

An integrated Waste Management Project has recently been funded by ADB in Rarotonga and Aitutaki island. The project includes the institutionalisation of recycling programs to reduce the quantity of '*waste*' and the supply of operating equipment for recycling 'waste' material at each of the two new 'waste' management facilities (ADB 2001b). NZODA is also funding a recycling Centre in Rarotonga for the recycling of 'waste' in the Cook Islands. Glass, aluminium and paper are the initial identified products for recycling, NZODA, (2000).

Samoa

In 2000, there were four companies involved in the recycling of glass bottles, aluminium cans, and other metals. The operations are Vailima Brewery, Tropical Island Company Ltd., Samoa Recycling and Waste Management and West End Company Limited.

In 2000, the Vailima Brewery paid consumers ten cents for one small bottle returned and 20 cents for a big bottle. The retailer receives 20 cents for one small bottle and 30 cents for a big bottle. In addition, delivery trucks that maintain a regular supply of Vailima beer to retailers also collect the empty bottles. The consumers return the empty bottles to the retail outlets which are within walking distance of their homes. It was reported in 2000 that this return bottle scheme was working satisfactorily, and the resuse process was economically viable.

In the past there was a tax of 50 sene per container on all imported carbonated drinks in cans, and PET bottles. This was replaced by an import duty of one tala (approx. 3.50 Tala to 1 USD) per litre and an excise of 30 sene per litre on both locally produced and imported products. In 2000 the Government of Samoa charged 30 sene for every imported container of cans, plastic or glass bottles. Ten sene per container is reimbursed if the importer has shown the government that it has re-exported the containers (A-N-D, 2000). It is reported that the reimbursement is not a sufficient incentive as there is virtually no recycling occurring via the export of containers (*Pers. comm*., Graham, 2002).

Pepsi, operating as Tropical Island Bottling Co. Ltd., was using plastic PET bottles but according to one report had no return scheme in 2000 (A-N-D, 2000). However, the company was considering two schemes. One scheme

involved the collecting, shredding and compressing of bottles before disposing at the dumpsite. The other scheme is a return scheme in which they will pay two cents per bottle returned to the factory site. There was doubt whether this would be an adequate incentive for consumers to return bottles. Another report says that the company used to refund five sene per empty bottle when it first introduced the PET bottles, but have now reduced this to two sene per bottle. PEPSI is liable for the exportation of empties but does not comply (SPREP: SKM-Samoa, 2000).

5.3 Women in Business and Organic Certification in Samoa

Women in Business Foundation (WIBF) is a non-government organisation which encourages and trains women in business ventures. It has a close working relationship with Ecowoman in Fiji (Refer to Section.6.5). The Foundation is currently focusing on the development of organic farming. Women in Business Foundation have assisted five villages to gain organic status for their products from the National Association of Sustainable Agriculture, Australia Ltd. Five other villages have achieved conversion status for organic products.

There are significant potential implications of organic certification in PICs as follows;

- Allows villages to compete in the niche world market for organic products produced without artificial fertiliser, chemically synthesised weedicides, pesticides, fungicides, fumigants or growth promotants;
- Organic farming avoids the environmental and public health impacts associated with the use of agricultural chemicals, and mineral fertilisers, which contribute to pollution of freshwater catchments and the marine environment (Convard, 1993). Many manufactured fertilisers provide only one or two elements in a water soluble form, making them prone to leaching into waterways, especially if incorrectly applied. Nutrients held in organic soil improvers are released slowly thereby greatly reducing potential for leaching; and
- In addition to conserving carbon and nutrients, organic fertilisers also avoid the high input of non-renewable energy required to produce chemical, mineral or non-organic fertilisers.

In the Samoan villages where organic farming is promoted, the Foundation is working with women and youth groups. The church is also involved via the youth groups.

Farmers are being trained in stringent record management and the systematic farming procedures that organic farming dictates. Women in Business Foundation work with the female head of the household and their extended families in the production of honey, micro-expelling coconut oil, crafts, flower, breadfruit, taro, and pineapple growing (OFA News, 2001; A-N-D, 2000).

The village people do not normally practice composting or recycling. Women in Business Foundation are introducing people to the benefits of composting and instructing them in production. It is reported that there is much more interest in composting since organic farming has been introduced into certain communities, and that people respond positively once they know the benefits to the environment and to their health. However, it is also reported that people need to be educated, and currently very few people will continue composting unless their activities are monitored regularly. Nevertheless, the Foundation is continually asked by farmers for help in obtaining organic certification. The Kava farmers have recently requested that their farms be registered for organic certification, and there is also a waiting list of coconut oil farmers who are seeking certification.

Women in Business Foundation have two project proposals in order to expand the program work, especially the need for ongoing training. The projects are aimed specifically at youth, and the Foundation hopes to establish training on land provided by the Department of Lands and Environment at Tafaigata. A second project would be conducted in villages interested in organic farming, and is again aimed at youth and *pulenu'u* (the village mayors who are elected by the Ministry for Internal Affairs). Funding is being sought for both projects.

The Foundation has established the Samoa Organic Farmers Association (SOFA) and in collaboration with UNDP are asking for UN Volunteers to begin at least one of the two projects. The Foundation is interested in introducing composting toilets into villages such as Tufutafoe and Falealupo which are totally reliant on rain water, and which experience long dry periods, and villages such as Satoalepai, where the majority of the village toilets are built on the shoreline of a waterway which is home to turtles and many other birds and sea life (*Pers. comm*., Adi, 2002; OFA News, 2001).

Personnel from the Ministry of Agriculture in Fiji together with an Ecowoman representative visited WIBF to observe their management and production systems with a view to replicating them in other countries. WIBF trainers have travelled to Nuie and Tuvalu to advise on establishing local programs for organic certification (OFA News, 2000).

5.4 Integrated Biosystems for Resource Recovery

Integrated biotechnology systems offer potential for innovative management of the *waste* stream from industries such as breweries and piggeries (Warburton *et al*., 2002). A number of pilot projects have been conducted in Africa and the South Pacific, which involve a partnership between community and the private sector and offer a system which can

potentially provide all the means of production for yields of fish, livestock, and crops, while eliminating or minimising pollution.

5.4.1 Biosystem Waste Management in Namibia, Africa

The Brewing-Aquaculture-Agriculture project (ZERI-BAG) was initiated in 1997 at the Tunweni Brewery at Tsumeb in the North of Namibia. The ZERI project was jointly funded by United Nations University and Namibia Breweries Limited.

ZERI (Zero Emissions Research and Initiatives) promotes an interdisciplinary practice-oriented approach aimed at supporting the development of sustainable societies as an alternative to high resource-consumption dependent economies. This approach involves the use of innovative technology and software, and the integration of industry, science and governments in the development of a paradigm of sustainability.

The brewery in Nambia produces sorghum beer and *makeu*, a non-alcoholic drink with different flavours (e.g. banana). The objective of the strategy is to eliminate the *waste* stream by establishing a facility which diverts the solid and liquid '*waste*' streams to inputs of an integrated farming system. The *waste* water from the brewery is discharged into a settling tank. After filtering, the water is fed into the anaerobic bio-digester, and after fermentation into shallow, aerobic algae basins. Manure from pigs is washed into the bio-digester where it is mixed with the sewage from the office building. The methane is used for cooking by the workers on the site, and it is planned to pipe methane gas back to the brewery where it will be used to supplement fuel to run the brewery. The runoff from the digester is discharged into the shallow algae basins to produce fodder for the pigs.

The spent grain from the brewery is mixed at a 50 per cent ratio with water-soaked and chopped local grasses to provide structural material for mushroom growing. The subsequent use for mushroom bulks after fruiting is for vermiculture. The worms serve as a food source for the pigs and potentially for chickens. The water from the algae basins flows into two deepwater fish ponds where it was anticipated that fish would be harvested at between eight and ten tons/ha per annum.

Various challenges have been encountered during the project. These include sand being blown into the algae basins by the wind, digester inefficiencies, high evaporation rates, mosquitoes, problems with mushroom substrate, and the high alcohol content of spent grains making it unsuitable for direct feeding to worms or pigs (although it was reportedly providing 50 per cent of the pig's diet) (*Pers. comm*., Pauli, 1997; Pauli, 1996).

However recent reports are that the project in Namibia is now functioning well and 400 kg of mushrooms are being produced per week, all of which are consumed by local communities. There are 60 pigs around the brewery, a fully functioning digester and a small algae pond. According to the program director the fish pond does not get the full attention it requires as finding expertise on fish farming in the desert is indeed a tough one (*Pers. comm*., Pauli, 2002).

5.4.2 Biosystem Waste Management in the South Pacific

An Anaerobic Digestion (AD) process for agricultural purposes was introduced by the South Pacific Commission (SPC) in the early 1960s to promote livestock development in PICs. The process was utilised as a method of recycling *waste* water from livestock. This was followed in the late 1970s with the development of long term projects for the bio-conversion of animal '*waste*' into value-added products to improve the rural economy and reduce pollution. Unfortunately the aims of the projects were never fully reached, mainly because of poor management resulting in many inactive bio-digesters on farms around some Pacific Island Countries (Ajuyah, 2000a; Ajuyah, 1999c).

Fiji

It was not until 1997 that a functional demonstration bio-digester was built in Fiji at Montfort boys' town by Professor George Chan of the United Nations University, Tokyo, Japan. Montfort boys' town is a boarding facility for street children, and currently houses 145 boarders. The bio-digester is a slurry tank design and has a capacity of $20m^3$. It is fed by gravity with 600 L of animal waste daily plus wash water from a 60 herd pig unit. Gas production is approximately $4m^3$ - $8m^3$ per day and it is used mainly for cooking and lighting. Total capital investment is approximately $F7000 and pay back time is expected to be less than five years.

Other co-products from the AD process are used as fertiliser for crops and fish, including vermiculture. The boarding house has, in recent years, attained a high level of self-sufficiency in both fibre and energy production, and the next phase of the development plan is to use the methane to produce electricity from a co-generator. In recognition of the role of the project in Fiji as a model for youth rehabilitation it was officially registered for the World Expo 2000 in Hanover, Germany. One of the keys to the successful operation at Montfort was the management. The vocational school is run by missionaries who aim to maximise food production, and there is ample labour available from the residential students (Ajuyah, 1999a; Ajuyah, 1999c; Ajuyah, 1998; *Pers. comm*., Foo, 2002).

Samoa

An innovative project has been in progress in Samoa since 2000 to study the use of aquatic plants for the treatment of brewery '*waste*' water and to investigate how spent grains and yeast can be used in poultry feed, in addition to mushroom cultivation. The project was funded by SIDA and executed by the Department of Biotechnology, Royal Institute of Technology (KTH), Stockholm, with research projects implemented in 2000 in co-operation with the following organisations;

- USP-Alafua Campus (scavenger chicken project);
- Vailima Brewery ('*waste*' water treatment project) and Sac Farm (duck project); and
- NCDS-MAFFM (Nuu Crop Development Station, Crops Division of the Ministry of Agriculture, Forests, Fisheries and Meteorology) (mushroom project).

In 2001, UNESCO Regional Office in Apia funded the pilot project on organic fertiliser and Poultry Production which was implemented at the NCDS-MAFFM, in cooperation with Integrated Bio-Systems Network (IBSnet) of the International Organization of Biotechnology and Bioengineering (IOBB). In this pilot project, Samoa Breweries Ltd provided the spent grains and yeast free of charge, Samoa Tropical Products Ltd would provide coconut meal, outer shavings of coconut kernel and coconut shells along with other coconut '*wastes*'; and DLSE (Department of Lands, Surveys and Environment of the Government of Samoa) and IBSnet assisted in trouble-shooting and problem solving. Construction of the enclosure and materials for the project start-up (including labour and birds) cost a total of 11,290 Samoa Tala ($US1 = $3.5 Tala approximately).

At the Vailima Brewery in Apia, most of the spent grain, all yeast and waste water had been dumped or discharged into the ocean until 1999. Spent grains were sold at the Brewery in Vaitele for about two Samoan Tala per 20 kg sack but most of the spent grains remained unsold and had to be dumped at the Tafaigata Dump which is located about 20 minutes drive from the Brewery. Following the project and DLSE Seminar-Workshop in 2000, the spent grain was given away and by 2001 it was all being used. The Brewery made savings in reduced diesel consumption from transportation and avoided paying the gate fee of 30 Samoan Tala per truckload of waste. Samoan farmers are now also starting to use the yeast and there is a strong interest by the Samoa Breweries to treat all its *waste* water before discharge, and also recycle treated water for re-use. The project site has a 5.25 m^3 tank system (four open-top biofilters and three treatment tanks) that can biologically treat *waste* water with hydraulic retention time of 16.5 days to lower the BOD of 2000mg O2/L to 95 mg O2/L. No chemicals or aeration is needed to achieve this reduction. Future work in 2002 will include testing a sand filtration system to removal algae in the effluent to lower the BOD further and to reduce the hydraulic retention time.

At the NDCS-MAFFM site, the integrated biosystem pilot project for organic fertiliser and poultry production uses spent grain and yeast to grow feeds (insect larvae of black soldier fly and common household fly and earthworms) for scavenging chickens. Ducks can scavenge spent grains but have a natural preference for papaya and leaves from some local plants. The duck enclosure has a play pool that is cleaned daily and the washwater is used to fertilise a pond to grow aquatic plants (Salvinia, which has about 15 per cent crude protein) and mosquito fish. These are in turn used as duck and chicken feed. All feed residues were used to grow earthworms. All activities are conducted in an enclosure (about 400 m^2) which can house 100 birds.

Such a system, which is designed for adoption by households, can eliminate the dumping of spent grain onto landfills, and the discharge of spent yeasts into the ocean, while providing organic fertiliser, chicken food and the potential for commercial scale poultry production (Foo, 2001; SIDA, 2000a; SIDA, 2000b; *Pers. comm*., Foo, 2002; *Pers. comm*., Dalhammer, 2002).

Lesson Learned from PIC pilot projects

- It was found that, in joint research projects between PICs and foreign organisations, where an unfamiliar strategy such as BTS are being trialed, ongoing communication is essential and the use of e-mail is a cost-effective method to maintain feedback and exchange of information;
- Local feed resources were not a problem as they were available in abundance. However, the challenge was to create a routine that the workers can follow in the collection of feed materials (coconut, papaya, leaves of plants) and preparation of the feeds;
- Chickens are good scavengers and are easier to raise than ducks. It was found that ducks were problematic since they preferred not to eat spent grains if they contained spent yeast (probably because of the smell), but would eat spent grain when they were hungry (in the morning) and did not have another food source;
- It was also found that coconut needed to be grated before feeding to the ducks since their beaks are unable to pick on the hard white kernel of the coconut. Young coconuts were readily consumed;
- Rats were found to be a considerable threat to young chicks and ducklings and it was necessary to cover pens

with small mesh chicken wire. It was also necessary to use chain link fences secured at the bottom by stones to prevent intrusion from cats and dogs. Since chickens and ducks were not vaccinated it was necessary to maintain good house-keeping routines in the pens to prevent diseases (Foo, 2001);

- There is a local constraint with raising poultry in an enclosure as it requires an additional workload to manage the activity. This is a major change for most Pacific island households where traditionally free-range poultry production requires minimal effort. To compensate for this change, there must be a sufficient economic incentive to justify the work inputs. Simple management routines should therefore be further developed to reduce work hours;
- Problems were encountered with poor growth of aquatic plants, possibly due to trace element/nutrient deficiency in pond water, and mosquito larvae breeding in the pond water, which were controlled using mosquito fish.
- Mushroom cultivation was abandoned due to inadequate local follow-up and technical capability. There were also problems with larvae (probably fruitfly) infection of mushroom bags, and attacks on the bags from rats; and
- The Nuu Crop Development Station was using spent grain as an ingredient for composting before developing a better system. The new system involved producing maggots and earthworms from the spent grain and yeast and this allowed for the production of poultry food and compost, all from the same process (*Pers. comm.*, Foo, 2002).

An integrated biotechnology project is a possible option for a IWP pilot. Since pigs play such an important role in the tradition, culture, nutrition and economy of PICs, investigating a system that can potentially provide all the means of production for high yields of fish, livestock, crops and processed goods at competitive prices, while eliminating or minimising pollution deserves consideration and investment (Chan, 1997; Ajuyah, 1999c). A *Green Pigs* pilot project is suggested in Annex III, and further ideas for projects related to managing household pig pens are in Annex IV. A biosystems approach could be incorporated or designed as a separate project.

5.5 Community-based composting in Bangladesh

This program offers practical ideas for a non-mechanised community composting enterprise and although conditions in Bangladesh differ from PIC conditions in certain respects, the initiatives indicate that it is possible to sustain a low-cost or profitable waste management program without dependence on expensive equipment, which requires ongoing maintenance. A small-scale village composting plant could be considered as pilot project as part of the IWP.

Since 1995, Waste Concerns, an NGO based in Dhaka Bangladesh, have been establishing a network of community-based decentralised aerobic composting plants.

It is estimated that Dhaka produces between 3,000 and 3,500 tons of garbage daily. It is also estimated that more than 87,000 people in Dhaka are engaged in the waste recycling industry in some form or another. *Ferrywallas* go door-to-door purchasing various products that would otherwise be added to the *waste* stream. This creates an incentive in the first place for householders to separate their '*waste*'. The purchased products pass through various middle-people with the non-reusable material eventually being used by manufacturers as raw materials for recycling. A relatively small number of informal sector scavengers called *tokais* (mostly children) search for recyclable and re-useable materials from garbage dumps, rubbish bins and from the streets. These items are then sold to entrepreneurs throughout the city who arrange for the materials to be sorted, cleaned and then sold through a marketing chain that also ends at several types of recycling factories. Since the organic content of garbage produced in Dhaka can be as high as 80 per cent, Waste Concerns was interested in determining whether there was any value in the remainder of Dhaka's highly scavenged solid *waste*.

Dhaka City municipal workers and the *tokais* collect less than 50 percent of the waste stream. There is no waste collection service in the slum areas of Dhaka where 30 percent of the population lives. The founders of Waste Concerns attempted to interest the Local Government Engineering Department (LGED), and other government ministries in their ideas for community composting plants and offered voluntary assistance to establish the plants. However, most government ministries were not interested in the community composting plants, preferring instead the large, high-cost mechanised projects.

5.5.1 Composting Pilot Project

Waste Concerns then decided to initiate a pilot community-based decentralised composting project in 1995 in Mirpur district, Dhaka. They conducted community surveys with the assistance of the Environmental Task Force of the Gothe Institute in Dhaka to establish whether there was a desire for an alternative household collection service. The survey revealed that eighty percent of residents surveyed were dissatisfied with the existing municipal services provided by the Dhaka City Corporation (DCC). Seventy seven percent of households said that they were prepared to pay Tk 15-60 per month for an additional waste management service. Farmers were also surveyed to establish whether there was a market for the compost. Ninety four percent of farmers surveyed were interested in buying the compost. By the late

1980s, modified rickshaws were already being used as '*waste*' collection vehicles by several NGOs and CBOs in Dhaka to deliver garbage to DCC pick up points (Mohit, 2000). Waste Concerns also utilised this method to provide a household collection service.

The Lions Club was persuaded to allow the community-based composting plant to be installed on a portion of their vacant land. The plant was built on 1000 square metres of this land within a housing estate. The plant is divided into the following sections: '*waste*' delivery, residual removal, sorting and testing; active composting (comprising 50 per cent to 6 per cent of the total area), maturing, screening and bagging, a store room for bagged compost, facilities for storage of equipment and worker's personal items; and an office. An area is also allocated for the demonstration of organic farming.

The intention was to develop an appropriate low-cost composting technique that could be performed in a relatively small space in a densely populated urban area without producing any foul odours. Two methods of composting were tested. The Chinese covered pile system and the Indonesian windrow technique. The Chinese method was found to be more suitable for rural areas because it produced unpleasant odours whereas the Indonesian technique was odour free except for a tolerable odour when turning the piles. Therefore the Indonesian method was selected.

Initially Waste Concerns were collecting garbage from 100 households which increased to 400 households after three years. Householders initially paid Tk ten per month which rose to Tk 15 after 12 months (approx. Tk 1 = 1 USD). The income received was spent on the salary of the part time van drivers and *waste* collectors. In 1998 with support from the Regional Urban Development Office (RUDO) of the United States Agency for International Development (USAID) in New Delhi, Waste Concerns began to increase the capacity of the community-based *waste* management project from one ton/day to three ton/day.

The collected *waste* is separated and sorted at the resource recovery (composting) plant and then heaped into piles under cover. The pile is aerated and the temperature is maintained using aeration bamboo poles and by turning the pile at the correct time. Water is added to optimise decomposition. To increase the nitrogen content of the pile and maintain the carbon/nitrogen ration within the optimum range, chicken and cow manure is added to the pile. Sawdust is also mixed into the pile to increase the air spaces.

The composting process takes 40 days with an additional 15 days to allow for the compost to mature. The compost is then screened for different grades and packaged for marketing. Two tons of solid*waste* produces approximately 500kg of compost. In 1998, one kg of compost was sold for between Tk 2.5 to Tk 5.0. Compost was being produced at a cost of Tk 1.77 per kg.

Costs and earnings from community operated plant

Six female workers from the informal sector operate the composting plant. The quality of compost is monitored by the University of Dhaka. In 1998, of the total cost to run the composting plant, 62 percent constituted the labour cost. At the time these calculations were made, the composting plant was processing two tons of raw materials a day. The cost of collection of raw materials from households constituted 31 percent of the total cost. This cost was fully recovered from the financial contribution of households for the collection service (Enayetullah and Maqsood Sinha, 1999; APPC, 2001; Maqsood Sinha and Enayetullah, 2000a; Enayetullah and Maqsood Sinha, 2000). In fact, a profit of Tk 12,000 was being earned from the service in 1998. Total costs and earnings of the enterprise in 1998 are recorded in Tables 4 to 6 below ($1US was equivalent to Tk 50 at the time).

Table 4. Fixed Costs from a Three-Ton Capacity Composting Plant

Item	Tk	$US
Construction of composting shed with drainage facility	268,200	5,364
Construction cost of sorting platform with shed	45,000	900
Construction cost of office and toilet facility	50,000	1000
Purchase of three rickshaw vans @ Tk 15, 000 each	45,000	9000
Water and electricity connections	50,000	1000
Equipment for composting, and dress for workers	50,000	1000
Total Fixed Costs	**508,200**	**18,264**

Table 5. Operational Costs Per Year for Compost Plant

Item	Tk	$US
Construction of composting shed with drainage facility	268,200	5,364
Construction cost of sorting platform with shed	45,000	900
Construction cost of office and toilet facility	50,000	1000
Purchase of three rickshaw vans @ Tk 15, 000 each	45,000	9000
Water and electricity connections	50,000	1000
Equipment for composting, and dress for workers	50,000	1000
Total Fixed Costs	**508,200**	**18,264**

Table 6. Earnings Per Year From Compost Plant

Item	Tk	$US
Sale of compost produced from processing 500 kg of compost per day from 2 tons of raw material	400,000	8,000
Charge for house to house collection service at Tk 15/household for 400 households	72,000	1,440
Total Earnings	**472,000**	**9,440**

Tables adapted from Enayetullah and Maqsood Sinha (1999).

Benefits of community-based composting enterprise

Aside from the financial benefits, Waste Concerns sees the following advantages arising from decentralised composting;

- Decrease in waste management costs by reducing large volumes of solid '*waste*'. Small three-ton per day capacity community-based composting plant (CBCP) in 1998 could save DCC Tk 8,970,900 ($US17,958). These figures were based on the average per ton solid '*waste*' management cost in Dhaka in 1998 (to collect, transport and dispose of '*waste*') of Tk 820 per ton;
- A small three-ton capacity compost plant can save 1093 square metres of land fill per year;
- Improvement of overall environment of neighbourhood by controlling illegal disposal of garbage;
- Well run CBCPs can generate employment for poor people, especially women and provide potential recycling business opportunities for small entrepreneurs; and
- Returns organic matter to the soil and minimises the use of chemical fertiliser.

Lessons Learned

Success of a community-based project depends largely on identifying and addressing the community's needs. The sustainability of the project depends on involving the community in the cost-recovery/cost-sharing process. Charges for the service should be minimal during the start-up phase of the project. When the benefit of the service has been demonstrated, charges can be increased. It was found that people do not object to paying more when they experience the benefits of an improved service.

If a small-scale project is successful it will expand naturally as other householders see the results and join the scheme. This has been the case in Dhaka where, not only has the initial trial attracted more customers, but other community-based projects have been initiated by CBOs in adjoining districts. Community-based composting is considered to be viable in Dhaka, and this is demonstrated by the fact that many entrepreneurs approach Waste Concerns for technical advice and training in the operation of a community-based composting plants.

NGOs can play an important role in initiating and demonstrating new concepts and in providing technical expertise and training. Small-scale composting plants can be located within community areas if appropriate scientific composting methods are utilised.

In Dhaka, women from the informal sector were particularly interested in working in the composting plants. It was observed that, in a culture where only low status people such as community sweepers work with waste, the work in the composting plant is socially acceptable. Most of the women who worked in the original composting plant were

previously working in clothing factories, or as domestic help and had long working hours. In the composting plant they work an eight-hour day with a weekly holiday.

Marketing of compost can be a major problem. In the Dhaka project, this was overcome by involving private sector fertiliser companies. Waste Concerns arranged for fertiliser companies and small nurseries to purchase compost-based fertilisers produced from the plant. They have been contracted to supply bio-fertilisers to Alpha Agro Ltd., a private fertiliser company, and PROSHIKA, one of Bangladesh's largest NGOs. Alpha Agro Ltd. is marketing the product all over Bangladesh. The companies are also purchasing the compost and mixing it with chemical fertiliser. The print media also played a major role in publicising the composting project in Dhaka.

Response from government

Other challenges encountered by Waste Concerns has been the slow response from municipal authorities to replicate the decentralised community composting initiative. There is no policy on solid waste management at the national level for city corporations and municipalities. Although Waste Concerns has convinced Dhaka's Municipal Corporation and Public Works Department to provide government land on which they can establish more community-based composting plants, the identification of potential sites for establishing composting-based plants is a problem.

Waste Concerns argues that the following institutional support is required to enhance the wide replication of the decentralised community-based composting system:

- Land should be made available free of charge or at a nominal rate to entrepreneurs to facilitate the establishment of composting micro-enterprises;
- Access to ethical loan facilities;
- Assistance with technical advice and training; and
- Assistance with marketing of the compost.

In August 1998 Waste Concerns was selected as a Sub Implementing Agency (SIA) for the implementation of Community-Based Urban Solid Waste Management in Dhaka (Component 3.3.2) of the Sustainable Environment Management Program (SEMP), being executed by Ministry of Environment and Forest (MoEF), with financial assistance from UNDP. The project (1998-2003) objectives were to:;

- Improve solid *waste* related problems by promoting community-based solid 'waste' recycling activities at the community level of fiveidentified communities of Dhaka city;
- To create recycling job opportunities for the poor (especially women); to conduct study, research, documentation and experiments on solid waste recycling, clinical waste management, and organic farming; and to develop a community, private-sector and municipal partnership to improve the overall environment. There is also an educational component of the project including the publication of training manuals.

Waste Concerns also signed a memorandum of understanding with the Public Works Department in September 1999, and with the Dhaka City Corporation and Dhaka University in August, 2000, to establish community-based composting plants in eight different areas of the city.

Expanding the enterprise

Since the initial composting plant was built, another four community composting plants have been established and are operating in Dhaka, and one is under construction. Apart from Dhaka, a composting plant has also been established in Khulna, the third largest city in Bangladesh (*Pers. Comm*., Enayetullah, 2002).

Since 2000, Waste Concerns has also initiated a program in slum areas where the residents are participating in projects to compost their kitchen waste in specially designed compost barrels. The technique was adapted from middle and high-income households in Sri Lanka, where the barrels are used to produce compost in extremely confined areas. This project has been implemented with the support of UNDP's LIFE program and from Oxfam-UK. Six households share one barrel. Compost is produced in about four months from the barrels and Waste Concerns buys the compost and the income is shared among the people from the cooperating households. There are two types of barrels provided. One green coloured perforated barrel is provided to each group of six household for the processing of organic waste. One yellow coloured non-perforated barrel is also provided to groups of 12 households for the collection of in-organic waste (Maqsood Sinha and Enayetullah, 2000a; Enayetullah and Maqsood Sinha, 1999; APPC, 2001; Enayetullah and Maqsood Sinha, 2000; *Pers. comm*., Enayetullah, 2002).

A small-scale village non mechanised composting plant could be considered as a potential project within the IWP activities. Refer to Annex VI for Websites showing composting plant in the village setting.

5.6 How Partnerships with Governments can Enable Communities to Manage Waste and Control Pollution in PICs

This section examines some of the partnership arrangements that are possible between government and community in the management of *waste*. It is not the purpose of this review to advise governments on the complex institutional, financial or organisational measures that could be undertaken to conserve resources and protect public health in PICs. However there are a number of relatively immediate and inexpensive strategies that governments could adopt which would enable communities to minimise waste and improve pollution control. The strategies could include institutional support for private sector recycling activities, and government-sponsored community-based waste management initiatives such as exist in Palau. The responsibility of government to work with communities in the management of hazardous residues is also briefly discussed.

5.6.1 Government Support for Resource Recovery and Appropriate Technology

The following practical assistance can be offered by governments to enable community-based waste management:

- Encourage private sector recycling operations by providing incentives and minimising taxes (such as export tax on recycled cans or import taxes on recycling equipment). It is considered advisable by some analysts not to subsidise recycling operations, but a tax on landfilling makes recycling more competitive if the recycler is paid the appropriate disposal fee for each tonne of waste recycled. A tax on landfilling is not recommended where arrangements for inspection and enforcement would lead to an increase of illegal dumping at unauthorised sites. In this case, some other in-kind support can be offered to the recycling industry, (Coad, 1999);
- In some cases government might consider guaranteeing to purchase a specific quantity of the output of recycling industries that it is seeking to promote. Again some analysts suggest that the financial involvement of government is not advocated, since *the recycling industries should be self-sufficient and financially viable*, but given the economic constraints in PICs, and the environmental issues at stake, this kind of partnership may be the most workable option;
- Government offices should set an example by segregating and recycling *waste* paper and there should be a rigorous policy for government offices and services that recycled products will be preferred when it is possible to use them;
- Support deposit schemes that encourage the return of items such as drinks bottles and cans, in order to increase the supply of clean secondary material;
- Support a reliable and segregated solid '*waste*' collection service and utilise the strong tradition of community decision-making processes to discuss and clarify finance and management options. Undertake investment in infrastructure only when adequate arrangements are in place to ensure longer term maintenance and continuity of management (World Bank, 1995);
- Extend drop-off centres for recycling materials, both by providing more convenient container locations and by adding to the materials that are collected for resource recovery;
- Legislate against, or increase the import duty on certain *waste* creating products, such as has been done in Kiribati to discourage the import of drinks in glass bottles (A-N-D, 2000);
- Tax importers of packaged products to cover the potential cost of disposal such as was attempted in Samoa (A-N-D 2000; *Pers. comm.*, Graham, 2002) and promote alternative packaging; and
- Environment departments and finance departments could provide information and assistance to members of the community with an interest in resource recovery. This could include information on costs and other implications of reprocessing technology and the requirements of local industrial hygiene and pollution control legislation (where it exists), and possibly assistance in obtaining finance for equipment. Similarly, pictorial information could be provided on appropriate sanitary installations to encourage people to build their own ecologically sound toilets, and to stimulate local business to provide this service to communities and the private sector. Instruction and demonstration on the workings and maintenance of on-site systems, especially septic tanks, would be very useful.

Existing government supported services, such as the Environment Resource Information Centre (ERIC) in Tonga, the Education and Awareness Unit (EAU) in Fiji (Refer Section 6.6) and the SIDAPP/People First Network in the Solomon Islands (Refer Section 6.2) are facilities where information on resource recovery and appropriate technology could be provided.

5.6.2 Government/Community Partnership in Palau

The Environmental Quality and Protection Board (EQPB) under the Office of Environmental Response and Coordination Office of the President in Palau has initiated a number of community-based waste management programs.

The EQPB is the environmental regulatory and enforcement agency in Palau with a current staffing of 22 personnel. The EQPB is mandated under the Environmental Quality Protection Act of Palau to provide environmental education (EE) to the general public on the protection and conservation of natural resources, public health and the environment. The EE division of EQPB focuses on school curriculum education in addition to outreach programs in the Palauan community. Waste management programs undertaken by EQPB includes the following activities:

- *Recycle for a School Need* and *Adopt a School* program in Koror Elementary School and Harris Elementary School;
- A Battery Drive once a year. All communities are aware of EQPB's program and they actually drop off batteries throughout the year, not just during the annual drive;
- Oil Recycling Program. EQPB only accepts used oil from large companies as they currently do not have the capacity to service all communities and sectors;
- A composting program headed by the Science Department of the Palau Community College;
- Clean-up the World is conducted every December. Due to limited resources, the Clean-up the World campaign has now been incorporated with Earth Day, on-going school programs, and other environment related activities;
- A trash receptacles, recycling, and trash segregation program which has been conducted for three years is near completion and EQPB is looking for additional resources to continue the program;
- A Toner Recycling Program, where toner was collected and sent to the US for recycling, but is now discontinued; and
- Bicycle Recycle Program, which repaired bikes and gave them away in order to promote energy conservation, has now been completed (*Pers. comm*., Bells, 2002).

5.6.3 Government/Community Management of Hazardous Wastes

Management of hazardous residues is one area where government intervention is unavoidably required. Education can alert people to the dangers of hazardous materials and indicate proper procedures such as usage, storage and separation of *waste* streams, and these awareness raising programs are essential (Tonga Trust, 1998). However, regulation, collection, and safe disposal requires some kind of centralised management. Examples of partnership between government, community, and the private sector regarding hazardous waste are referred to in this Section, and community-based management activities have been described in Section.3.5.1 and Section.4.3.3.

Potentially hazardous material that communities are commonly exposed to includes:

- Batteries (vehicle, photovoltaics, and small household);
- Used oil;
- Agricultural chemicals;
- Medical refuse;
- Paint and solvent;
- Industrial residues (from timber treatment, mining processing);
- Transformer oils possibly containing PCBs (poly chlorinated biphenyls); and
- Septic tank sludge.

In 1995, the members of the Pacific Islands Forum formulated the Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes (*Waigani* Convention) and to control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region. The Convention is a sub-regional adaptation that complements the global Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989). Once a government becomes a signatory to the Waigani Convention there are associated activities which can be undertaken such as:

(i) Banning import of hazardous and radioactive residues;
(ii) Minimising the production of hazardous residues;
(iii) Establishing proper disposal methods for hazardous residues;
(iv) Developing national legislation to prevent and punish illegal trafficking of toxic residues; and
(v) Considering becoming signatories to the London Dumping Convention, the SPREP Convention and the Basel Convention, UNESCAP, (2000).

The Waigani Convention came into affect on October 21 2001.

SPREP is co-ordinating a project for the Management of Persistent Organic Pollutants in Pacific Islands which aims at identification and removal of stocks of unwanted and residual chemicals and the rehabilitation of contaminated sites. This includes production of a comprehensive database on types, quantities and locations of residual chemicals and unused pesticides in the region. All chemical and oil contaminated sites in the region have been identified, and an assessment has been made of the extent of contamination (SPREP: Burns *et al*., 2000).

The following discussion includes issues relating to the management of hazardous residues which could be addressed under an IWP pilot project.

Automotive residues

A relatively recent trend in some PICs is the growth in the motor vehicle fleet with imports of used vehicles out of Asia. Loans to buy these vehicles have been made readily available, especially to government employees, who have their fortnightly wage directly garnished by the banks. Many families are still paying off the loan long after the vehicle has become unusable (*Pers. comm*., Fatai, 2001). Motor vehicles are a major contributor to solid waste (car bodies and tyres) and potentially hazardous substances such as oil, oil filters, solvents, heavy metals and batteries.

The TEMPP project in Tonga worked with its counterpart ministry in developing environmental codes of practice. These are intended as voluntary guidelines for industry/small business to follow in their establishment and operation. The codes of practice are an opportunity for the public and private sector to work with government in introducing environmental management activities in a cooperative rather than legislative framework. Reflecting the trend with motor vehicles noted above, the first of these codes has been developed for automotive repairers, or mechanics, on Tongatapu. The automotive code was developed out of several workshops with industry and government agencies. With a strong industry input, the code reflects the industry's responsibilities and capabilities in minimising environmental impacts from the automotive trade. It is hoped that the code will assist in addressing the pressing problem of used oil disposal. For example some 20-40,000 litres of lubricating oil are reportedly imported into Tonga each month (*Pers. comm*., Toma, 2001).

BP Oil (Fiji) is currently formulating a program to collect used oil from various Pacific islands. The collected oil is used as feedstock in industrial boilers and furnaces (quantities involved are too small to support re-refining). Used oil recycling is also available through Mobil shipping the used oil to Fiji for burning in furnaces (SPREP 2000: SKM-Fiji).

The automotive code of practice in Tonga will provide the link at the business level with these oil company programs. Under the code, the repairers agreed to allow car owners who change their own oil to dispose of the used oil at the repairer's premises. Lead acid car batteries are also included in the code, with repairers acting as drop-off points for batteries, which then go to an existing recycler (Atenisi University who neutralise the acid and collect the lead). It was not possible to find out what is done with the acid casing at Atenisi, but generally in PICs, battery casing is dumped or burnt (*Pers. comm*., Fairbairn, 2002).

This is an example of how small business and communities, supported by government, can work together with industry in implementing simple measures such as drop-off points for used oil or batteries. It is too early to provide comment upon the success of this initiative which commenced in 2000. Monitoring of the effectiveness of such a program could be achieved through a comparison of records of oil shipped out and oil imports, and also through surveys of vehicle owners to assess awareness and actual usage of the oil drop-off facility.

A pilot project for improved management of used automotive waste is outlined in Annex III.

Agricultural chemicals

As discussed in Section.5.4, the use of agricultural chemicals can be avoided by practising organic farming. While there is a movement toward this practice, there is currently wide use of these potentially hazardous materials in some PICs. Government and non-government organisations can work with the community to reduce exposure to, and misuse of agricultural chemicals.

A pesticide awareness program which began in Tonga in 1996, and is conducted by The Tonga Community Development Trust, has the following objectives;

- To mitigate impacts from use of all imported agricultural chemicals such as pesticides, fungicides, fertilisers, herbicides, insecticides;
- Promote awareness of the dangers of pesticide misuse; and
- Identify and encourage alternative environmentally sound behaviour and activities, (Tonga Trust, 1998).

The Seed Savers Foundation worked with the Tonga Trust providing training in saving seeds of varieties not dependent on chemicals (*Pers. comm*., Fanton, 2002). Surveys were conducted with farmers which resulted in the following areas being targeted for action and education.

- Tongan translation of all agrochemical labels/instruction;

- Health-related hazards of agro-chemicals: signs, symptoms, treatments and precautions;
- Safe storage, handling and disposal of agrochemicals;
- Proper use (quantity, quality and timing) of agro-chemicals for different crops;
- Safety in the field; and
- Safety in the home.

Photovoltaics - Batteries

Since the oil shock in the 1980s, there has been an introduction of renewable energy technology into the PICs with photovoltaics (PVs) being the most popular option. In addition to automotive use, this is the major source of discarded batteries in PICs

It is estimated there are approximately 6000 PV systems in the region and solar powered systems are widely advocated as environmentally friendly technology. However the batteries associated with these systems normally have a lifetime of about 5 years, and over the last decade, the proper disposal of used batteries in the region has been challenging. Some have been sent to Fiji or the US for recycling while many have been striped for the lead which are used in fishing weights or fishing nets, as has been previously mentioned. The acid cases and the panels from PV systems are generally dumped randomly, and not in controlled landfills.

Although no specific monitoring of environmental impacts have been made, it would appear that PIC communities, at present, have not experienced any major consequences due to the careless use/disposal of used batteries. However, as concentrations of lead, acid, other chemicals and residues increase over the years, health impacts will become noticeable, and obviously by then it will be too late. Most countries are improving their environmental policies although policing and enforcement are difficult (*Pers. comm*., Fairbairn, 2002). For this reason, demonstrative education is the most effective and immediate measure that governments and other organisations can undertake to ensure people are aware of the unseen threats associated with exposure to hazardous residues and materials.

Section Six will focus on networks of education and information exchange which operate through PICs to facilitate waste management, and conserve natural assets.

6. Participatory Education and Information Exchange

6.1 Introduction

There are NGOs, Community-based Organisations and regional organisations throughout PICs which work with communities to raise awareness and enhance skills to address the challenges of environmental degradation and the related decline in public health. These processes could also be referred to as partnerships, but in this case there is more of a focus on the exchange of information. Strategies are used which attempt to maximise participation and mutual understanding. Some of these organisations and their activities will be described in this Section, with particular emphasis on *waste* management and pollution control, although these issues are inextricably inter-related with many factors that affect survival and quality of life.

6.2 Community Networks in the Solomon Islands

A number of related organisations work with communities in the Solomon Islands to creatively address interconnected public health and conservation issues, including *waste* minimisation and pollution prevention.

6.2.1 SIDT

The Solomon Islands Development Trust (SIDT) is affiliated with the Foundation for the Peoples of the South Pacific International (FSPI), and is one of the longest established (20 years) and most widely recognised NGOs in the Solomon Islands. It now works through a strong grassroots network of community workers and trainers, based in the villages, providing training and awareness and practical assistance on a range of development and household issues, including *waste* management.

Until 1995 SIDT travelled throughout the Solomon Islands on outreach programs using mobile teams bringing education and awareness programs to village people and holding workshops on nutrition, sanitation, malarial and AIDS prevention. They have also campaigned strongly against uncontrolled commercial logging and have provided training in micro-forestry enterprises. They used various educational materials along with their own publications, dramatic presentations, songs and stories.

After an independent review revealed that there were no noticeable changes in the behaviour of village people as a result of receiving SIDT information, SIDT reorganised. Since 1996 Village Demonstration Workers (VDW) have replaced the mobile teams. The VDW approach fills the need for a more permanent person(s) present in the village reinforcing the information that has been disseminated.

The NGO has seven departments: the Village Resource Centre; Women's Study Programme; Conservation in Development; Volunteers; Sei! Theatre; the Link Magazine; and the training team. They operate in all ten provinces in the Solomon Islands, with at least one SIDT Centre in each province. These centres are directed by field officers who lead between 14 and 24 trained Village Demonstration Worker teams. Approximately 215 persons are employed in this outreach structure, which allows SIDT to participate in a variety of different nationwide activities. The SIDT network has already provided training in, among other things, Sup Sup Gardens (described below), toilet construction, and upgrading kitchens. The SIDT network therefore is an excellent channel for promoting improved *waste* management practices.

The AusAID funded Rural Water Supply and Sanitation Project collaborated with SIDT's nationwide group of VDWs and theatre groups in the field to promote clean and efficient water supply, and basic community sanitation and hygiene practices (FSPI, 2001; AIDAB, 1994; AusAID, 2000a; AusAID, 2000b).

6.2.2 APACE-KGP/Sup Sup/SIPMN

Since 1978, Appropriate Technology for Community and Environment (APACE) has designed and implemented projects which enable self-determination for communities, particularly in food security and resource management. These programs, contribute directly and indirectly to improved *waste* management and pollution control.

One of APACE's projects is a sustainable agriculture project called *Integrated Kastom Agriculture for the Solomon Islands.* This project aims to address problems of environmental degradation which are due to unsustainable trends in subsistence food production. The project involves researching traditional agricultural methods from a number of areas and integrating them with more intensive methods drawn from permaculture and organic farming. The project's main focus is village level food security and connected issues such as resource management, indigenous knowledge, crop diversity, farmer group development, nutrition and avoiding dependence on imported packaged food (*Pers. comm.* Jansen, 2002). This involves supporting a number of village-based models of integrated food gardening (developed by the communities themselves), a training program, and the development of a seed bank and organic farmers network. Pacific Edge Permaculture and Media, Kastom Garden Program (KGP), The Seed Savers Network (based in Australia), and The Solomon Islands Department of Agriculture all support the initiative.

The staples of Solomon Island gardeners are vegetatively-reproduced root crops such as *cassava*, *taro*, *yam* and sweet potato. Hybrid crops sold by East Asian seed companies such as tomatoes, Chinese cabbage and ball cabbage are also eaten. This is a problem as these seeds are often expensive, unviable and dangerous to local crop diversity. The Solomon Islands Planting Materials Network (SIPMN) was set up in 1995 as part of the APACE Kastom Garden Program to improve regional self-reliance in relation to seed supply for village gardeners. SIPMN is a network of farmers, extension workers, community-based groups and others who exchange seeds and raise awareness about farm-level conservation of crop diversity. The network is a low-cost, sustainable system that assists village farmers to access open-pollinated varieties of seed and encourages farmers to save their own seed on-farm.

Between 300 and 1500 seed packets are produced each month and then distributed to SIPMN members. Hundreds of local varieties of seeds and staple crops such as yams and taros have been discovered, multiplied, and distributed. In addition, this program has been able to bring together 350 members in most provinces of the Solomon Islands. This active network of people in the villages and relevant organisations are now increasingly aware of conserving crop diversity.

The KGP seed gardens use organic farming methods and promote the separation and use of organic matter, which would normally create a *waste* problem. No organic material is burnt and soil fertility is maintained through mulching and crop rotation. Simple methods of managing pests are practiced such as hand picking, ash and chilli botanical sprays, general garden hygiene and encouraging natural predators. In many respects the KGP centre in Honiara has now taken over some of the *Sup Sup Garden* program functions of demonstration small gardens and planting material distribution. KGP have had a long relationship with SIDT and supply seed and information to SIDT's village development worker network, and is planing to establish a seed production centre at SIDT (*Pers. Comm.*, Jansen, 2002).

The *Sup Sup Garden* project focussing on home vegetable gardening was started in 1986 by the Honiara Town Council (HTC) as the *Keep Honiara Clean Campaign* under funding support from the Ministry of Health and Medical Services (MHMS), WHO and UNICEF. The initiative was renamed *Keep Honiara Healthy Campaign* in 1989 to incorporate other relevant issues such as the linkages between personal hygiene and environmental cleanliness, nutrition, proper yard maintenance, and home composting of organic wastes (Tutangata, 1999; SPREP: SKM-Solomon Islands, 2000).

As the project evolved over the years, a demonstration gardening and distribution centre was established under the project to educate participating householders, mainly women, on the techniques of vegetable gardening, composting and food preparation through a regular weekly gathering. The fundamental message of *Sup Sup Garden* was to recycle household organic waste into productive food gardens. They also employed some other interesting strategies such as using recycled tyres for small garden beds.

It is estimated that over 10 per cent of all households in Honiara were participating in the *Sup Sup* project. However, since each active participant was also able to pass on *Sup Sup* experience to two or three neighbours, it is estimated that the actual beneficiaries of the project were many more than the direct participants (SPREP SKM-Solomon Islands, 2000; Barker, 1990; *Pers. comm*.; Jansen, 2002; *Pers. comm*., Fanton, 2002).

Although the *Sup Sup Garden* program is no longer officially operating in Honiara, the concept is still fairly widely applied and understood so its efforts could be seen as a success. Aside from the work of the KGP which embraces similar concepts as *Sup Sup*, the Department of Agriculture has introduced a program that is promoting similar *Sup Sup* ideas and methods for urban gardening (*Pers. comm*., Jansen, 2002).

KGP also promote the separation of organic and inorganic household waste (e.g., tins, plastic, batteries etc.). They have recently been involved (through SIPMN) in lobbying on the issue of toxic waste dumping, in particular the proposed dumping in Makira province of 3 million tonnes of contaminated soil mixed with industrial residues, reputedly contaminated with heavy metals including mercury, lead and arsenic from textile factories in Taiwan. Recent SIPMN press releases call on Solomon Islands authorities to ban the importation of toxic residues into the Solomon Islands. SIPMN argue that the dumping of toxic material in Solomon Islands not only endangers the environment and human health of all local communities but could threaten the development of organic agriculture and a potential organic product market (SIPMN, 2002a; SIPMN, 2002b; *Pers. comm*., Jansen, 2002).

6.2.3 SIDAPP/People First Network

The People First Network was established as a not-for-profit organisation through the Ministry of Provincial Government and Rural Development. It has received funding and technical support from the Solomon Islands Development Administration and Participatory Planning Programme (SIDAPP), a project of the United Nations Development Programme (UNDP) and the United Nations Office for Project Services (UNOPS). The network aims to:

- Facilitate point-to-point communications to and from the remote provinces of the Solomon Islands;
- Facilitate rural development and peace-related information flows among all social groups; and
- Facilitate the exchange of information between communities and development programmes, NGOs, government offices, the media, businesses and other stakeholders.

The PFnet system, offering basic email services, seeks to improve connectivity while dramatically reducing the costs of communication, making it affordable and sustainable over time for low-income users. Particular attention is being given to gender equity and democratic governance.

PFnet has two key components. One is an Internet Café in Honiara, which allows residents of the capital city to access the Internet for all locations across the Solomon Islands or the wider Internet. The Café has been operational since February 2001 with ten workstations, and is already financially self-sufficient. The Café also serves as a training facility for a number of rural development stakeholders and community members.

The second and most important component of PFnet is the creation of a network of email stations located in remote islands across the country. The stations use a simple, robust and well-proven technology, consisting of a short-wave radio (already ubiquitous and well-known in the South Pacific), a low-end computer, and solar energy.

Initially, PFnet plans to deploy 25 remote email stations across the nine provinces of the country. This depends on available funds. However, once the system is in place, it is simple to add any number of stations on a modular basis. For example, an NGO upgrading rural clinics, a CBO operating a recycling scheme, a bank implementing a micro-credit scheme, or an environmental group running an eco-tourist site, may all wish to include a communication component to their projects (Tuqiri, 2001; Leeming, 2001; Biliki, 2001; *Pers. comm*., Agassi, 2002).

On October 10, 2001, the first of the PFnet rural email stations was deployed at Sasamunga in South Choiseul Province. Sasamungga is the name for a community of five villages, and is connected to a wider area with a population of around 2500 by a 14km road. It is the largest population concentration in Choiseul. Another email station will be installed in Ulawa, Makira/Ulawa Province in March 2002, and a further station will be constructed in Temotu in April 2002 (*Pers. comm*., Agassi, 2002).

The KGP is working with the People First Network to highlight its work including a proposal to establish an email station in North Malaita as a pest management advisory service. The PFnet offers the potential for an effective channel for exchange of information on *waste* management and pollution control issues and could be used to promote IWP activities and encourage feedback within and beyond the communities where pilot projects are being implemented.

6.3 Community Theatre in Vanuatu

Community theatre is particularly relevant to public understanding of sustainable development concerns. Throughout PICs, community theatre assists government, NGOs and Regional organisations in presenting environment

related discussions and messages in a flexible non-technical, interactive and entertaining format. It also allows community members to easily participate as carriers of the message.

Wan Smolbag (WSB) is a well known theatre company in Vanuatu, and its activities will be described here to illustrate the practical role theatre groups can play in community development and resource management. The core activities of WSB have been funded by a number of donors including the UK Department for International Development (DFID), UNICEF, AusAID and the Secretariat of the South Pacific (SPC). Ongoing funding is required for specific performances. There are many other local theatre groups in PICs, which are often part-time and rely on donations from agencies which request their services. Several of the projects described in Sections Three and Four benefited from the talents and creative input of local performers.

Wan Smolbag (WSB) began in 1989 when 15 voluntary part time actors established the NGO, Wan Smolbag Theatre to develop performances on social, environmental and population issues. The group specialises in 20-50 minute theatre pieces and travels widely including to remote villages on outer islands. It has formed strong links with communities and government agencies. At WSB, plays of 30 minute duration take about two weeks to write and rehearse before they are taken to towns and villages of Vanuatu. Ten minute specials created for conferences and meetings take about two or three days to produce. The troupe creates at least two new plays and tours six times each year.

WSB also adapts and teaches plays to associated theatre groups in Vanuatu and other PICs. There are seven theatre groups under the Wan Smolbag Theatre umbrella in Vanuatu. They are WSB 1, WSB 2, WSB Kids, Health Force, Tuk Welu, Whurhan and Haulua. Involvement with theatre groups in other PICs included a program in the Solomon Islands in 2001 where WSB conducted drama training, environment and health workshops, as well as various performances related to the environment, health, community and governance. WSB also worked in collaboration with WWF-SPP and Live and Learn Environmental Education in Fiji conducting workshops with teachers as part of Live and Learn's Development Drama and Green Schools Projects. In the village of Korobebe in the Koroyaniitu National Park, a drama called *Invasion of the Litter Creatures* was performed. WSB visited Cuvu Village in Singatoka, Fiji, working with the Cuvu theatre group, conducting workshops and performing at local schools in collaboration with FSP on the Wai Bulabula/Coral Gardens Project (Refer Section.4.2). Wan Smolbag has 21 plays in its active repertoire (Wan Smolbag, 2001b; Wan Smolbag, 2001c; *Pers. comm*., Walker, 2002; *Pers. comm*., Lucas, 2002).

As part of its community outreach, WSB has a drop-in centre and reproductive health clinic staffed by two nurses and seven volunteers and its own radio recording studio. WSB produces publications, music cassettes (including songs about the environment with a new tape planned for 2003 which will be accompanied by a users guide), videos, radio programs and posters. A feature-length film was produced on good governance (Wan Smolbag, 2001a; *Pers. comm*., Walker, 2002).

Wan Smolbag has a research department, which reviews the effectiveness of the plays and people's attitudes and needs regarding various topics. The main lessons that have been learnt by the theatre company are:

- Educational theatre needs to keep repeating the same messages in different forms;
- Research is essential, particularly into what people, especially young people, think and understand about topics such as AIDS, STDs and the environment; and
- Awareness-raising should be backed up with services where possible. This is the reason the theatre built its own drop-in centre, where services such as STD treatment and condom distribution can be provided.

Waste Management Play

In 2000, the WSB *Waste Management Play Production* Project was approved for assistance from the Canada Fund. The purpose of the project was to develop and produce a drama on *waste* management, to enable the population of Port Vila and surrounding areas, to have a better understanding of recyclable and re-useable urban rubbish, and to promote improved *waste* disposal methods in an urban environment. Health Force Theatre, who are based at WSB headquarters in Port Vila, and who are an associate group trained and managed by WSB, were employed to conduct the project activities.

The first step was for the HFT troupe to educate themselves about *waste* management and pollution control. The project research began with studying information from a SPREP-funded waste management survey that was conducted by FSP in Port Vila and Luganville. The material included a consultant's report on the Municipal Dump. HFT met with the Waste Management Committee which had been established specifically to work on SPREP's *waste* management project. The HFT group decided to target one community to attempt to improve their *waste* management practices, particularly the habit of dumping *wastes* into the river and sea, and the burning of plastics and other '*waste*'.

HFT met with a representative from the Department of Agriculture, and discussed the issues of burning gardens in peri-urban areas, and the potential for recycling of garden and food*waste* via composting and as animal feed. The troupe was informed that the Department of Agriculture did not support the burning of gardens, and encouraged agro-forestry using nitrogen-fixing trees inter-planted with garden crops. The department also encouraged people to

use branches from trees as mulch or for stakes and fencing. As part of their preparation, HFT visited an Agricultural Department demonstration plot that showed various methods of utilising organic *waste* as a resource.

HFT visited the Port Vila Municipal Dump and the Wan Smolbag Theatre's Environment Officer provided training in '*waste*' management practicalities. This included information on the different kinds of *waste* produced, how they break-down, composting of organic matter, recycling, burning of *waste*, dumping of *waste*, and the Port Vila Dump Site pollution and climate change issues. HFT also took part in the 2000 International Clean-up the World campaign, and they joined the 2001 Campaign Committee. They are also on the 2002 Committee for the Melanesian Arts Festival to assist with minimising *waste* at the festival and to promote cultural and bio-degradable alternatives to plastic.

As a result of their research and self-education, HFT started promoting a *waste* minimisation scheme at Wan Smolbag Haos. This proved to be quite difficult and demanded constant reinforcing. The company is re-using paper and disposing of food wastein a composting bin labelled *Kakai nomo* (food only). HFT also began talking with their neighbours at Tagabe to explain the environmental impacts of burning *waste* especially plastics.

As FSP had conducted a survey in the Municipal districts, HFT developed a survey with the assistance of WSB's research officer, for peri-urban settlement areas and villages outside the Municipal boundaries. The survey was conducted in 892 households and aimed to establish people's knowledge of different types of *waste* and the householders' methods for disposal. The survey indicated that the great majority of people were not recycling organic material (93 per cent of respondents did not make compost), and although respondents in the survey said that they divided *waste*, this did not include separating food and garden '*waste*' for compost. Other items were separated that could be re-used for various purposes.

All this information helped the troupe decide on the approach and content of their play

> The issue of *waste* management is huge and what needs to be addressed is complicated and diverse. So, as a group we decided that we should only focus on a few messages so that the messages in the play were not too confusing (Canada Fund Project, 2001).

The play was scripted by the troupe and senior WSB actors assisted with production over 3 weeks. Guests from various government and non-government agencies were invited to review the performance and provide feedback. WSB Environment Officer and the Director worked with HFT on after-show workshop activities including questions and games related to *waste* management to conduct with the audience.

Working with children

HFT subsequently performed to a total of 2,750 people, in 21 schools and 16 communities on the two islands of Efate and Santo. Radio programs and posters supported the performances. HFT made 20 trips, with 20 different school groups, to the Port Vila dump sites. They explained the problem of the dump filling up much faster than expected, and showed them the different kinds of *wastes* there, and then the children were asked questions to test comprehension about *waste* minimisation (Canada Fund, 2001; Wan Smolbag, 2001).

Many children wrote letters to HFT in English to express their enthusiasm, and the example provided below indicates how powerful theatre can be in conveying messages that could otherwise be dismissed as irrelevant and authoritarian. Effective theatre allows the audience the space to identify with the subject matter and have a genuine response to the message.

> To the Actors,
>
> Waste Management Play, One small bag theatre
>
> Dear Actor
>
> Thankyou very much for performing your play for us, We really enjoyed it and we wish next year you will perform again another play for us. I really loved it, and it was very exciting. My favourite part was when father was talking to the sons about their ground and told them to look after it, but the sons said Don't worry about the ground. I'd also like you to write out all the songs and send it to our school about not throwing rubbish in the bush and teaching us not to plant (sic) it near the sea or the river. And we look forward to seeing another play again.
>
> Yours sincerely
>
> Wendy Mera, Class 6, Central Primary School, Port Vila (Canada Fund 2001).

The Director of WSB reported that they plan to go to phase two of the *waste* management project, if they can secure funding, and establish a schools monitoring system with the students. The schools network would build on the performances and trips to the municipal dump that the HFT conducted in 2001. They want representatives from each Class 6 on a committee to look at supervising disposal in schools around the town. They would encourage the committee to lobby other students and the teachers to develop educational materials together, and also to make a radio program in the WSB studio. The Director expressed the opinion that changes in behaviour in relation to*waste* management

and resource protection will take at least a generation to be achieved and information exchange needs to be ongoing and responsive (*Pers. comm*., Walker, 2002).

It could be useful to include a related theatre production as part of a IWP pilot project to promote objectives in an engaging format, especially in schools.

6.4 Live and Learn and Green Schools in Fiji

Live and Learn (LLEE) was established as an NGO in 1999 with the objective of building the capacity of teachers to promote peace and stability through environmental education. LLEE's philosophy considers the environment in its totality including the ecological, political, physical, technological and sociological conditions. It also recognises the value of local knowledge, practices and perceptions in enhancing sustainability. Environmental education should be interdisciplinary and can be taught across the curriculum, with an emphasis on participatory problem solving to foster a sense of personal responsibility, motivation and commitment.

Live and Learn is working in partnership with WWF under a Memorandum of Understanding. Live and Learn and WWF complement each other in the sense that WWF is a resource for materials, leaflets, posters and Live and Learn has the expertise in hands-on education such as training of teachers and learning methodologies. WWF is the focal point for the Television Trust for the Environment (TVE) network which is a useful resource for educators. LLEE, WWF and the Wan Smolbag Theatre are collaborating on a THREE year environmental education project.

The Live and Learn Green Schools Fiji (GSF) project commenced in 2000 as a pilot project funded by the Japanese Government and has been introduced into 120 schools. GSF emphasises a research action-based approach to Environmental Education in which teachers and students work together to monitor and evaluate their own values, practice and progress in improving the environment. The focus has been on the development of critical thinking skills through environmental schools audits. LLEE's strategy is to strengthen the teacher's capacity to facilitate a process where the students were in charge and felt they owned the particular problem(s). So the prime objective of GSF is not to raise environmental awareness but to strengthen creative thinking skills and build capacity for change through a participatory learning process.

FSP-Fiji has requested LLEE to assist with the training of teachers in Sigatoka as part of the Wai Bulabula/Coral Gardens initiative (Refer S.4.2.2). This will commence in March 2002. FSP has provided LLEE with support during workshops in the areas of theatre and drama.

During LLEE's work with teachers and schools they found that *waste* is one of the three top concerns among students and teachers after river pollution and climate change. Many groups, communities and schools are involved in clean-up campaigns and *waste* awareness. But LLEE have found no evidence to suggest behavioural changes in the community from these campaigns. In fact, their view is that most clean-up and '*waste*' awareness campaigns are short lived and ineffective.

It was found that when LLEE have not directly promoted *waste* management as a problem many teachers, communities and students have identified '*waste*' as a community and government concern. It was reported by the LLEE coordinator that a community component of a successful *waste* management project would include a thorough understanding of the beneficiaries' perception of '*waste*' and the environment. This understanding would help to eliminate assumptions that are often made before project implementation commences. LLEE has found that it is particularly important in environmental education to protect the learning process rather than push a particular issue. In other words, that people identify and investigate for themselves and come to their own solutions. LLEE has found that if the learning process is protected, the outcomes are more sustainable. Promoting certain issues comes at a high risk to the sustainability of a project (*Pers. comm*., Nielsen, 2002; Nielsen and Rabici, 2000).

6.5 Ecowoman/SPACHEE

Ecowomen is a collective of Pacific women engaged in science and technology, which aims to strengthen linkages between professionals in science and technology and their urban and rural counterparts in communities. The collective's stated objectives are to:

- Advance equity and empowerment;
- Foster respect for traditional knowledge;
- Facilitate access to education and skills;
- Promote concern for and care of the environment for present and future generations; and
- Lighten the load for women.

Ecowoman was established as a long-term initiative of The South Pacific Action Committee for Human Ecology and Environment (SPACHEE) supported by the South Pacific Peoples Foundation of Canada (SPPF). SPACHEE provides

a central point for expert knowledge on environmental issues and has worked to raise government and popular awareness of environmental topics. This has included projects in urban and peri-urban settlements on developing gardening and yard cleaning services, the production and sale of compost, and improving sanitation (OFANews, 2001; OFANews, 2000; Ecowoman, 1998; *Pers. comm*., Lechte, 2002).

Of particular interest for this review is the work of Ecowomen/SPACHEE in programs related to community-based *waste* management and the development of a Participatory Learning and Action (PLA) Trainer's Guide and a Community Environment Workshop Handbook for Women. The PLA manual draws on local experiences gained in conducting PLA projects in Fiji but emphasises that every situation is unique and training modules should be flexible to adapt to circumstances. The manual is for the use of local leaders, government and non-government organisations and anyone wanting to incorporate PLA techniques when working with communities. PLA uses versatile participatory tools and techniques to democratically engage participants in a mutual education process. PLA is used to gather information about certain topics, such as *waste* management practices, through the experience and decision-making shared by communities (Refer Section.4.3.3).

The Community Environment Workshop Handbook for Women is a guide for women leaders in planning and conducting workshops on themes such as *waste* management. Examples of *waste* management initiatives presented in the handbook include a *Household Waste Management Workshop* and the objective of the workshop is to assist women to think about their consumer habits and to find healthy and environmentally friendly alternatives. Issues addressed and activities undertaken at the workshop included:

- An analysis of the participants household shopping list and associated packaging;
- Investigating how rubbish is disposed of, and how long it takes to decompose;
- Ways in which household *waste* can be reduced, reused and recycled;
- The impact of household chemicals;
- Healthy and safe alternatives for household chemicals;
- Hazardous *waste* and what to do with it;
- The effect of poor *waste* management on health;
- Types of appropriate technology available and the associated benefits for women and the environment from utilising it;
- Biological waterless toilets; and
- The environmental impacts of disposable diapers.

Another example of a community-based Waste Management Project presented in the handbook is Vision Fiji's development of cheap community rubbish bins from 44 gallon drums. The drums are mounted between two pine posts on a swivel so that the rubbish collector can easily empty the contents. Small holes are inserted into the bottom of the drums to allow rain and moisture to pass through. The bins are also at a sufficient height above the ground to prevent dogs from reaching the contents. The bins are painted bright yellow and a campaign was conducted in schools and service clubs about using the bins.

The handbook also presents a method of recycling plastic shopping bags by weaving and crocheting them into useful products such as handbags, evening bags, change purses and backpacks. The bags can have inside pockets, are decorated with local resources such as shells, are durable and washable. This craft using recycled plastic bags was developed by women in the Marshall Islands (SPACHEE/Ecowoman, 2000; Ecowoman, 2000).

SPACHEE is involved in a program to convert Water Hyacinth weed into fertiliser and weaving material, and is in the process of teaching communities involved in the Wai Bulabula project how to weave with the copious amounts of Water Hyacinth being harvested from the constructed wetland ponds (*Pers. comm*., Bowden-Kerby 2002; *Pers. comm*., Lechte, 2002).

SPACHEE collaborates with the Department of Environment (DoE) and the Education and Awareness Unit (EAU), and other government departments and NGOs on environmental education activities, including being on the management committee of the Fiji EcoVan (*Pers. comm*., Penjueli, 2002; *Pers. comm*., Tokaduadua, 2002) (Refer Section 6.6).

An example of the outreach achieved by Ecowoman/SPACHEE is provided in the following story. When one of their colleagues arrived to live on Makogai Island in 1991 she found malnourished children, dry and infertile land, water shortage, a scarce vegetable supply, a shortage of medicinal plants, and a community of 123 people divided into six Christian denominations. Using ideas she learnt from an Ecowoman Waste Management Workshop, she taught the community to set up compost heaps, initially under shady trees to conserve moisture, and the community was asked to spill all the '*waste*' water from their kitchens and bathing into the heap. After three months the compost heaps were used

to develop a vegetable nursery. Cut grass and fallen leaves were spread on the barren land and the women were asked to do their laundry and dishwashing in that area. Earthworms flourished in the area after four months and the land was then tilled and a vegetable garden was cultivated. Soon each household started making their own composts and planting vegetables, fruits and flowers. Medicinal plants were inter-planted in the garden and their strong scent deterred pests.

Members of the community now exchange fruits and vegetables, and the diet and their children's health has improved. From this experience the community realised the importance of working with their environment and have decided, among other things, to ban bush burning for five years (Ecowoman, 2000).

6.6 The EcoVan in Fiji

There are an increasing number of government sponsored environment education facilities throughout PICs and this trend encourages co-operation between government and community in regard to environmental management and protection. This co-operative relationship is particularly important in PICs where environmental regulations are often non existent and/or are rarely enforced. The EcoVan operated by the Department of Environment in Fiji and it's agency, the Education and Awareness Unit (EAU), is a mobile multi-media environmental education facility. The EcoVan was donated by the British government and Shell Fiji Ltd. who has been providing free fuel for the vehicle.

Other ministries and agencies in Fiji are also able to use the EcoVan for their environmental awareness programs. A departmental policy has been instituted that covers hiring procedures for the Ecovan and a maintenance program for the vehicle and its equipment. It is reported that one of the major constraints for the optimum utilisation of the Ecovan is the general staff shortage that prohibits continuous use of the Ecovan throughout the year.

There is increasing demand from schools for EcoVan environmental exhibitions and activities. Community programs are often provided in the evenings, and during specific campaigns. Programs, in which the DoE has utilised the EcoVan include the following activities:

- A week-long environment exhibition organised for the Western Division.

  In collaboration with Lautoka City Council attended by 2000 students. The exhibition was assembled by different government departments and NGOs in the Western Division. The exhibition included display boards, environmental games, scientific instruments, energy saver tube lights, and environmental literature. The show was the first of its kind in the area and was designed mostly for schools in the Division. The subjects covered during the show were the ozone layer, climate change, turtles, mangroves, waste management, forest management, coral reefs and sustainable development. This was linked to the Wai Bulbula/Coral Gardens project (Refer Section.4.2) which was being conducted in that District.
- A promotion tour by the EcoVan to schools and departments around Viti Levu to provide teachers and officers with background information on the purpose and future usage of the EcoVan. The trip was also used to distribute an environment calendar and school packages produced by the department.
- Participation in Environment Awareness campaigns conducted by other organisations. For example, the Ecovan is extensively used in the National Tidy Towns Competition, National Environment Campaign, International Ozone Day, World Water Day, Clean up Days, University Open Day, National Arbour Week and National Food Day Celebrations. The exhibitions display material provided by different organisations which highlights their environmental activities and includes video shows, and hands on activities.

In addition to these exhibitions, the van is provided free of charge for use during environmental campaigns (*Pers. comm*., Tokaduadua, 2002; *Pers. comm*., Penjueli, 2002).

6.7 Participation in Regional Workshops

International gatherings of representatives from various communities can provide an opportunity for participatory education and information exchange, if conducted with that purpose in mind. Often what takes place informally between meetings is as significant as the organised agenda. A regional community is established in one location, if only for a finite period, and the personal connections that are made can create networks of communication which allow ongoing sharing of information, when people return to their own countries. It is important in the PICs, where communities are scattered over vast distances, and meaningful communication tends to only take place on a face-to-face basis, that these gatherings regularly occur, when funding permits.

Stakeholder Meeting

One such gathering, of relevance to this review, was the *Regional Meeting for Stakeholders in Wastewater Management in the Pacific* which took place on 10-15 October 2001, in Majuro, Marshalls Islands, followed by a workshop on *waste* management technologies. The objective of the Stakeholder meeting was to discuss a draft policy statement on *waste* water and to develop a regional framework for action. The program included presentations covering

a range of public health and conservation issues related to *waste* water management, and field trips to sanitation and water facilities in Majuro (SOPAC, 2002).

Representatives from the following countries attended the meeting, American Samoa, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, New Zealand, Niue, Papua New Guinea, Palau, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. Also in attendance were technical advisers from in and outside the region, and personnel from regional and international organisations (SOPAC, SPREP, SPC, PWA, WHO, UNESCO, UNEP/GPA).

Environmentally Sound Technologies Workshop

Following the Stakeholder policy meeting, there was a three-day workshop on *Environmentally Sound Technologies (EST) for Integrated Waste Management in Pacific SIDS*. The participants discussed suggested technologies and practices for management of liquid, solid, and hazardous *wastes* for a regional EST Directory (UNEP-IETC 2001). This information and the References in Section Seven provide the technical background for the strategies discussed in this review.

Although the workshop was attended by government representatives, these people can take back to their communities the information and perspective that an international gathering can provide. For example, the Manager of the *Tuvalu Waste Management Project* (Refer Section 4.3) was able to share his experiences regarding various strategies that were being trialed in the WMP, such as the collection of hazardous *waste* from within the community, and whether fishermen can be persuaded not to use lead from batteries. Similarly, the Environment Officer from Nauru had the opportunity to discuss with the workshop participants his concerns regarding disposal of sewage from the temporary refugee camps located on Nauru. Members of the group suggested basic strategies, which might help reduce pollutant loadings (*Pers. comm.* Adagio, 2001; *Pers. obs.*, Crennan, 2001).

Gender Equity

The fifteen PIC delegates were predominantly from the water and sanitation sector, although several personnel were from other government organisations such as Ministry of Works, Environmental Protection Authority, Waste Management, and the Ministry of Lands Survey and Natural Resources. All the PIC delegates and the majority of the advisers at the meeting were men. This is incongruous, given that it is usually women who have responsibility for the management of water and sanitation in the home. Even though men are more likely to undertake the technical training to manage centralised systems, less than 10 per cent of the population in PICs is serviced by reticulated sewerage systems. The other 90 per cent maintain their own household systems and practices, and they should be represented. Efforts should be made toward a more inclusive gathering at future meetings concerned with such critical issues as the conservation of natural assets, and the health and quality of life of PIC communities.

6.8 Participatory Education and the IWP

The pilot projects planned as part of the IWP activities have the potential to be a valuable exercise in participatory education and information exchange. This review has identified the following community-based *waste* management issues and strategies that could be included in the pilot project program:

- Village composting enterprise for green *waste* (Refer Sections 4.3, 4.7 and 5.5);
- Integrated biosystem using pig manure (Refer Sections 5.4 and 4.5.3);
- Minimising the use and impact of disposable diapers (Refer Section 4.4.3);
- Composting toilets: domestic and public (Refer Section 3.2 and Section 4.7);
- Co-composting of septic sludge and green *waste* (Refer Section 3.5.1);
- Recycling used vehicle oil (Refer Section 5.6.3);
- Minimising use and impact of agricultural chemicals (Refer Sections 5.3, 5.6.3 and 6.5);
- Household compound *waste* management system including pig raising and greywater re-use, and organic gardens (Refer Sections 5.3 and 6.2.3); and
- Village management of *waste* separation and litter prevention (Refer Section 4.4.3 and Section 5.2).

Some of these project possibilities have been described in more detail in Annexes III and IV. The promotion of the IWP program could be supported by interactive media such as community theatre (Refer Sections 3.2.1 and 6.3) and the low-tech rural email networks currently being established in PICs (Refer Section 6.2.3).

The process of community involvement in the IWP should allow participants to identify their own priorities, and this perspective should be accommodated within the priorities of the IWP. For example, concern for sick children is more likely to motivate change in *waste* management practices, than the threatened loss of species diversity (Refer Sections 2.4 and 2.5). To maximise potential for technology transfer, all stakeholders need to be included in project

design and implementation, benefits need to be demonstrated to create demand, and commitment and incentives incorporated to ensure ownership (Refer Sections 3.3.2, 3.4, 4.4.2, 4.7).

This review has not included technical or design detail for the various *waste* management strategies discussed, or for the proposed pilot projects. There are many manuals, publications and reports available that provide this information specifically for PICs and, in general, for developing and developed country conditions. The References in Section 7 include this material. The review has focused, instead, on the relationship between people, technology, and the natural environment. Various programs and initiatives have been examined where an attempt is being made to understand and improve that relationship in order to protect public health and conserve natural assets. This is to suggest that, in any country, the most appropriate technology should be applied in each location, and that a selection from a range of equally accessible technical options should be based on a thorough appraisal of the cultural, socio-economic and ecological context to be serviced.

Annex I: Glossary of Terms

Aerobic	A biological process facilitated by aerobic microorganisms living and acting in the presence of free oxygen.
Aquifer	A saturated, permeable geological unit that can transmit significant quantities of groundwater under ordinary hydraulic gradients.
Anaerobic Digestion	A biological process which occurs in the absence of oxygen facilitated by the activities of anaerobic microorganisms.
Bring Centres	Bring centres are used to collect bulky waste, segregated recyclable items and hazardous domestic wastes. The generator is required to bring these items to the centre or bin location. Civic amenity sites are an example of bring facilities. Also known as drop-off-points.
Borrow Pits	Ten quarries that were created by the United States during WWII to build an airport at Funafuti, in Tuvalu. Over the years they have been increasingly used as rubbish dumps.
Carbon	A widely distributed element which forms organic compounds in combination with hydrogen, oxygen etc. Products containing high levels of carbon are paper, cardboard, wood products and sawdust.
Carbon Nitrogen Ratio	The ratio of carbon to nitrogen indicates its source of decomposition. Balancing the carbon/nitrogen ration is important during composting to facilitate decomposition while maximising nutrient retention.
Catchment	A drainage area or basin in the context of both surface water and groundwater. Also, the terms catchment and watershed can be used interchangeably, with the term catchment being more commonly used.
Circular System of Resource Management	Emphasises resource conservation, and the recovery of materials and nutrients via recycling and reuse within a circular system based on the household, the community and the municipality.
Compost	A mixture of various kinds of decomposed and decomposing organic matter used as a slow release fertiliser and soil conditioner.
Composting	The controlled aerobic decomposition of organic materials.
Disposal	The final process in solid waste management, in which the solid waste is put in its final place. Disposal relates to the residue after waste has been segregated, reused and recycled.
Domestic Solid Waste	Solid waste generated at private residences / households.
Ecological Sanitation	Recognises that outputs and wastes of one system are inputs to other systems, and that actions taken now have unpredictable effects for decades to come. Manages waste as close as possible to its source; minimises the use of water to transport waste; and develops and utilises appropriate or intermediate technologies to encourage household and community-level construction, operation and management of facilities, and permit re-use and/or disposal at the local level.
Effective Demand	Educated demand for behaviour change which aims to bring about total community participation and ownership of a programme.
Eutrophication	The process of a water body becoming enriched with nutrients that stimulate aquatic plant growth, such as algae, resulting in depletion of dissolved oxygen.
Free on Board (fob)	A term of sale meaning that the seller agrees to deliver the merchandise aboard the carrier without extra charge to the buyer.
Freshwater	Water that is suitable for use by humans but may not be potable, owing to microbiological contamination. Freshwater is generally taken to mean water that has an acceptably low salt content. When salinity of the water is above an acceptable limit, it is often referred to as brackish water.
Freshwater Lens	A specific type of aquifer found on small islands consisting of a freshwater zone overlying and in contact with seawater. Between the freshwater zone and the seawater, a transition zone occurs where salinity gradually increases with depth.
Garden Waste	Organic waste from gardens.

Generator of Waste	Any person or organisation that discards material as waste. (Not the same as a producer of waste, which is a manufacturer of items that become waste).
Green Waste	Organic wastes including garden waste, food and wood wastes.
Greywater	Also know as sullage, comes from kitchen, bath, shower, and laundry. Comprises organic matter, fats and oils, skin cells, body fluids, microorganisms, and sometimes household chemicals. As opposed to blackwater, which is waste water from the water toilet containing high percentage of urine and faeces.
Incineration	Contained burning / combustion under controlled conditions.
Informal Sector	Individuals and organisations working for financial gain without being registered as an enterprise or being licensed or taxed as an enterprise.
Intermediate Technology	Technology that is simple, understandable and suitable for maintenance and repair at the local level and incorporating the best of local knowledge, skills and resources.
Landfill Waste Disposal	The practice of filling land with waste materials.
Leachate	Water that has percolated through landfilled waste and generally contains contaminants absorbed from the waste material.
Maneaba	The *maneaba* has a central position in the community life of the I-Kiribati. Usually a large open sided building, it is regarded as a meeting house of justice, entertainment and accommodation.
Manual Pit LatrineEmptying Technology (MAPET)	The Netherlands Ministry of Development Co-operation financed a project between 1988-1992 to develop appropriate pit emptying technologies for low-income, unplanned areas of Dar-es-Salaam. Typically, a team of MAPET emptiers consists of three people, each of whom is self-employed. Each team is responsible for the continuity of its activities and income. As a team they decide how to co-operate to share the work load. Each team works full time and depends on its own efforts to find customers.
Natural or Environmental Assets	Comprise non-renewable resources such as minerals and fossil fuels; the finite capacity of natural systems to produce renewable resources such as food crops, forestry products and water supplies; the capacity of natural systems to absorb emissions and pollutants; and the provision of ecological services such as waste assimilation, erosion and flood control and ultraviolet radiation protection (also considered natural income).
Natural or Environmental Capital	Refers to any stock of natural assets that yields a flow of valuable goods and services into the future such as a forest, fish stock or aquifer.
Nitrogen	A colourless, odourless, gaseous element which forms about 78 per cent of the volume of the atmosphere and is the primary constituent in all living matter.
Nitrogen Cycle	The continuous circulation of nitrogen and nitrogen compounds in nature between the atmosphere, the soil, and the various organisms to which nitrogen is essential.
Organic Law	In this case refers to the The Organic Law in PNG of Provincial Governments and Local Governments, 1996. Organic law is any written or positive rule of conduct, or collection of rules of the people, prescribed under the authority of the State in its constitution.
Potable Water	Freshwater that is safe to drink by humans. This means it does not contain any substances or organisms that are harmful to human health. The World Health Organisation (WHO, 1993) and other organisations publish guidelines for potable or drinking water based on acceptable physical, chemical, microbiological and radiological criteria.
Pulenu'u	The village mayors who are elected by the Ministry of Internal Affairs (Samoa).
Putrescent Waste	Waste which undergoes rapid biodegradation, e.g., household commercial food waste, and food processing waste.
Recycling	Returning material discarded as waste to the economy - the concept of a cycle or loop. This usually involves some form of sorting and processing but sometimes items that are taken from the waste stream and reused without processing.
Reprocessing	The conversion of waste materials into another product such as paper products into a building material or converting organic waste materials into compost (which facilitates recycling of carbon and nitrogen and other nutrients).

Resource Recovery	A wider term than recycling as it includes the recovery of energy from waste, by burning it or making gas which is used as a fuel. Also used generally to mean recovering useful material from waste.
Re-use	Re-use of waste materials, e.g., used glass jars for storing household food items.
Rotaloo and Natureloo	Commercial brands of composting toilet.
Sanitation	Study and practical application of sanitary measures. In this review sanitation refers to the management of human excreta and greywater. The term is also culturally specific, e.g., in the US sphere of influence sanitation is used in a broader context and often includes solid waste management. In the US context wastewater management is used instead of sanitation and usually refers to waterborne and waterless (or dry) sanitary measures.
Segregation	Keeping separate so that items that are segregated are never mixed at any stage.
Separate	Refers to segregation when used as an adjective (as in separate collection) so that two or more streams are never mixed at any stage, or when used as a verb (sorting) refers to extracting one type of material from a mixture.
Separation	Usually means sorting.
Septage	Solids and liquid from septic tanks.
Sewage	Toilet and liquid biological waste, i.e., faeces, urine and greywater. Can also refer to any matter transported in sewers such as industrial or agricultural effluent.
Sewerage	System of pipes and pumps that transports sewage.
Social Capital	The relations between individuals and groups. For example, mutually recognised bonds, channels of information, or norms and sanctions. It is the value of these aspects of the social structure that can be utilised as resources to fulfil the interests of the particular community.
Solid Waste	Garbage, rubbish, trash, (in solid form).
Sludge	Heavier solid particles in waste water that are difficult to break down and which settle out.
Sorting	Sorting means selecting certain categories of materials from mixed ‘waste’, so that items that are removed may have been contaminated by unwanted materials.
Ta’ovala	Ceremonial or decorative woven wrap, worn around the waist by Tongan men women and children.
Tokai	Means the picker. Scavengers who retrieve materials from the rubbish dumps and streets of Bangladesh.
Vermiculture	Using worms to process biodegradable waste to make a fertilizer or soil conditioner.
Waste Management Facility	A facility which manages waste materials and may encompass a recycling centre, composting facility, and landfilling operation.
Waste Management Hierarchy	A priority list for waste management measures typically encompassing waste avoidance/ prevention, waste re-use, recycling, reprocessing, waste treatment (energy recovery) and waste disposal (landfill).
Waste Water	Water carrying wastes from homes, businesses and industries that is a mixture of water and dissolved or suspended solids.
Waste Minimisation	Any activity that reduces the amount of waste generated. That is, reducing the amount of material that is at any time classed as waste. Includes waste avoidance and waste reduction, but in some usage does not include recycling.

Annex II: Waste Management Options (Adapted from Dever 1999)

WASTE TYPE	AVOIDANCE	RE-USE	RECYCLING	REPROCESSING
ORGANIC WASTE Kitchen waste, garden waste coconut husks and palm fronds	Plant low waste generation plants-low maintenance garden Do not collect grass clippings Plant different vegetation	Feed pigs, chickens, dog. Some green waste can be used as mulch to conserve soil moisture and keep plant roots cool	Mulching with organic matter is also a way of recycling carbon, nitrogen and other nutrients. Reprocessed organic matter via composting is also an effective method of recycling carbon, nitrogen and other nutrients	Home composting of vegetable matter, NOT meat. Some plants (e.g. palm fronds) can not be composted. Requires separate collection and centralised shredding and windrow composting
METALS Steel cans, old cars & vehicles, appliances, equipment, aluminium Can, other scrap metal	Import controls to encourage use of economically recyclable packaging eg. Aluminium cans, and to fund (subsidise) export recycling and/or local reprocessing. Rationalise (control) number of models imported	Cans have limited opportunities-use for household storage Local reuse for parts-establish formal reuse scheme if not currently in existence Local refurbishment/reconditioning and resale Local reuse via waste exchange eg. window frames	Export to NZ, Australia, US or Fiji for recycling (subsidised by import duty)	Export to NZ, Australia, US or Fiji for reprocessing (subsidised by import tax)
PAPER Newspaper, writing paper, magazines etc Cardboard Liquid Paper Board Sanitary	 Use cloth nappies	Mulch on gardens etc Possible-e.g seedling containers	Export for recycling, garbage separation at kerbside needed, transport should be subsidised As above As above	Can be shredded and feed to a worm farm or composted as high carbon material
CONSTRUCTION Plastics, metal, wood, concrete, plasterboard, ceramics, containers, fibreglass and asbestos	Import controls to use economically recyclable materials	Off cuts, left-over materials can be sent to waste exchange centre, some containers can be reused for other products	Metal off cuts and steel can be exported to Australia, NZ, Fiji, or US	Metal off cuts and steel cans can be exported to Australia, NZ, US or Fiji Ceramics can be crushed for road fill
PLASTICS PET, Rigid and flexible HDPE, PVC	Import controls eg. bans, tariffs, levies, duties -to encourage local glass bottle reuse scheme, to discourage the importation of products packaged in PET, and to fund (subsidise) export recycling Buy products in recyclable aluminium can Buy local soft drink bottled in re-useable/ returnable glass bottles Encourage use of	Reuse for water /liquid Storage within the home Use plastic threads to make crafted bags for sale, and for decorative accessories Encourage re-use of shopping bags ie. take old ones to the supermarket and use again. Use shopping bags for other purposes around the home e.g. as storage bags	Export to NZ, Australia, Fiji or US for recycling (subsidised by import tax) for PET, HDPE (rigid) others not commercially viable	Export to NZ, Australia, Fiji or US for recycling (subsidised by import tax) for PET, HDPE (rigid) others not commercially viable

WASTE TYPE	AVOIDANCE	RE-USE	RECYCLING	REPROCESSING
PLASTICS (cont)	re-useable shopping bags or baskets. Implement charges for shopping bags to minimise use			
GLASS				
Bottles, jars	Import controls to encourage use of economically recyclable packaging eg. aluminium can, and to fund (subsidise) export recycling and/or local reprocessing	Encourage/support local glass bottle re-use scheme-by imposing import controls (levies) on non locally recyclable materials eg. PET		Crush and use for drainage aggregate, fill material, concrete aggregate
Windows, mirrors		Encourage re-use in households. Establish formal reuse system eg. second hand building supplies		
TEXTILES				
Clothes, curtains, carpets etc		Re-use within the family. Local reuse eg. via church, op shops etc. Reuse as rags. Local reuse via waste exchange		Not feasible
HOUSEHOLD HAZARDOUS WASTES (HHW)				
Old household / garden chemicals and poisons	Education to minimise consumption. Use all product as recommended.	Waste chemical exchange		
Old medicines	Use all product as recommended			
Batteries (small)	Education to limit use and encourage use of rechargeable batteries	Nil	Technology still under development	Not feasible
Vehicle batteries		Recover lead for limited safe local re-use	Recover lead for export recycling. Export to NZ, US,Australia, or other recycling (subsidised by import levy)	
Oil (automotive)	Education to minimise waste oil generation		Export to NZ, US, Australia or Fiji for recycling (subsidised by import duty)	As for recycling
Paint	Use all paint	Local re-use via waste exchange	Export empty cans to NZ, Australia, US, or Fiji for recycling (subsidised by import duty)	
Aerosol cans	Better management of usage. Encourage use of alternative products eg. in re-useable pump spray packs or recyclable packaging	Nil	Export to NZ, US, Australia or Fiji for recycling	As for recycling
Other		Local re-use via waste exchange	Export to NZ, US, Australia for recycling (subsidised by import levy	As for recycling
Tyres		Export to NZ, Australia, US		

WASTE TYPE AVOIDANCE	RE-USE	RECYCLING	REPROCESSING
WASTE WATER			
Human excreta		As composted fertiliser and biogas	Composting toilets, and biogas plant
Sewerage		Nutrient for plant production in ponds, composted or dried sludge as fertiliser	Constructed wetlands, anaerobic biodigestion, algae ponds and biogas, sludge composting
Greywater		Water source for tree crops and selected gardens	Wash water gardens, evapotranspiration trenches and absorption or infiltration beds, fish ponds, constructed wetland, sand and other simple filtering systems
Animal excreta		Fertiliser for crops and fish	Composting or co-composting with other manures or biodegradables, anaerobic bio-digestion, algae ponds and biogas production

Annex III: Outlines of Potential Community-based Project Activities

Suggested Pilot Project No 1: Automobile waste management

Project Goal

To improve the management of waste materials produced from private and small business motor vehicles and so minimise the environmental impact of increasing vehicle numbers.

Background to Project

A comparatively recent trend in some PICs, (for example Tonga and Samoa), is the increasing number of imports of used motor vehicles from Japan and elsewhere in Asia. These imports often tend to be older vehicles of poor quality not accepted in markets in New Zealand or Australia (e.g flood damaged vehicles). While they provide mobility for the owners, the motor vehicle is a major source of waste materials and pollution to the wider environment (used oil, solvents from servicing, paint residue, heavy metals from tyres and engine wear, tyres and car bodies). Furthermore, in the corrosive tropical environment the service life of vehicles is short. Derelict cars are an increasing problem, being a bulky waste item that is difficult to dispose of. Available landfill machinery is usually not large enough to crush car bodies.

Initiatives are under way in some PICs to counter some of the effects of increased vehicle ownership. Schemes for waste oil recycling being developed by the oil companies and lead acid battery recycling. For example, Tonga is introducing a code of practice for the automotive repair industry.

However there are obstacles to improved vehicle waste management, including the low level of awareness of the threat to water supplies of inappropriate disposal of wastes such as oil or batteries. There needs to be increased community awareness of the contribution that vehicle usage makes to waste problems. Action is also required at a governmental level to provide infrastructure for the removal of bulky wastes such as car bodies. Action to improve the management of automotive waste could contribute to the SAP goals of protecting surface and groundwater quality.

Suggested Location

A suitable location for an Automotive waste pilot would be an island with a reasonable sized urban area and private (and public) vehicle fleet, with an oil recycling program in its initial stages. An atoll or low coral island with reliance on groundwater for potable water would be appropriate, or alternatively a location with a sensitive shallow enclosed lagoon where urban stormwater runoff was an issue.

Specific Project Objectives

These could include among others:

(i) To increase awareness among communities of the types of waste and problems caused by motor vehicles;

(ii) To increase participation rates in any existing recycling projects related to motor vehicle wastes (e.g. oil or batteries);

(iii) To develop new local businesses;

(iv) To increase the proficiency of automotive repairers in managing waste materials; and

(v) To encourage beneficial uses for waste materials such as tyres.

Project Outputs

(i) Community education campaign and supporting materials specific to automotive waste;

(ii) Code of practice for automotive businesses; and

(iii) Collection and reporting of specific data on vehicles and waste components arising and recycled Project Tasks.

The project could include the following activities:

(i) Project initialisation and consultation with community, automotive businesses, chamber of commerce and government agencies in target area;

(ii) Seeking assistance and sponsorship from vehicle importers and dealers;

(iii) Literature review;

(iv) Collection of data on vehicle and component imports;

(v) Collection of data on any existing recycling/reuse;

(vi) Survey of visible evidence of automotive waste (derelict vehicles, oil containers, batteries);

(vii) In consultation with industry prepare a code of practice for environmentally sound automotive repair, submit code to government for approval;

(viii) Publicity of available recycling facilities for oil and batteries;

(ix) Presentation of findings to automotive repair industry; and

(x) Prepare publicity material (posters) for automotive outlets.

Community and NGO inputs

Main community and NGO inputs would be through industry groups such as Chamber of Commerce, any automotive industry association and fleet operators such as taxi companies. Schools or environment NGOs would have a role in data collection and monitoring.

Verifiable Indicators

Key verifiable indicators of project success would include:

(i) Statistics on recycling/return of materials such as oil (available through oil companies or Department of Trade and Industry);

(ii) Surveys of public awareness of facilities for automotive waste collection; and

(iii) Visual count of automotive debris in public areas and allotments.

Related Activities

This project would relate closely with urban water quality projects, for example measuring oil contamination of groundwater or urban runoff. The project could be the catalyst for a government or external donor project aimed at removing car bodies for disposal.

Suggested Pilot Project No 2: Green pigs

Project Goal

To improve the management of waste materials produced from pig rearing and maximise the recycling of organic waste to pig feed.

Background to Project

The raising of pigs is an important livelihood activity for many rurally based pacific islanders. On a small scale with isolated households the pigs perform a valuable recycling service and cause few problems. However with increasing density of settlement and more intensive pig raising, problems increase. Where pigs are penned in confined quarters the run-off can be a significant source of nutrient and bacterial pollution to surface and groundwaters. An example is the piggeries beside the internal lagoon on Funafuti, Tuvalu. Free ranging pigs cause a different problem by rooting in refuse bags and compost heaps.

On the other hand, pigs are excellent recyclers of organic material. Large amounts of vegetable and food scrap that would otherwise contribute to organic leachate from landfills are diverted to pig food in the islands. The manure from the piggeries is a potential source of fertiliser for agriculture, particularly if processed first through composting or vermi-composting (worm farming). (Vermi-culture with pig manure is not effective if the pigs are dosed with antibiotics, as is the case in some piggeries).

Suggested Location

A suitable location for Green Pigs would be a village location with an established pig raising industry. Preferably it would be one where pigs are penned in a defined area and are already contributing to a water pollution problem in an adjacent stream or lagoon or to groundwater.

Specific Project Objectives

- To increase awareness among communities and pig owners of the effects that run-off or filtration from piggeries can have on water quality;
- To identify locally appropriate techniques for processing of pig manure to compost or vermi-compost;

- To develop a new local business based upon production of vermicompost and use as fertiliser; and
- To maximise the recycling of organic waste to pig food.

Project Outputs

(i) Community education campaign and supporting materials specific to pig manure;

(ii) Demonstration unit for composting and vermi-composting (if no antibiotics used) of pig manure;

(iii) Demonstration garden plot using compost or manure as fertiliser;

(iv) Water quality monitoring site as indicator of effect of piggery on water quality;

(v) Collection and reporting of specific data on effects of piggeries on water quality; and

(vi) Guidelines for environmentally sound pig rearing.

Project Tasks

The project could include the following activities:

(i) Project initialisation and consultation with community, Department of Agriculture and other stakeholders;

(ii) Literature review including making contact with other projects composting or vermi-composting pig manure;

(iii) Establishment of water wells and/or surface water monitoring sites for basic water quality monitoring (Nitrate nitrogen, ammoniacal nitrogen, Faecal coliform);

(iv) Undertake regular monitoring, analyse and report results;

(v) Set up pilot composting operation;

(vi) Set up demonstration garden beds;

(vii) In consultation with Department of Agriculture extension staff prepare guidelines for environmentally sound pig rearing;

(viii) Presentation of findings to community, eg through open days at demonstration site; and

(ix) Prepare publicity material.

Community and NGO inputs

Within the project location community a working group could be formed of pig owners. Schools could be involved in the water quality monitoring.

Verifiable Indicators

Key verifiable indicators of project success would include:

(i) Measurable improvement to water quality in vicinity of demonstration piggery;

(ii) Visual observation of improved piggery run-off;

(iii) Acceptance of compost for garden use; and

(iv) Uptake of composting techniques outside of project participants.

Related Activities

This project would relate closely with water quality projects directed at reducing pollution in surface water streams and lagoons. The project would also tie in well with agricultural development and extension projects.

Suggested Pilot Project No 3: Demonstration Dry Sanitation System

Project Goal

To increase the acceptance of waterless toilet technologies as a mainstream sanitation option in SIDS.

Background to Project

In the SIDS management of human excreta is an ongoing problem which threatens the environment and public health. Centralised sewerage systems use precious water supplies for treatment, are expensive to build and maintain, and often discharge into water bodies causing pollution. Septic tanks and pit latrines, while less costly to build and maintain, also degrade groundwater supplies and contribute to nutrient enrichment of streams and lagoons.

Various designs of composting or waterless toilets have been used in developed countries in sensitive areas for many years, and a number of designs have been trialed in the Pacific region in recent years. Appropriately designed and maintained waterless toilets can potentially make a major contribution to reducing groundwater and surface water pollution and so improving public health. Significant advantages of waterless toilets are that they:

- Do not use water and so save on water bills, keep precious water supplies for more important human and animal needs;
- Prevent pollution of groundwater, streams and coastal fishing areas;
- Can provide more effective destruction of disease causing organisms than common waterborne sewage treatment;
- Can be built cheaply from local materials; and
- Can produce a useful soil improver that costs nothing to generate or transport.

However there are barriers to be overcome in gaining acceptance of waterless toilets as a mainstream sanitation option. These include ingrained attitudes to sanitation which are common to every society, and the perception by many that a flush toilet is a symbol of progress. Overcoming these barriers requires carefully researched and planned project activities. Projects need to be sustained and trial facilities properly operated and maintained to ensure the toilets do not acquire a reputation for malfunction.

Suggested Location

A suitable location for Waterless toilets would be a village or urban location (obviously without centralised waste water collection) where existing septic tank disposal practices are impacting adversely upon groundwater or an adjacent lagoon. The location should include a high profile site for a demonstration unit where a number of people would use the facility (for example a school or church establishment). Given the need to gain cultural acceptance of the technology and not just demonstrate its technical effectiveness, a high profile local host should be found for the demonstration unit, eg a high ranked person or prominent sportsperson. As responsibility for maintenance of public toilets is usually problematic, this issue should be resolved in pre-project consultation regarding site location.

Specific Project Objectives

(i) To establish demonstration waterless toilets as publicly accessible facilities;

(ii) To operate and maintain these in good working order for the life of the project and beyond; and

(iii) To demonstrate the linkages between septic tank effluent and groundwater pollution.

Project Outputs

(i) Demonstration units operating, being used and being maintained;

(ii) Guidelines for design, construction and operation of waterless toilets specific to the project location;

(iii) Reporting of findings; and

(iv) Demonstration plot utilising compost produced.

Project Tasks

The project could include the following activities:

(i) Project initialisation and consultation with community, Department of Health and other stakeholders;

(ii) Establish, in cooperation with local counterparts and community, the attitudes and cultural factors which may affect acceptance of technology, and work with community representatives to find ways to accommodate these factors;

(iii) Literature review including making contact with other similar sanitation projects;

(iv) Set up groundwater quality monitoring to demonstrate how septic tank effluent spreads in groundwater;

(v) Undertake regular groundwater monitoring, analyse and report results;

(vi) Customize toilet design to local situation;

(vii) Build and maintain demonstration units;

(viii) Set up demonstration garden beds for use of compost (may not necessarily be for food production if this is culturally offensive);

(ix) Presentation of findings to community; and

(x) Prepare publicity material.

Community and NGO inputs

Local NGOs and community groups, in particular women's groups should be closely involved in the design process and selection of sites for the initial facilities. Schools could be involved in the water quality monitoring.

Verifiable Indicators

Key verifiable indicators of project success would include:

(i) Successful operation and maintenance of toilets in absence of project involvement;

(ii) Uptake of toilets outside of project participants;

(iii) Community attitude surveys demonstrating acceptance or interest in waterless toilets; and

(iv) Measurable improvement to groundwater quality (if project on large enough scale to significantly reduce pollution from septic systems).

Related Activities

This project would relate closely with water quality projects directed at reducing pollution in groundwater and lagoons.

Annex IV: Additional Community-based Project Possibilities

1. Household management of pigs

If pigs are to be raised in pens for family use in the urban and peri-urban compound, then the pens should be well away from human habitation for reasons of nuisance (odour and insects) and to keep animal faecal matter out of the human living environment. It is useful to remember that there is a number of diseases that can be transmitted between pigs and humans, and vice versa. In the past, a common place for pigpens was at the narrow end of an islet where the lack of fresh groundwater prevented human habitation. The pressures of modern living have brought the pigs back to the family compound to prevent theft and for convenience of care.

At the household level, awareness needs to be raised of the potentially contaminating aspects of pig raising practices. There may be an opportunity for Town Councils or Village Committees to be involved in regulating the standards of pigpens, proximity to housing and water catchments, and other protective measures. The aim should be to contain the animal excreta in as safe a manner as possible. In other words, the pigs need toilets as much as humans. If the pen has a concrete floor with a raised edge to contain liquids and a drain to take wastes to a storage and treatment area, then this would be adequate. It has been noted that the food given to pigs in PICs is usually solid, so there is not a great deal of spillage as happens where hogs are fed with grain mashes and similar sloppy food.

A slight slope on the floor of the pen would assist in either washing or, preferably, scraping the wastes to a composting chamber or small septic tank with wastewater garden disposal. A simple cheap system using plastic lined trenches filled with sand and gravel would accept the liquid wastes which could then be mulched with dried or composted solid wastes. Clumping bamboos and the Drumstick Tree could be trialed. They grow quickly, can provide fodder for the pigs and both plants have other uses. Where the pens are sited near a wetland area, then effluent could be discharged to areas of heavy grass growth (not directly to freestanding water) for further treatment.

A pilot project to develop a standard practice for household pig pens could involve a single household, or a number of neighbouring households from an extended family could co-operate, rather than attempting the complication of wider village involvement. However, a village committee could supervise the project and assist with ideas.

2. What to do with the dirty diaper?

In some PICs, the introduction of disposable diapers has greatly increased the paper-based volume of waste, which is being littered on beaches, in lagoons, and dumped at landfills. Some estimates indicate an increase of more than 70 per cent in domestic solid waste due to used disposable diapers. If they are not dumped they are burnt, and as the diapers have a plastic backing, this strategy is also not advisable. There are suggestions that diapers should be banned, which is not likely to happen. A pilot project, which addresses this controversial issue, could be developed with local community education specialists.

Certain issues need to be understood such as:

- Why families use disposable diapers instead of washable nappies or whatever was used traditionally;
- What ideas people have for reprocessing or appropriate disposal; and
- What incentives might encourage the use of alternatives.

Despite being expensive, and a drain on the family budget, diapers are popular because they are very convenient (and possibly prestigious), so an imaginative campaign is required to reduce their use and/or impact.

3. Co-composting sludge and green waste

Village co-composting of sludge from septic tanks with green waste has been suggested as a possible pilot project (See Section. 3.5.1). This would produce a soil improver, reprocess green rubbish, and could encourage increased maintenance of septic tanks, as there would be somewhere nearby to empty the sludge and some ulterior motivation to do it more regularly. Pig manure from household pens could possibly be included if a consistent supply of septage was not available.

The pilot project would involve developing a methodology for treatment which ensures protection of public health, a co-operative effort between householders and a village committee, and institutional support from Public Health and other relevant authorities who were trained to undertake monitoring. A science class at a local school could assist with the monitoring of composting indicators such as temperature. Many of the social issues discussed in the sanitation trials in Section 3.2 would also need to be addressed in a comprehensive participatory education and information exchange program. Training in the proper construction, function, and maintenance of septic tanks could be included in the program.

If a small-scale project is successful it will expand naturally as other householders see the results and join the scheme. The sustainability of the project depends on involving the community in the cost-recovery/cost-sharing process (Refer Section 5.5.for community-based composting).

4. Integrated Pacific EcoHome

Rather than addressing single issues in a pilot project, it could be useful to apply the principles advocated in this review and consider as many inputs and outputs of the household compound as is feasible within the IWP agenda and budget.

This could include some or all of the following inter-related systems:

- Properly maintained rainwater tanks;
- Properly maintained and protected well (if applicable);
- Convenient system for separating household waste, including hazardous residues;
- Compost enclosure for organic household waste and pig manure;
- A composting toilet with drainage trench into food trees, and/or into;
- A simple greywater recycling system feeding into;
- Demonstration organic food garden using household compost;
- And nursery garden to produce seeds and seedlings that are adapted to local conditions (and possibly sold to the public) with; and
- Pig pen constructed to contain run-off and filtration, and maximise convenient, hygienic use of manure and effluent for gardens.

If the EcoHome pilot could be established at a residence that is in the process of being built then breezeways and energy efficient design could be incorporated into the structure and layout of buildings and compound. If the compound is already established then the above suggestions could be adapted to existing conditions, where practical. A possible location for this pilot could be at the home of a priest or religious leader, adjacent to a church, as this is often owned and maintained by the community, is a semi-public venue, and has a rotating residency. Of course, this would involve extensive pre-project consultation with the church community, and the engagement of the resident pastor and family.

If appropriate, the EcoHome could provide educational material on issues such as alternatives to plastic bags and disposable diapers, managing household chemicals, and producing nutritious food on-site from household waste. Demonstrations of various waste minimisation and pollution prevention strategies could be included in meetings that occur at the church compound, including kava groups, women's groups and youth groups (Refer to workshops conducted by Ecowoman at Section 6.5). The EcoHome could include a drop off facility for cans and other recyclables from the community, and any funds raised from activities could go to the church.

There are many indicators that could be monitored in this pilot project including:

- User and community response to the various systems in place;
- Changes in quality of groundwater in the vicinity of the compound;
- Changes in the status of the soil at the garden site; and
- Evaluating the growth performance of various food and tree crops amended with the compost.

The EcoHome could be linked to government, NGO and CBO information services such as the EcoVan, (Refer Section.6.6) and the People's First Network (Section 6.2.3). Perhaps an email station could be established at the EcoHome using a simple system consisting of a short-wave radio, a low-end computer, and solar energy. This may increase the interest of young people in the overall activities of the pilot project, and the church and community may be attracted by the benefits of accessible inexpensive networking.

Annex V: Potential Resource People

The following people have relevant experience working with communities to manage waste and reduce pollution, and have agreed to be recommended as resource personnel for IWP activities.

Carol Steinfeld
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Contact for Tonga Code of Practice for automotive repairers

Maliepo Toma
Deputy Secretary, Industries
Ministry of Labour, Commerce & Industries
Government of Tonga
E-mail: industry@kalianet.to

Annex VI: List of Selected Useful Websites

Waste Concern, Dhaka, Bangladesh, NGO specialising in community compost plants: www.wasteconcern.org

Images and a plan of the Community-Based composting plant built by Waste Concern can be viewed on: www.wasteconcern.org/project_1.htm and images of the compost barrels in Dhaka can be viewed on: www.wasteconcern.org/project_3.htm

Pacific Islands Forum Secretariat Web site: Forum Secretariat plays a role in coordinating development activities to prevent waste of resources: www.forumsec.org.fj

1996 Electronic Conference on Zero Emissions by breweries: http://www.ias.unu.edu/proceedings/icibs/resources/zebb

The Living Waters Charitable Trust, supports initiatives which empower communities and groups to improve and protect their quality of water: http://www.livingwater.org.uk/_living_water_/_living_water_.html

Free Water and Sanitation News Service: http://www.wsscc.org/source

Pacific Water and Wastewater Association. Regional Association of Pacific Island organisations operating in the water sector: http://www.pwa.org.fj/

Search aids: search engine for family of International and Water Supply Centre (IRC) and Water Supply and Collaborative Council (WSSCC) web sites at: http://www.irc.nl and IRCDOC online at: http://www.irc.nl/ircdoc

Water Partners International aims to improve the lives of children and their families with sustainable water projects: http://www.water.org/solution/project/guatemala/xix.htm

Department of Water and Sanitation in Developing Countries at the Swiss Federal Institute for Environmental Science and Technology (EAWAG) in Duebendorf, Switzerland. Aims to assist in developing multidisciplinary approach to water, sanitation and solid waste management concepts and technologies appropriate to the physical and socio-economic conditions prevailing in developing countries: http://www.sandec.ch, http://www.eawag.ch

Model self-financing integrated development project (an entire ecological sanitation and waste disposal system which can be set up using local money LETS systems without the need for any formal money) which has been placed in the public domain and is available for downloading from: www.flowman.nl

Dutch NGO De Twaalf Ambachten has developed a new composting toilet, the Paper Leaf Toilet that collects faeces in a perforated biodegradable plastic bag filled with a layer of straw or hemp. No water for flushing is needed: http://www.de12ambachten.nl/

The Low Cost Sewerage Network. The network has also established its own electronic discussion group: lcsewerage http://www.lboro.ac.uk/departments/cv/wedc/garnet/tnclowcs.html

Sanitation Connection, an Internet-based resource that gives access to up-to-date information on technologies, institutions and financing of sanitation systems around the world. Look for links for low-cost waste water treatment (ponds and reedbeds) and waste water reuse: http://www.sanicon.net/

Low Cost Sewage Discussion List: http://www.jiscmail.ac.uk/lists/lcsewerage.html

Night soil/sludge treatment: http://info.lut.ac.uk/departments/cv/wedc/garnet/tncnight.html

Solid waste management recycling: http://info.lut.ac.uk/departments/cv/wedc/garnet/tncswmre.html

This site is set up to describe the work of Peter Morgan who has been working in the rural water supply and sanitation sector for 25 Years. Features composting toilet: http://aquamor.tripod.com/

Centro de Innovación en Tecnología Alternativa A.C. Dry latrines (desiccating, urine separating): http://www.laneta.apc.org/esac/citaesp.htm

Composting Latrines: frequently asked questions: http://www.lboro.ac.uk/garnet/compost.html

Ecological Alternatives in Sanitation: http://www.lt.slu.se/ecosan/

Ecological Sanitation Notes: http://www.wkab.se/index.html

A three-year supraregional sector project on Ecologically and economically sustainable waste water disposal and sanitation systems, started in 2001, funded by German Federal Ministry for Economic Cooperation and Development (BMZ): http://www.gtz.de/ecosan/english/index.html

Rotaloo Composting Toilet: http://www.rotaloo.com//

World of Composting Toilets: http://www.compostingtoilet.org/

Sanitation squatting platform (SanPlat): http://www.sanplat.com/

National Wastewater Recycling Association (Australia): http://www.nowra.org/

Wastewater Management Network (GARNET): http://info.lut.ac.uk/departments/cv/wedc/garnet/tncwwm.html

Collaborative Working Group on Solid Waste Management: http://www.melissa.org/cwg/

The Compost Resource Page: http://www.oldgrowth.org/compost/

Solid Waste On-line: http://www.solidwaste.com/content/homepage/default.asp?VNETCOOKIE=NO

Basel Convention on Hazardous Waste: http://www.basel.int/

Health Care Waste Management: http://www.who.int/water_sanitation_health/Environmental_sanit/health_care_waste.htm

Campaigning for better public toilets for all. Launched in May 1999, BTA produces publications, organises meetings and support campaigns. BTA is one of the sponsors of the Loo of the Year Award: http://www.britloos.co.uk/

International Solid Waster Association: http://www.iswa.org/

Institute for Inland Water Management and Waste Water Treatment (Netherlands): http://www.riza.nl/index_uk.html

Sulabh International, Social Service Organisation that promotes human rights, environmental sanitation, health and hygiene, non-conventional sources of energy, waste management and social reforms: http://www.sulabhinternational.org/

Environmental Sanitation (WHO): http://www.who.int/water_sanitation_health/Environmental_sanit/envindex.htm

Global Environmental Sanitation Initiative (WHO Water Supply Collaborative Council): http://www.wsscc.org/gesi/index.html

WELL, a resource centre network providing services and resources in water, sanitation and environmental health for the Department for International Development (DFID) of the British government and partner agencies. WELL is managed by Water, Engineering and Development Centre(WEDC) Loughbouough University, UK, London School of Hygiene & Tropical Medicine (LSHTM), and International Water and Sanitation Centre, The Netherlands (IRC): http://www.lboro.ac.uk/well/

IRC International Water and Sanitation Centre: http://www.irc.nl

WHO Global Water Supply and Sanitation Assessment 2000 Report: http://www.who.int/water_sanitation_health/Globassessment/GlobalTOC.htm

WHO Water Supply and Sanitation Links to Health: http://www.who.int/water_sanitation_health/diseases/wshlinks.pdf

Burden of Disease Unit, Centre for Population and Development Studies, Harvard School of Public health: http://www.hsph.harvard.edu/organizations/bdu/

WHO, WELL, DFID (The Department for International Development) Guidance Manual on Water Supply and Sanitation Programmes: http://www.who.int/water_sanitation_health/diseases/wshlinks.pdf

WanSmolbag Theatre, Vanuatu: http://www.unaids.org/bestpractice/collection/subject/children/wansmolbag.html

Adopt a Watershed: www.Adopt-A-Watershed.org

People First Network Solomon Islands and The People First Network and Internet Café Training Services: http://www.peoplefirst.net.sb/Projects/projects_summary.asp
http://www.peoplefirst.net.sb/General/Training.htm#Contact

The Centre for Ecological Pollution, specialising in ecological resource-management solutions: http://www.cepp.cc

Sustainable Strategies, a consulting firm specialising in ecological engineering, planning, management and design for residential, commercial and community projects: http://www.ecological-engineering.com

Zero Emissions Research and Initiatives. Aims to create a new paradigm of sustainable industry by targeting zero gaseous, liquid and solid emissions, and by making Zero Emissions a world-wide industry standard: http://www.zeri.org/

Container Deposit Legislation (CDL): Websites: www.geko.net.au/~gargoyle/CDL/

http://www.recyclesa.com.au/Forward.htm

http://www.finlaysons.com.au/environment/sa_containerdeposit.htmlwww.isf.uts.edu.au/CDL_Review

http://www.isf.uts.edu.au/CDL_Review/participation#What

The Institute for Public-Private Partnerships, an international training and consulting firm that focuses on fostering public-private partnership opportunities in the environmental (water/sanitation and solid waste), energy, transportation, technology, and social sectors: http://www.ip3.org/

Integrated Biosystems Network: http://www.ias.unu.edu/proceedings/icibs/ibs/ibsnet/

Kastom Gardens Project in the Solomon Islands which aims to address problems of environmental degradation which are due to unsustainable trends in subsistence food production: http://www.apace.org.au/docpublish/kastom.html

APACE (Appropriate Technology for Community and Environment) Since 1978 APACE has designed, managed and implemented overseas aid projects that have had a very practical effect in enabling self-determination for communities caught in the cycle of poverty: http://www.apace.org.au/docpublish/projects.html

Pacific Edge provides permaculture education, design consultancy and media services: http://www.magna.com.au/~pacedge/pacific/index.html

The Seed Savers' Foundation, promotes the exchange or non hybrid seeds and the preservation of heritage seed varieties: http://www.seedsavers.net

Permaculture International Limited, National permaculture professional and networking organisation: www.nor.com.au/environment/perma

National Association of Sustainable Agriculture Australia. Promotes organic agriculture and national organic certification agency: www.nasaa.com.au

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Annex VIII: Personal Communications (Pers. comm.)

The following personnel provided information to the authors, by telephone, e-mail and in person, which is referred to in this review. Most communications were made during the review, but prior communications have also been included where relevant, and the date is provided in the text.

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Jenkins, Sue, Director, Foundation of the Peoples of the South Pacific-Kiribati

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Murphy, Rebecca, Program Manager, JICA Australia Office, Sydney, Australia

Nasome, Epeli, Director, Department of Environment, Suva, Fiji

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