From Development to Sustainable Development in the Cook Islands

by

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Declaration

This work contains no material which has been accepted for the award of any other degree or graduate diploma in any University or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

Robert Patterson
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Abstract

This thesis contributes to the academic understanding of the role of technology transfer in underpinning sustainable development in developing countries. This contribution has two main components. First, the thesis offers a multidisciplinary review of academic literatures in developing a model of technology transfer from developed to developing countries that achieve sustainable development outcomes. Second, the thesis offers a detailed case study of an on-site wastewater management technology in the Cook Islands. The innovative on-site sewage treatment technology used in this project has been developed by the author over the past twenty years. The project took the form of a 'demonstration' Evapocycle system was installed at the recently completed education centre built by the non-government organisation Youth With a Mission on the island of Rarotonga. The problems of wastewater treatment in the Cook Islands, which are exacerbated by tourist development, are described. It is argued that the Evapocycle system could reduce problems associated with 'conventional' septic tank systems in use on Rarotonga, thus leading to a more sustainable development. The technology transfer model developed by Kedia and Bagat is reviewed and is applied to the chosen example. The thesis concludes that problems experienced in introducing the on-site treatment system to the Cook Islands can be explained by the model.

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Preface

Since 1977, I have worked as an Environmental Health Officer (EHO) for a number of Tasmanian local government councils, the Tasmanian Department of Health Department and, since 1992, as a consultant specialising in on-site wastewater treatment and disposal. The safe disposal of sewage from developments not serviced by sewerage infrastructure requires some form of on-site wastewater technology. On-site wastewater technology is not an exact science and presents many challenges especially in cool, wet and remote areas that are characteristic of many parts of Tasmania. In 1981, as a Health Department EHO, I was offered the opportunity to enrol at the University of Tasmania, Centre for Environmental Studies, to broaden my understanding of environmental matters in general and possibly identify improved techniques for reducing the environmental impacts of on-site wastewater treatment systems.

Then head of the Centre, Dr Richard Jones's first question to me when we spoke about on-site wastewater treatment was, 'What is the problem?' To me the problem was obvious; wastewater containing sewage and other pollutants was not being effectively treated and disposed of on-site created a statutory nuisance, a situation that was dangerous to the health of the inhabitants of the building and also environmental degradation with potentially widespread consequences. In the face of my puzzled silence, Dr Jones repeated his question; 'What is the problem?' I was now a bit shocked, because surely a leading academic in environmental studies could see that the problem was obvious. The accumulation of untreated sewage and other pollutants near a habitable building had the potential to cause serious health and environmental problems. As we talked, however, Dr Jones pointed out that the serious health and environmental problems I was concerned about were consequences of the sewage and other pollutants escaping from the building and being conveyed into the surrounding environment. Dr Jones then asked how is the sewage able to escape? He explained that water is very useful when used inside a building as it allows the flushing of toilets, the washing of clothes and dishes, showering and other activities that enable healthy living for the occupants of that building. Unfortunately, when the water leaves the building it becomes the means by which sewage and other contaminants are carried into the environment. Without water, sewage and other contaminants can not escape

and cause problems. 'The key problem', Dr Jones concluded, 'is to eliminate the water from the wastewater once the wastewater has left the building'. Notwithstanding its simplicity, and my years of experience as an environmental health professional, this was a revelation. It was immediately apparent that what was required was a wastewater treatment system that could effectively evaporate the wastewater. Although some conventional evaporation systems already existed, they had limited capacity and relied on exposed surface exposure and sufficient evaporation potential that limited their application to small developments in low rainfall areas. I then embarked upon 12 year project to develop an innovative method of high-volume, on-site wastewater evaporation. The resultant 'Evapocycle' system could evaporate approximately five times the volume of wastewater treated by conventional evaporation system of a similar size.

To allow the Evapocycle system to be commercialised three Australian companies were formed: Australian Environmental Solutions (AES), International Environmental Solutions (IES) and Humanitarian Environmental Solutions (HES). AES was responsible for all Evapocycle projects in Australia; IES was responsible for overseas Evapocycle projects while HES was responsible for the production of the Field Septic Tank System (FSDS) components required to pre-treat sewage before the wastewater is evaporated in the Evapocycle. IES was also responsible for Evapocycle and FSDS patents and project contracts. There have been a number of successful Evapocycle projects in Australia and strong interest has been received from a number of overseas interests in relation to the application of Evapocycle technology especially in undeveloped countries in regions where the cost of centralised sewerage infrastructure has delayed development and its associated economic benefits.

In 2005 I was approached by a member of our church to assist in the construction of a Missionary training college on Rarotonga in the Cook Islands. The project was being undertaken by Youth With a Mission (YWAM). Founded in 1960, YWAM is an international movement of Christians from many denominations that aims to prepare young people for short term missionary work with poor and other disadvantaged people. YWAM is a non-government, not for profit organisation and currently operates in more than 1000

locations in over 149 countries, with a staff of nearly 16,000(YWAM n.d.). I agreed to act as an honorary wastewater consultant for this project with IES providing all material support required for the installation of an Evapocycle system, also at no cost to YWAM.

During my time at the Centre for Environmental Studies I was also introduced to the philosophy of environmental ethics which gave me a general understanding of another dimension of development, in particular the notion of appropriateness of development especially in environmentally sensitive areas. As a practising Christian I believe in assisting those less fortunate and being a responsible steward of the resources we have been blessed with to ensure these gifts are passed on to future generations. Providing innovative technical solutions to prevent pollution damage to the environment is important. However, equally important from a moral perspective is limiting the use of that technology to facilitate development that may not be in the interest of future generations.

Accordingly I am approaching this study as a reflective practitioner. In my role as a technical consultant with an environmental interest in improving on-site wastewater treatment, I recognise the overlapping nature of environment and development concerns and I am engaged in this study to better understand the nature of the relationship of these concerns in the transfer of the Evapocycle to the developing world to ensure my efforts contribute to sustainable development in these regions.

In relation to the use of Evapocycle it is important to identify any barriers that will impede the effective transfer of this technology to a developing nation such as the Cook Islands. This commercial focus, however should be balanced by the broader moral question in relation to the appropriate use of Evapocycle technology that may enable development that may not be in the interest of future generations.

Chapter 1

Introduction

1.1 From development to sustainable development

Until the late 1970s development was generally understood to be primarily concerned with increasing incomes and over all national levels of economic growth. It was an understanding famously summed up by US President Harry S. Truman in the 1949 speech that introduced the idea of underdevelopment: "greater production is the key to prosperity and peace" cited in (Rist, 2002, 71-72). Correspondingly, the United Nations (UN) launched its first Development Decade in 1961 with the claim that development is "progress toward self-sustaining growth of the economy" (UNDP, cited in Weisse et al., 1994, 184), and GDP was taken to be the prime measure of development.

The inadequacy of this narrow economic understanding of development was brought home to many during the late 1970s and early 1980s by two undeniable realities. First, despite the dramatic growth of the world economy after 1950, the severe poverty of many developing nations not only persisted but worsened as many experienced uncontrolled population growth. Indeed, the world economy tripled in size between 1950 and 1974 while the gap between the world's richest and poorest grew alarmingly (UNDP, 1999). Second, it became increasingly evident that the environmental side-effects of the industrialisation on which this economic growth was based were only further entrenching poverty in many developing nations. Recognition of these realities saw conventional models of development 'those that viewed development as effective modernisation of the globe along Western lines'come under increasing challenge (Pepper cited in Baker, 2006, 1). In this modernist model of development, society is understood to go through sequential stages of economic growth (Rostow cited in Baker, 2006, 2). Traditional societies develop to a stage of economic 'take-off' in which new industries and entrepreneurial classes emerge, as was the case in Britain in the nineteenth century. As industrial economies reach 'maturity', steady economic growth outstrips population growth. A

'final stage' is reached when high levels of mass consumption allows the emergence of social welfare. This model of development thus assumes a linear progression, in which it becomes necessary for developing societies to catch up with Western style development. This resulted in the governments of developing countries opening up their economies to Western values, influences and investments and their becoming more integrated into a global capitalist market system (Baker, 2006, 2).

The term developed nation is used to categorize countries with developed economies in which the tertiary and quaternary sectors of industry dominate. Countries not fitting this definition may be referred to as developing. This level of economic development usually translates into a high income per capita. Countries with high gross domestic product (GDP) per capita often fit the above definition of a developed economy. However, anomalies exist when determining "developed" status by the GDP per capita alone. The Human Development Index (HDI) is an indication of a country's level of development ('developed' or 'developing'). HDI looks beyond GDP to a broader measure of human well being and is a useful measure of a nation's development status (UNDP 2008). The HDI provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and enrolment at the primary, secondary and tertiary level) and having a decent standard of living (measured by GDP/capita) [purchasing power parity – this is a way of standardising different currencies to allow comparison]. HDI is not intended to be a fully comprehensive measure of human development. It does not, for example, include important indicators such as gender or income inequality and more difficult to measure indicators like respect for human rights and political freedoms. The UN relies upon a range of indicators and is constantly engaged in seeking to develop new ways of shedding light on the quantitative and qualitative dimensions of human development. What the HDI does provide is a broadened prism through which viewing human progress and the complex relationship between income and well-being (UN HDR Report, 2007/2008).

The 1972 UN Conference on the Human Environment, held in Stockholm, marked an important step forward in recognition of the links between environmental problems and poverty. The conference brought representatives from developed and developing

nations together to delineate the 'right' of every member of the human family to a healthy and productive environment. A series of meetings followed that focussed on the rights of people to adequate food, to sound housing and safe drinking water (WCED. 1987.xi). The term 'sustainable development' came into the public area in 1980 when the International Union for the conservation of Nature and Natural resources presented the World Conservation Strategy (Baker 2006,18)

In 1987, *Our Common Future,* the Report of the World Commission on Environment and Development, the so-called Brundtland Report, adopted the concept of sustainable development as the central plank of its call for critical and urgent innovation in international governance. The Brundtland Report called for humanity to make development sustainable: that is, it called for "development meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, 8). The Brundtland Report argued that sustainable development, as opposed to simply economic development, is founded upon the dynamic linkages between economic and technical improvement, human well-being and environmental well-being (International Institute for Sustainable Development 2008).

As fashioned in the Brundtland Report, the concept of sustainable development shifted focus away from the absolute limits to growth stressed by environmentalists through the 1970s, towards limitations imposed by the present state of technology and social organisation on environmental resources and *'by the ability of the biosphere to absorb the effects of human activities'* and the need to *'adapt life-styles within the planets ecological means'* (WCED 1987, 9). Therefore, there are ultimate limits to growth. Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. The Brundtland Report also recognised the importance of private and community groups whose members can often provide an efficient and effective alternative to public agencies in the delivery of programmes and projects (WCED 1987, 328). This recognition opened the way for non-government organisations (NGOs) to be considered a serious element in

environmental and developmental issues, a process that culminated with the first Earth Summit in Rio de Janerio in 1992 (Adams, Redclift cited in Redclift 2005).

The 1992 Earth Summit or United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 sought to translate the Brundtland Report's vision of sustainable development into a practical agenda for government. The goal of the Earth Summit conference was the establishment of a new and equitable global partnership through the creation of new levels of cooperation among states, key sectors of societies and civil society. Recognising the integral and interdependent nature of the Earth (our home) twenty-seven principles were proclaimed in a Rio Declaration accompanying a comprehensive plan of action for the 21st century known as *Agenda 21.* (UNCED, 1992). The Rio Declaration reflected increasing concern with a number of global environmental issues including the importance of future economic development not being prejudicial to the environment. One of the principle features of *Agenda 21* was the call for partnerships between business and environmental groups (Redclift, 2005). The 'official' corporate response of the Rio Conference was contained in the publication of the World Business Council for Sustainable Development *Changing Course* which helped conceptualise the phases through which corporate involvement in the environment had passed: the prevention of pollution in the 1970s, measures to encourage self regulation in the 1980s and a concern to incorporate sustainability into business practices in the 1990s (Murphy and Bendell cited in Redclift, 2005).

In 1997 fifty-three heads of state or government and sixty-five ministers of environment and other areas attended a United Nations General Assembly Special Session (UNGASS) to review the implementation of *Agenda 21.* This event is known as Earth Summit II and was held in New York. Reports on the state of the world's environment painted a dismal picture of the global environment continuing to deteriorate at an alarming rate (Baker 2006, 61). However, the UNGASS meeting was significant in that NGOs for the first time were able to deliver speeches to the plenary sessions and to have access to ministerial-level consultations. This was a clear indication that the system of environmental governance promoted by the UN

encourages the participation of private and voluntary groups (Elliott, cited in Baker 2006, 62).

The World Summit on Sustainable Development (WSSD) was held in Johannesburg in 2002 (UN Department of Economic and Social Affairs, 2004). The poor report card for *Agenda 21* at the 1997 Earth Summit II was only worse at WSSD. It highlighted the limited achievements in global efforts to promote sustainable development. A number of problems were identified including: a generally fragmented approach by member states together with a lack of progress in addressing unsustainable patterns of production and consumption, inadequate attention to the core issues of water and sanitation, energy, health, agriculture, biodiversity protection and ecosystem management issues (Baker, 2006, 65). In response WSSD emphasised 'implementation' rather than just awareness of sustainable development and the full implementation of *Agenda 21*, the Programme for Further Implementation of *Agenda 21* and the commitments to the Rio Principles, were strongly reaffirmed. Member States committed, in the Johannesburg Plan of Implementation (JPOI), to take immediate steps to make progress in the formulation and elaboration of national strategies for sustainable development (NSSD) and begin their implementation by 2005. In 2007 eighty-two Member States of the UN have reported to the Council for Sustainable Development (CSD) or to the Division for Sustainable Development (DSD) that they were implementing an NSSD; this corresponds to 43 percent of all countries, and 79 percent of all countries for which information is available (UN Department of Economic and Social Affairs-NSDS Global Map 2008).

Twenty one years on from the Brundtland Report, the process of shifting in practice from development to sustainable development is still underway. This process is not easy or straightforward and in the final analysis, sustainable development must rest on political will. Failures to manage the environment and to sustain development threaten to overwhelm all countries. Environment and development are not separate challenges and are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base and the environment cannot be protected when development proceeds without accounting for the cost of environmental destruction. These problems cannot be treated separately by fragmented institutions

and policies. They are linked in a complex system of cause and effect (Brundtland Report 1987, 17).

1.2 Ecological Modernisation: linking ecology and economy

The 1990s and the period post-Rio was seen as a turning point in the relation between corporate business and the environment, in which environmental concerns needed to be internalised, and made a central part of corporate governance (Redclift 2005). The term ecological modernisation was coined in the early 1980s to provide a formula for the interplay of ecology and the economy. The intention was to link the drive for modernisation in developed market economies and the long-term requirement for more environmentally friendly development through innovation in environmental technologies (Janicke 2008). Essentially, ecological modernisation refers to the way in which new, cleaner technologies can be utilised effectively by business, within a policy framework that is conducive to more sustainable practices, and which holds out the prospect of a 'win/win' situation of stimulating economic growth without increasing pollution (Redclift 2005).

Ecological modernisation is different from purely end-of-pipe approaches (that attempted to treat or remove pollutants at the end of the process before they were discharged into the environment) in that it encompasses all measures taken to foster eco-innovation and to support diffusion of those innovations. Ecological modernisation allows economic growth to be at least partially decoupled from environmental harm (Murphy, 2000 cited in Baker 2006, 137). Decoupling reduces the amount of physical emissions (not just emissions but reduces the overall resource flow including both inputs and outputs) from developments that cause environmental damage (Rio Declaration *Agenda 21*). Decoupling can be achieved by increased 'eco-efficiency' stemming from technological change, or a shift to less environmentally harmful products. Decoupling breaks the causal chain between economic activity and negative environmental effects (Baker 2006, 137). Ecological modernisation theory offered a new, environmentally sensitive way of looking at the relationship between the economy and society; however it has been the subject of extensive criticism. The environment is seen to be reduced to concern about resource inputs, waste and pollutant emissions. Critics argue that this reduction has a

'seductive appeal': belief in an efficiency response to the environmental problem minimises the degree of social and cultural changes that are necessary to promote sustainable development (Weizacker *et al.* 1997 cited in Baker 2006, 139).

1.3 Eco-efficient innovation

The broad reception of the idea of ecological modernisation is complemented by the development of a number of alternative concepts that have similar meanings. "Eco-efficient innovation' - the introduction of environmentally friendly technology which also increases resource productivity – comes closest to this understanding of ecological modernisation. It has become part of the European Union (EU) Lisbon strategy for growth and employment. In 2004 the "High Level Group" of the EU Commission stated that a "promotion of eco-efficient innovations is needed in major investment decisions" which should in turn lead "to less pollution, less resource-intensive products and more efficiently managed resources" (Kok cited in Janicke 2008).

The ecological effectiveness of environmental innovation depends on its radicalness (degree of difference) from conventional practices. Ecological modernisation may come in the form of incremental improvement (cleaner technology) or radical innovation (clean technology). Incremental improvement increase eco-efficiency in existing processes through the introduction of improvements aimed at reducing waste from production. Incremental improvement will improve efficiency but did they did not really step outside the existing conventional methods of reducing waste. For example incremental innovations that remain restricted to niche markets will have only a limited effect. Radical innovation comprises ecologically friendly products and processes that are completely new that address an environmental problem in a radical new way by restructuring the architecture of an old process. Radical innovation allows the system or product to persist on a much higher level of environmental performance (Hellstrom, 2006).

The degree of diffusion of environmental innovations is influenced by the role of "smart" government regulation. Smart regulation plays an important role in the political competition for environmental innovation and can be identified as the key

driving force behind environmental innovation. Environmental regulation may create impediments for companies and industries. But generally it also presents a number of distinct advantages including the creation of markets for complying products or systems. Regulation helps to increase the predictability of markets with competitors being required to enact the same measures (performance requirements). Regulation also reduces internal impediments in companies to implement technological change (Janicke, 2008).

Apart from resource saving, eco-efficiency implies the reduction of environmental impacts by attempting to align the use of resources throughout the whole of a product's life cycle to correspond to Earth's carrying capacity, and at the same time deliver competitively priced goods, satisfy human needs and bring quality of life (Hellstrom, 2007).

1.4 Transfer of technology

At the opening of the High-Level Segment meeting of the UN Commission on Sustainable Development (CSD-16) The Way Forward (New York, May 2008), the Rio Principles were reaffirmed. The attention of the international community was again drawn to the severely inadequate progress with regards to technology transfer and capacity building for sustainable development in developing countries (UNCSD 2008). Technology transfer may be defined as a process for moving a technology, technologies or technical knowledge from the social context of its origin to other social contexts conceiving of a new application for an existing technology. Successful technology transfer means that it is necessary to develop a broad view of technology, one that encompasses not just machines and equipment, but also the skills, practices, knowledge, cultural aspirations, value-based assumptions and social processes necessary to make things happen. Thus, to achieve sustainable development, technologies are best viewed as total systems that include know-how, procedures, goods and services, as well as organisational and operational matters. A "technology transfer" is, in reality, a structural process of learning. The key components of a technology transfer can be identified as knowledge derived from real-world experience combined with human expertise capable of transforming that knowledge into action (Srinivas, 2008).

This thesis seeks to offer a contribution to the academic understanding of the role of technology transfer in underpinning sustainable development in developing countries. It seeks to provide this through a detailed case study of an on-site wastewater management technology in the Cook Islands. Before introducing the case study, however, Chapter 2 draws upon academic literatures to develop a model of technology transfer for sustainable development in developing countries.

Chapter 2

A Model of Technology Transfer for Sustainable Development

The central ethical principle informing ideas behind sustainable development is that of equity, in both its intergenerational and intragenerational dimensions. The argument for not reducing the ability of future generations to meet their own needs is that, although future generations might gain from economic progress, those gains might be more offset by problems arising from environmental and social deterioration. Many people would acknowledge a moral obligation to future generations, particularly as people who are not yet born can have no say in decisions taken today that may affect them (Beder, 2000). New scientific knowledge and technology are among the important legacies people can leave to future generations to ensure sustainability of development. These new technologies are important in increasing eco-efficiency through capacity building. Capacity building empowers people in developing nations through the acquisition of knowledge, technical skills and appropriate technology to be able to solve there own problems. Without effective transfer of appropriate technology important legacies for future generations will be lost.

Agenda 21 provides some of the earliest, very useful and largely latent recommendations for public policies to promote transfer of technology for sustainable development. Developed countries in particular have a moral responsibility to lead responses, and to assist people in developing countries towards sustainable development. Developed countries have largely achieved their present levels of wealth and social capacity for self-determination and improvement through two centuries of colonial exploitation that have left many regions of the world poor and with severely their populations compromised social capacity for self-determination and improvement. Principle 9 of the Rio Declaration (1992) also addresses transfer of technology (UNFCCC, 2003).

> Principal 9 of the Rio Declaration 1992
> "States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technical knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies".

Capacity building for eco-efficiency in the area of wastewater management is a process which seeks to build, develop, strengthen, enhance and improve existing scientific and technical skills, capabilities and institutions in developing countries to enable them to asses, adapt, manage and develop environmentally sound technologies. Capacity building for eco-efficiency must be country-driven, addressing specific needs and conditions of developing countries and reflecting their national sustainable development strategies, priorities and initiatives. The purpose of capacity building is to strengthen people's capacities in developing countries to promote the wide spread dissemination, application and development of environmentally sound technologies and know-how, to enable them to implement those technologies (UNFCCC, 2008). Capacity building should be broadly flexible and able to be adapted according to local technical, environmental and social conditions. Technology transfer is rarely successful and sustainable without some form of capacity building. In addition to the transfer of specific technology to technical organisations, capacity building efforts should also include the extension of education and training to other groups in the community such as community or school groups, and the inclusion of women and children; the methods and delivery of education and training must be adapted to local conditions and to the skill levels of the trainees; and is best achieved by developing local trainers (UNIDO 2002).

2.1 Steps in the technology transfer process

The transfer of environmentally sound technologies (ESTs) and know-how for social and cultural capacity building from developed to developing countries can be divided into the steps summarized in Table 2.1, according to the different participants in the process; this is not a strict division of roles, and action may be taken by both the supplier (developed nation) to the recipient (developing nation).

Table 2.1 Steps in the technology transfer process

Supplier side (Developed Nation)	Recipient side (Developing Nation)
a) research and development	a) identify the need and create awareness of the need for ESTs
b) project preparation	b) develop capacity for the adoption of ESTs
c) demonstrations	c) assess technological options
d) project implementation or technology commercialization	d) implement and operate technology
e) feedback analysis	e) feedback analysis

(Source FCCC/TP, 1998)

The five stage process outlined in Table 2.1 commences with the research and development of a new technology by the supplier organisation in the developed nation. The recipient organisation's first step is to identify the need and create awareness of the new technology in the recipient nation. Project preparations then undertaken by the supplier that should include an assessment of any potential barriers to the effective transfer of the technology. The recipient organisation will develop a capacity for the adoption of the technology. Demonstration projects will assist in the development recipient organisation's adoption capacity and enhance the effective transfer of the technology and allow the assessment of

the technological options in relation to the recipient country's requirements. Full project implementation and commercialization will ensure the technology product's longer term sustainability and facilitate its adoption in the recipient country. Feed-back analysis is the final stage of the process and is important to identify improvements in both product installation and operational effectiveness. Feed-back analysis also includes gaining a greater understanding of the broader social impacts in relation to the adoption of the technology.

The implementation of such a process calls for the involvement and commitment of different actors. There are six main actors who may enter the process at different stages: governments, private sector business, multilateral financial institutions, international organisations, NGOs and consumers. These actors often perform multiple functions; for example, the private sector develops, manufactures, markets, finances and operates technologies. Thus, the boundaries between actors are not rigid and may differ for different types of technologies. All the actors participate in the process. Nevertheless, the process itself depends upon the varying environmental, economic, social and cultural (i.e.four pillars of sustainable development) conditions, in both developed and developing countries.

To be able to facilitate the adoption and implementation of ESTs it is essential to consider specific regional, national and sectorial barriers and incentives (FCCC, 1998). Barriers may generally be defined as factors that inhibit the technology transfer process. Examples of barriers are abundant in the literature[1]. One of the barriers relevant to the transfer of ESTs is cultural: consumer preferences and social biases. Experience has shown that technologies may fit poorly with, variously clashing with or transforming the political structures, everyday habits and inherited local knowledge of recipient societies. Ethical and spiritual values may also be shaken by certain technologies. Perceptive analysis of the complex and varied interactions between technological change and social changes is

[1] See for example: World Investment Report 1996, UNCTAD, and Technology and Finance: new opportunities and innovative strategies for sustainable development, UNDP as cited in FCCC/TP 1998)

crucial to ensuring that technology transfer contributes to sustainable development (Awny, 2004). A potential problem with the introduction of ESTs, such as more efficient wastewater management techniques, is that these ESTs may facilitate further proliferation of high consumption Western developments that will adversely impact on traditional social cultural values in some developing nations.

A first step in the process of overcoming barriers, such as potentially adverse impact on traditional social structures and cultural values, is to identify these barriers and assess them according to the technologies chosen (FCCC 1998). This assessment may be done in the project preparation step by the supplier and confirmed in the feedback analysis by both supplier and recipient organisations. Pre-project and post-project assessments may enhance the likelihood of success and the ability to replicate technology in other countries. A detailed assessment of the people to be involved and their needs and capabilities must be conducted by the supplier organisation and the existing infrastructure evaluated to determine its effectiveness (UNIDO 2002). The information gathered can then be used for debate among the actors involved in the process of technology transfer as well as those groups in society that will be impacted through the adoption of the technology.

Cultural differences must also be considered in relation to both supplier and recipient organisations involved in the transfer of technology. The transfer of technology from developed to developing nations involves organisations located in at least two distinct nations. The effectiveness of cross border transfer of organisational knowledge is profoundly affected by cultural diversity among the members engaged in such transactions (Araujo 2007). Social and cultural variations between nations (macro differences) and organisational cultural-based variation between organisations (micro) are involved in technology transfer are two factors that influence the success of transfer (Kedia and Bhagat 1988, 559).

2.2 A conceptual model

The transfer of technology from developed to developing nations often faces a complex array of social, cultural, economic and environmental barriers that will impede the effectiveness of such transfers. These barriers need to be clearly understood if the transfer of technology is to promote sustainable development. Ben Kedia and Rabi Bhagat, leading scholars of international management based in the USA, present a conceptual model of international technology transfer across nations that takes into account both macro and micro aspects of cultural difference of both organisations involved in the transfer of the technology. The receptivity to technological change on the part of the recipient country is also considered in the model. The Kedia and Bhagat model enables potential barriers to be clearly mapped so that strategies for overcoming them can be developed. One technique to effectively map these barriers is to apply the information identified by the conceptual model to a 'balanced score card' to allow a direct comparison to be made of the two nations involved in the technology transfer.

Kedia and Bhagat (1988, 559) reviewed the main trends in research into technology transfer prompted in the early 1970s by the widespread failure of post-war development strategies to overcome poverty in many regions. They identified two main groups of studies. The first group of studies described how technology gets transferred, what types of technology are likely to get higher levels of commitment on the part of the recipient organisation, and the nature and duration of the relationships as a function of the negotiations between the two enterprises. The second group of studies focussed on the adsorptive capacity of the recipient organisations and the level of technological development of the host country. The process of technology transfer is composed of the transfer of a systematic set of organized information, skills, intellectual property rights, and services from a supplier or donor organisation located in a developed country to a recipient organisation in a developing nation (Kedia and Bhagat 1988, 559). The absorptive capacity of a recipient organisation is linked to the learning capabilities

of those members associated with the acquisition of the technical knowledge associated with the technology.

The initial emphasis in the analysis of international technology transfer until the late 1970s, was on the costs of technology transfer, and on whether the choice of technologies was appropriate to local conditions in developing countries. Little attention was given in this analysis to the absorptive capacities and domestic technological learning of those who acquired foreign technologies; that is to the processes involved in assimilating imported technologies and putting them to work efficiently. The underlying assumption seemed to be that once a technology was acquired, its absorption and implementation took place almost effortlessly; however it is now widely accepted that such is not the case. The acquisition and absorption of foreign technologies, and further development, are each complex processes that demand significant efforts from the recipients. Several factors contribute to this complexity, including the fact that acquisition and mastery of technology is both costly and time-consuming, especially as acquired technologies often need to be adapted to local conditions. Technologies are not commodities that can be transferred as a complete ready-to-use set; they also contain tacit components that are not easily codified and transmitted in written documents, and require extensive learning efforts to be properly understood (WACC, 2006).

The studies reviewed by Kedia and Bhagat offer little in terms of theoretical understanding of constraining cultural influences consequently involved in the efficient transfer of technology. Kedia and Bhagat thus developed a scheme depicting the relative importance of cultural variations across nations, organisational culture, and strategic management processes at the level of an enterprise as determinants of the efficacy of technology transfer between nations is presented as Table 2.2. It shows that the effectiveness of transfer of technology is predominantly determined by macro-cultural variations when the

transfer is from a developed (or industrialised) nation to a developing (or industrialising) nation.

Table 2.2 Relative Importance of Cultural Variation and Strategic Management Processes as determinants of the Successful Transfer of Technology Between Nations

	From Developed (to other Developed Nations (e.g., U.S. to West Germany)	From Developed to Moderately Developed Nations (e. g. U.S. to South Korea)	From Developed to Developing Nations (e. g West Germany to India)
Social Culture	Least important	Moderately important	**Most important**
Organisational Culture	Moderately important	Moderately important	Moderately important
Strategic Management Processes	Most important	Moderately important	Least important

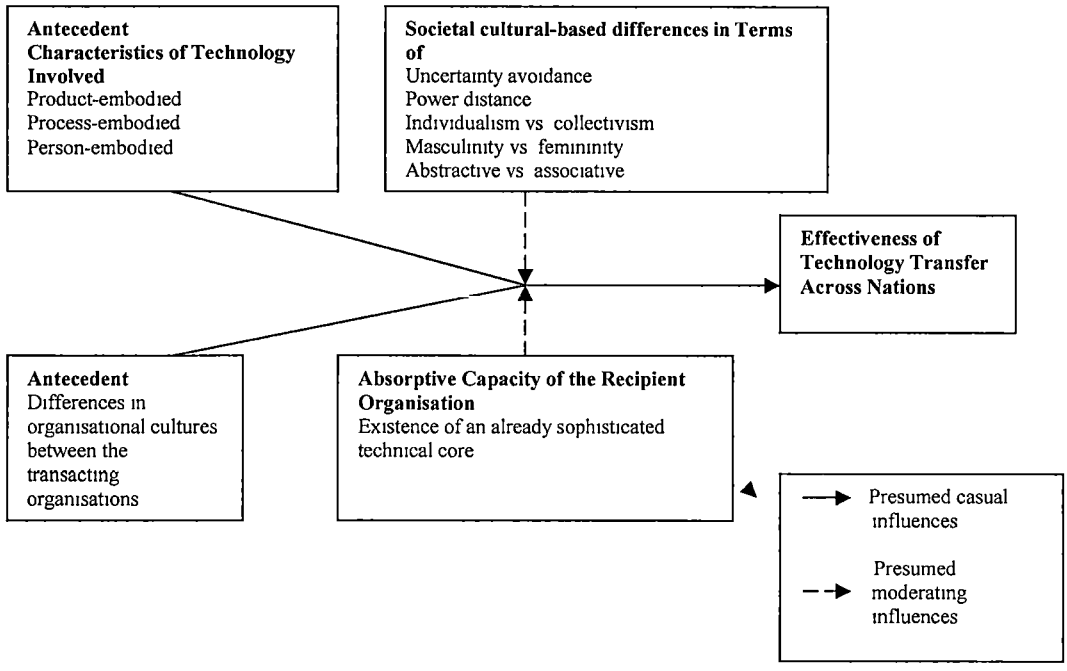
(Source Kedia and Bhagat 1988, 560)

The right hand column of Table 2.2 shows social culture as the most important determinant for the successful transfer of technology from a developed nation to a developing nation. Organisational culture is moderately important while Strategic management is the least important determinant. With this framework in mind, Kedia and Bhagat developed a conceptual model that depicts the role of cultural constraints and other important factors as determinants of efficacy of the transfer of technology across nations. The model has two causal antecedents

(organisational culture differences and specific characteristics of the technology involved) and two moderating factors (Kedia and Bhagat,1988, 561).

Kedia and Bhagat's model of effective international technology transfer is outlined in Figure 2.1. The model has four components that influence the effectiveness of technology transfer between nations. The model suggests that the effectiveness of technology transfer is moderated by variations in societal and cultural differences and receptivity to technological change in terms of absorptive capacity of the recipient organisations. Consideration of each component or sub-component of the model has allowed Kedia and Bhagat to develop a number of propositions that are useful in determining the effect of each component or sub-component in different scenarios. In the conceptual model Kedia and Bhagat also incorporated the work of Hofstede and Glenn and Glenn. Hofstede identified for dimensions of cultural variation in terms of Uncertainty avoidance, Power distance, Individualism vs. collectivism and Masculinity vs. femininity. Kedia and Bhagat incorporate Hofstede's dimensions of cultural variation in order to advance their research propositions that enable a better understanding the process of technology transfers in the context of cultural differences between the transacting organisations and nations involved. The final dimension of cultural variation that plays a role in the efficiency of technology transfers is provided by Glen and Glen in relation to abstractive versus associative tendencies in a given culture.

Figure 2.1 Kedia and Bhagat Conceptual Model



(Source, Kedia and Bhagat, 1988, 561)

2.2.1 Types of technology (Antecedent Characteristics of Technology Involved)

The first stage of Kedia and Bhagat's model is to characterise the technology to be transferred according to one of three process categories namely, 'product-embodied', 'process-embodied' or 'person-embodied'. In the case of product-embodied technology transfers, one transfers the physical artefact itself. Examples would be heavy earth-tilling machinery and sophisticated computer components. Process-embodied technology transfers involve the transfer of blueprints or patent rights of the actual scientific processes and engineering details. Examples include transfer of chemical technology for the manufacture of

synthetic fabrics and off-shore petroleum exploration technology. Person-embodied technical transfer depends on the efficacy of a mission undertaken by a supplier organisation in developing a sophisticated local technical core to implement and diffuse the imported technology.

Kedia and Bhagat (1988, 562) argue that, compared to product-embodied technologies, process-embodied and person-embodied technologies are considerably more difficult to transfer between nations. This difficulty is because cultural and strategic management factors play larger roles in such transfers and diffusions.

2.2.2 Compatibility of Societal Cultures (Societal cultural-based differences)

Kedia and Bagat's model stresses the importance of the culture of the developing country as a major determinant of the effectiveness of technology transfer. National cultures can be mapped according to their fit into a four-dimensional framework;

a. weak versus strong uncertainty avoidance.
b. individualism versus collectivism,
c. small versus large power distance, and
d. masculinity versus femininity.

To allow these cultural variations across nations and organisational cultural-based differences between organisations to be measured, each of Hofstede's components has been translated into a quantitative index (Clearly Cultural Uncertainty avoidance/ Individualism/ Power-distance/Masculinity Index, 2008). Each nation is rated on a scale of 1 to 120. These indices may then be placed in the model to allow the comparison of the relative status of supplier and recipient nations and organizations within the four dimensional framework of the conceptual mode.

2.2.2.1 Uncertainty avoidance

The index of uncertainty avoidance accounts for a society's tolerance for uncertainty and ambiguity. This variable indicates to what extent a culture influenced its members to feel either uncomfortable or comfortable with unstructured situations. Unstructured situations are novel, unknown, surprising, and out of the ordinary. Uncertainty avoiding cultures try to minimize the possibility of such situations by strict laws and rules (Clearly Cultural Uncertainty Avoidance Index (UAI) 2008). The main concern in relation to the effectiveness of technology transfer is the extent to which people in a society feel the need to avoid ambiguous situations and the extent to which they try to manage explicit and formal rules and regulations or by rejecting novel ideas (Kedia and Bhagat 1988, 563). Individuals in a society classified as high in uncertainty avoidance tend to behave guided by explicated and formal rules, and regulations, thus being more prone to rejecting novel ideas. Conversely, individuals in a low uncertainty avoidance society tend to behave in a more flexible way, thus enabling the acceptance of novel ideas (Araujo, A.L. 2007). For example in Germany there is a reasonably high uncertainty avoidance (65) compared to countries such as Singapore (8) and Denmark (23). In Germany there is a society that relies on rules, laws and regulations. The United States (US) scores a 46 compared to the 65 of the German culture. Uncertainty avoidance in the US is relatively low (Clearly Cultural Uncertainty Avoidance Index, 2008).

2.2.2.2 Individualism versus collectivism

In the Kedia and Bhagat's model, individualism is placed as the opposite pole in a continuum stretching from collectivism. This contimuum seeks to account for the degree to which individuals are integrated into groups and is especially concerned with the relationships between individuals and organisations. At the individualistic end of this dimension, ties between individuals are generally very

loose with people looking after their own self-interest. At the collective end we find societies in which social ties and bonds between individuals are very tight. People distinguish between their own in-groups, such as immediate relatives, clans, and members of their own organisation, and out-groups from a different community or a foreign country. In individualistic cultures, people are inner self directed, whereas in collectivist cultures, individuals are more traditional and other directed (Kedia and Bhagat 1988, 564). People in individualistic cultures are usually motivated by their own preferences, needs, rights, and contracts. On the contrary, individuals in collective cultures in general place great emphasis on the group and behave in ways more explicitly and rigidly guided by norms, duties and social obligations (Araujo, 2007). There are successful examples of technological diffusion in countries that are strongly collectivistic, such as Japan, Singapore, Hong Kong, and Taiwan and that the ability of these countries to absorb Western technology has been remarkable. However, individualistic cultures are better able to both generate and import modern Western technological advances (Kedia and Bhagat 1988, 565). For example, Germany can be considered as an individualistic culture with a high score (89) on the scale of Hofstede compared to a country like Guatemala which is based upon strong collectivism (6 on the scale). In Germany people place importance on personal achievements and individual rights. Group work is important, but everybody has the right to express his own opinion. The US can be regarded as an individualistic society (scoring 91).

2.2.2.3 Small versus large power distance

Power distance is the extent to which the less powerful members of organisations and institutions (like the family) accept and expect that power is distributed unequally; this represents inequity (more versus less), but defined from below, not from above. It suggests that a society's level of inequity is endorsed by the followers as much as by the leaders (Clearly Cultural Power Distance Index (PDI) 2008). The dimension of power distance is the extent to which less powerful

members of a society accept unequal distribution of power and rewards as normal features of their society. Hofstede (Kedia and Bhagat 1988, 564) has shown that different cultures possess different distributions of power in their organizational and social hierarchies and that the power distance norm can be used as a criterion for characterising societal cultures. Technologies that might introduce significant changes in the distribution of power, status (real and symbolic), and rewards in the recipient organisation of the developing country that emphasises power distance are least likely to be effectively transferred (Kedia and Bhagat 1988, 564). For example Germany has a 35 on the cultural scale of Hofstede's analysis. Compared to Arab countries where power distance is very high (80) and Austria where it is very low (11), Germany is in the middle with a relatively small gap between the wealthy and the poor, and a strong belief in the equality of each citizen. Germans have the opportunity to rise in society. On the other hand, the power distance in the US scores a 40 on the cultural scale. The US exhibits a more unequal distribution of wealth compared to German society (Clearly Cultural Power Distance Index 2008).

2.2.2.4 Masculinity versus femininity

The continuum of masculinity-femininity seeks to account for the distribution of roles in social change between genders. Kedia and Bhagat (Kedia and Bhagat 1988, 564) argue that women's values differ less between societies than men's values. Men's values range from one country to another from very assertive and competitive. Women's values are generally modest and caring and similar from country to country. The assertive pole has been called 'masculine' and the modest, caring pole 'feminine'. Masculine cultures generally emphasise assertiveness, acquisition of money and status, achievement of visual and symbolic or organisational rewards. In feminine cultures emphasis is placed on quality of life and other less tangible outcomes. In masculine cultures there are sharp distinctions between assertive roles that men are expected to perform and service roles that women are expected to fulfil (Kedia and Bhagat, 1988, 564).

Hofstede notes that in a masculine society the public hero is a successful achiever, an aggressive entrepreneur, and that big is beautiful Hofstede (cited in Kedia and Bhagat 1988, 564). In contrast, feminine cultures emphasis quality of life, preservation of the environment, helping others, and putting relationships before money and achievement. Masculine cultures are more effective than feminine cultures in absorbing and diffusing imported technology in organizational contexts (Kedia and Bhagat 1988, 564). For example Germany has a masculine culture scoring 66 on Hofstede's scale. Masculine traits include assertiveness, materialism/material success, self-centeredness, power, strength, and individual achievements (Clearly Cultural Masculinity Index (MAS) 2008).

2.2.2.5 Abstractive versus associative tendencies

A further dimension of cultural variation that plays a role in determining the efficiency of technology transfer is the abstractive versus associative tendencies in a given culture (Glenn and Glenn cited in (Kedia and Bhagat 1988, 566). Glenn and Glenn cited in Bhagat et al. 2002 note that individualist cultures are generally more abstractive than collectivist cultures. In individualist cultures, cause-effect relationships and Judeo-Christian modes of thinking are important, whereas in collectivist cultures, people emphasize associative modes of thinking, sometimes leading to association among events that may not necessarily be logically related; in addition, the context of communication is clearly more important in collectivist cultures (Bhagat et al. 2002). Communication in associative (collectivist) cultures is characterised by face-to-face contact, and it takes place among individuals who share a large body of information based on both historical and contextual models (Hall cited in Kedia and Bhagat 1988, 566). In contrast, a vast amount of communication in abstractive cultures tends to be conveyed through mass media and related technological methods that are rather dissimilar compared to face-to-face modes of communications. Communication structures that support information flows between globally dispersed individuals require appropriate

organisational mechanisms (i.e., technology) to leverage a firm's absorptive capacity, thereby enhancing the transfer of knowledge (Araujo 2007).

2.2.3 Differences in Organisational Culture

When examining the receptivity of countries to technological change, Kedia and Bhagat (1988) adopted the concept of negotiated order to understand the role of organisational cultural-based differences in technology transfers across nations. Social order is negotiated and organised activity is not possible without some form of continued negotiation. Negotiations are contingent on the structural conditions of the organisation and they reflect patterned, not random, lines of communication within the organisation. Negotiations also have temporal constraints and organisational structural changes may require a change to the negotiated order, for example the adoption of technological innovations. The concept of negotiated order focuses on the following:

(a) the number of negotiators, their experience, and whom they represent;
(b) the sequence and frequency of negotiations;
(c) the relative balance of power among the concerned parties;
(d) the steaks and visibility of the outcome of negotiations;
(e) the complexity of the issues and
(f) the alternatives to avoiding or discontinuing negotiations

If the negotiated orders in the micro cultures of two transacting organisations are significantly different in terms of these six dimensions, the transfer of technology between them would be difficult (Kedia and Bhagat 1988, 587)

2.2.4 Absorptive Capacity

Within the context of the conceptual model Kedia and Bhagat identify the following societal cultural based differences that also affect the absorptive capacity the recipient organisation;

(a) local versus cosmopolitan orientation,
(b) the existence of a sophisticated technical core in the recipient organisation, and
(c) the differences in strategic management between transacting organisations

An organisation's ability to adopt innovative technology is dependent on the degree of cosmopolitanism that is inherent in the organisation. The adoption and implementation of technology is greatly dependent on the mix and array of pre-existing priorities and conflicting alliances present in the recipient organisation. Cosmopolitan organisations manage potential conflicts more systematically, routinely ensuring the successful transfer of the innovative technology than local organisations that may be influenced by an array of local priorities, effective transfer of technology may be more difficult. (Kedia and Bhagat 1988, 568).

2.3 A balanced score card

The Kedia and Bhagat and Glenn and Glenn Conceptual Model Propositions, incorporating the indexed Hofstede components can be used in a balanced score card table with each proposition being rated positively (+) or negatively (-) depending on a particular nation's cultural characteristics. A positive result will provide an indication of the likelihood of an effective transfer of technology. These ratings will also be useful in allowing a comparison of developing nations with different cultural characteristics.

Since the development of the Kedia and Bhagat Conceptual Model in 1988, there have been profound changes in global communications, with the most notable being those stemming from the use of the internet. When operating in the virtual setting, both supplier and recipient team members interact and communicate electronically using a variety of technological mechanisms such as electronic message recording, issue analysis, audio and text message exchanges and e-mails (Araujo 2007), which are likely to excel at enhancing the velocity of knowledge transfer (Bhagat, et al 2002, 207) as cited in Araujo 2007)

To reflect the importance of advances in global communications, and the use of the internet in particular, in the overall enhancement of knowledge transfer a further proposition has been included to indicate the use of modern information and communication technology.

Table 2.3. shows a balanced score card template incorporating these propositions together with a developing nation's status in relation to these principles.

Table 2.3 Balanced Score Card

	Proposition (1-8) Kedia and Bhagat (9) Araujo	Recipient Organisation (Developing Nation)	Compliance (+ or -)	Recipient Organisation (Developing Nation)	Compliance (+ or -)
1	*Process- and person-embodied technologies are more difficult than product-embodied technologies to transfer and diffuse across nations because cultural differences at the organisational level, as well as the societal, level play greater roles in such transfers*				
2	*Transfer of technology is easier between two organisations that are similar in terms of their societal/national culture-based tendencies to either avoid or embrace uncertainty generated in their organisational contexts due to such transactions*				
3	*Organisations located in individualistic cultures are more successful than organisations located in collective cultures in their propensity to absorb and diffuse imported technology.*				
4	*Technologies that might introduce significant changes to the distributions of power, status (real or symbolic) and rewards in the recipient organisation of the developing country that emphasises power distance are least likely to be effectively transferred*				
5	*Masculine cultures are more effective than feminine cultures in absorbing and diffusing imported technology in organisational contexts*				
6	*Abstractive cultures are more effective than associative cultures in their ability to absorb and diffuse imported technology*				
7	*Differences in the negotiated orders of the cultures of the organisations involved in the transfers and diffusion of technology across nations affect the effectiveness of such transfers.*				
8	*Cosmopolitan organisations in societies that also have a sophisticated technical and strategic management orientation are more effective than local organisations in systematically managing technological transfers*				
9	*The use of modern information and communication technologies will positively influence a recipient organisations ability to acquire knowledge to assist in the effective transfer of technology.*				
	TOTAL				

Source (1-8) Kedia and Bhagat (1988), (9) Araujo (2007)

Chapter 3

A technology for sustainable development: The Evapocycle on-site sewage treatment system

3.1 Sewerage infrastructure historical perspectives

In most developed countries most people have access to safe drinking water and adequate sanitation as a result of major investments during the 20th century (Siegrist *et al.* 2007, 27) As developed nations implemented centralized water treatment in the late 19th and early 20th centuries, plants and piping networks produced and distributed drinking water while sewers collected wastewater for treatment in often remote plants. Today in the United States, centralized water and wastewater systems are serving 85% and 75% of the population, respectively. However, by the 1960's there were growing concerns about the sustainability of large centralized systems due to many components of large centralized systems that were at or approaching the end of their design life spans. Rehabilitation options for large centralized systems are often limited and extremely costly (Siegrist *et al.* 2007, 27). In contrast to the larger centralized sewerage systems established in urban areas, rural and suburban areas without centralized sewerage systems are serviced by private sewerage systems such as septic tanks. These private systems were also known as on-site systems and were seen as 'temporary solutions' and needed only until the 'sewerage' arrived. In Australia over the last 20 years, the advent of rural residential living ('life-style blocks') with reticulated town water and on-site wastewater treatment and disposal are becoming increasingly popular. The economic reality of what it would cost to sewer these 'spread out' sub-divisions has meant that on-site systems are now required to operate on a permanent basis (Kele 2007, 20).

There is a need globally for wastewater infrastructure that is effective in protecting public health and preserving water quality while being acceptable, affordable and sustainable. On-site and decentralized systems have the potential to achieve these goals in rural areas, peri-urban developments, and urban centres in small and large cities, especially in developing countries that have limited planning, technological and economic capacity to implement capital intensive and resource-intensive centralized systems Based on research and development efforts over the past decade or more,

modern on-site and decentralized systems have evolved and include a growing array of approaches, devices and technologies that can be applied at the household or small project level up to watershed scale (USEPA cited in Siegrist *et al.* 2007, 27). To enable more widespread use of on-site and decentralized systems, education and training have helped the standard practice while modifications to regulatory codes and development of management structures facilitate deployment of conventional and innovative systems (Siegrist *et al.* 2007, 27).

In Australia the relevant standards and legislation and by-laws were all updated around 1995 to 2000 (Kele 2007, 20). Currently performance requirements for on-site wastewater treatment and disposal treatment systems are identified in Australian/New Zealand Standard (AS/NZS) 1547:2000. *On-site domestic-wastewater management)*[1] The performance requirements prescribed by AS/NZS 1547:2000 ensured that on-site wastewater treatment systems were generally restricted to building lots of sufficient size with no site limitations such as non-absorbent soil types, high ground water tables, rock and steep slopes as identified in AS/NZS 1547:2000 that would prevent the effective operation of those systems. For example, a house building lot, with an area of 550 square metres and non-absorbent clay soil would fail to comply with the performance requirement AS/NZS 1547:2000 that requires wastewater to be effectively treated and disposed of within the property boundary (on-site). Building lot size and site limitation restrictions highlighted on-site wastewater treatment technology gaps that limited development in areas that could not be connected to centralized sewers.

In an attempt to solve some of these on-site wastewater technology gaps, the early 1980s also saw the introduction of a number of innovative on-site wastewater systems, such as Aerobic Wastewater Treatment Systems (AWTS) in a number of Australian states. AWTS did not rely on in-ground disposal and were designed to fit into wastewater holding tanks that collected primary treated (solids free) wastewater[2] from a house. Wastewater holding tanks required pumping out on a on a regular weekly basis into road tankers that transported the collected primary treated wastewater to centralised sewerage

[1] AS/NZS 1547:2000 defines various means of compliance on-site wastewater systems including conventional ground absorption trenches and evapo-transpiration systems, waste-water treatment units known as Aerobic Wastewater Treatment Systems (AWTS) and other innovative wastewater systems.
[2] The process of removing wastewater (sewage) solids such as faeces is known a primary treatment and is necessary to allow the in ground disposal (secondary treatment) system to function without clogging. Septic tanks are designed to facilitate primary treatment.

treatment plants. The use of holding tanks allowed development of residential areas without the need for costly sewerage infra-structure; however these developments were restricted to areas that were relatively close to existing centralized sewage treatment plants. The use of AWTS provided further on-site treatment and produced chlorinated wastewater that was approved for surface disposal onto prescribed garden beds. AWTS solved the high cost associated with the use of pump out road tankers, however other problems with the wide spread use of AWTS became apparent. These include the AWTS' need for frequent expert maintenance, increasing purchase and running costs and a serious health concern related to the surface disposal of chlorine treated sewage near houses that is a source for communicable diseases (Patterson 2007, 263). A need was identified to develop a wastewater management system that could be used in any location and for all situations where wastewater is generated. Such a wastewater system needed to comply with the relevant standard (AS/NZS 1547:2000), be able to be managed without expert maintenance and most importantly, not allow the potential to spread communicable diseases. The system needed to be efficient and practical especially in remote locations and able to be operated for extensive periods (3 to 5 years) while not being reliant on the need for frequent expert maintenance or rely on chlorine treatment.

3.2 Innovative wastewater solution - Evapocycle

The original development of the Evapocycle system commenced at the Centre for Environmental Studies at the University of Tasmania. Then Head of the Centre, Dr Richard Jones, was instrumental in encouraging me to clearly identify the key problems to be solved that would allow effective wastewater treatment and disposal under all conditions. Such a system should be designed to effectively eliminate all the problems caused by site limitations that prohibited the use of conventional on-site wastewater treatment systems. Dr Jones indicated that serious health and environmental problems were consequences of the sewage and other pollutants escaping from the building and being conveyed into the surrounding environment. He explained that water is very useful when used inside a building it allows the flushing of toilets, the washing of clothes and dishes, showering and other activities that allow sustainable healthy living for the occupants of that building. Unfortunately, when the water leaves the building it becomes the means by which sewage and other contaminants are carried into the environment. Without water, sewage and many other contaminants can not escape and

cause problems. Dr Jones indicated, 'the key problem (challenge) was to eliminate the water from the wastewater once the wastewater has left the building'. The aim of my research was therefore to design a wastewater management system that effectively removed water from the wastewater stream.

Evaporation is the simplest and most effective method of removing the water component from primary treated wastewater. Conventional evaporation systems are described in AS/NZS 1547:2000. Conventional evaporation systems are designed to operate by presenting a raised bed usually square in shape that is exposed to the sun into which primary treated effluent is directed. Evaporation occurs from this exposed surface. A major limitation of these systems is that by their design they are also exposed to rainfall. Rainfall is mixed with the wastewater increasing the total volume of water to be evaporated. To operate effectively conventional evaporation systems must be constructed only in areas where the evaporation rate exceeds both the area's rainfall combined with the actual wastewater loading. Insufficient levels of evaporation limit the areas in which traditional evaporation systems can be used. Insufficient levels of evaporation occur in many parts of Tasmania especially during winter months which prohibit the use of traditional evaporation wastewater systems in those areas.

3.2.1 Evapocycle innovative design features

The initial design challenge was to eliminate the ingress of external water into the system. Water may enter a wastewater system from a number of external sources such as surface runoff, high ground water tables, flooding and direct rainfall. The elimination of external water was achieved by positioning the Evapocycle on a prepared earth pad constructed on top of the natural ground surface. This elevated positioning effectively eliminated water entry from surface runoff, high ground water tables or flooding much in the same way as a building is protected. The elimination of direct rainfall was achieved by the positioning of an impervious membrane on top of the Evapocycle's core treatment zone similar to a roof on a house. A second impervious membrane was positioned at the base of the core treatment zone to ensure that ground water could not be drawn up into the core treatment zone through capillary action (surface tension) facilitated by the core treatment zone prescribed fill material. The positioning of both the top and base impervious membranes created the second design challenge. With both top and base

areas effectively water proofed the only remaining openings through which evaporation could occur was through the sides of the core treatment zone. This problem was solved by recognising that water can be made to move sideways through the adsorptive effect caused by capillary action created on the surfaces of the prescribed core treatment zone material. Put simply, moisture will migrate from a wet surface to a dry surface. Trial Evapocycle systems have demonstrated that Evapocycle has a very high evaporative capacity when compared to conventional evaporation systems, because of the extremely high surface area of rock aggregate in the protected core treatment zone on which the wastewater can evaporate. For example a 20m Evapocycle can evaporate approximately 5000L of wastewater each day compared to a conventional evaporation system that can evaporate approximately 900L of wastewater each day. Evapocycle operation is described by Patterson and Gatley (2007, 264-266).

3.2.2. Primary treatment challenges

Having solved the evaporation challenges associated with wastewater disposal systems a further problem was identified in relation to providing the effective primary treatment necessary as a precursor to the Evapocycle process. In domestic situations effective primary treatment could be provided by a standard septic tank, however in remote locations and in developments generating large volumes of wastewater, it may not be possible to use standard septic tanks due to their bulk and size limit of 3000L (AS/NZS 1547: 2000, 143). A need was identified to develop a primary treatment that was both portable and sufficient capacity that could be matched to the Evapocycle disposal system.

3.2.3 Field Septic Disposal System (FSDS)

In 1989, I invented the *Field Septic Disposal Systems* (FSDS) also known as Bioremediation In-field Personnel Units (BIPU).The FSDS consists of a number of transportable plastic boxes with water tight liners that may be configured to suit small (200L) to large (4000L) wastewater volumes. Very large wastewater volumes may be handled with multiple 4000L FSDS. FSDS fully comply with the requirements of AS/NZS 1546.1 (Brown, R. 2007). FSDS has been used successfully during civil emergencies where conventional sewerage infrastructure had been destroyed or was non-

existent. For example, following the 2004 Boxing Day Tsunami the Tasmanian Government donated ninety 300 person FSDS units to the NGO Oxfam (UK) for use in Aceh. Approximately 27,000 displaced persons in camps throughout Aceh were provided with sustainable sanitation through the use of FSDS.

Since 1996 Evapocycle installations have successfully operated in a number of commercial applications in Tasmania and South Australia, including licensed golf clubs, remote Forestry Tasmania tourist facilities, hotels, council sports ovals and domestic homes (Patterson and Gatley 2007, 266). The combination of the two on-site innovations of Evapocycle and FSDS means that sustainable on-site wastewater treatment can be used universally in all locations and for all situations where wastewater is generated.

3.3 Evapocycle application in developing countries.

A major advantage of the Evapocycle wastewater treatment system is that it is constructed on-site mainly from locally available materials using local labour. The main Evapocycle structural elements are the supporting walls for the core treatment zone. These walls are 600mm to 800mm high and may be constructed from any suitable material such as treated timber or bricks. This allows Evapocycle to be used in remote areas and overseas developing countries. All plumbing components and moisture barriers are made from plastic with minimum life spans of 15 years as required by the relevant standard (1546.1:1998). The early Evapocycle systems installed in 1996 for Forestry Tasmania were inspected in 2007 and found to be operating satisfactorily with no sign of structural failure (Patterson 2007).

Evapocycle systems can be adapted for use in non-powered areas such as those in use at the Forestry Tasmania tourist toilet facilities in the Arve Valley in southern Tasmania and Liffey Falls in the north of the state. In these situations the primary treated wastewater from the toilet block is pumped using a petrol pump every 7 to 10 days to the Evapocycle beds. Evapocycle systems are also suitable for situations that receive little or no use for extended periods such as these Forestry venues that receive small numbers for example, fewer than 10 daily visitors during the winter months.

To ensure continued effective operation each Evapocycle bed is constructed with two internal zones that can operate independently. This feature allows for one zone to be shut down in the event of unexpected damage, for example from a falling tree, and be repaired while the undamaged zone remains in operation. This capability is important to ensure continued operation in remote areas where technical support to conduct repair work may take some time to arrange.

The flexible nature of the Evapocycle system allows for additional Evapocycle beds to be constructed to service further site development. Decommissioning Evapocycle is also straightforward. When the system is no longer required the FSDS chambers are pumped out and removed or simply filled with sand and the Evapocycle beds disconnected.

The Evapocycle innovative design features, robustness and system reliability make this technology particularly suited for use in developing countries. However, as discussed in Chapter 1 the successful transfer of technology also includes the skills, practices, knowledge, cultural aspirations and social processes necessary to make things happen. Sufficient research and development has been undertaken in Australia that has confirmed the effectiveness of Evapocycle as a suitable on-site wastewater system especially in remote and environmentally sensitive locations. The next step in the technology transfer process is to undertake a project in a developing nation to assist in developing the adaptive capacity of the recipient organisation to acquire and practice the necessary skills and knowledge within their social context to effectively transfer the Evapocycle technology.

Chapter 4

Supporting sustainable development by transferring technology in the Cook Islands: transferring the Evapocycle

As discussed in Chapter 2 one of the keys to increasing 'eco-efficiency' in developing countries through capacity building is the effective transfer of appropriate technology. Without effective transfer of appropriate technology important legacies for future generations will be lost. Evapocycle was identified in Chapter 3 as an innovative wastewater treatment technology that is suited for use in environmentally sensitive remote areas. In this chapter, I shift my focus from Evapocycle technology, to the social, cultural, economic and environmental context of the Cook Islands into which this technology was transferred as part of this research. I focus particularly on the absorptive capacity of the Cook Islands in general and of a recipient organisation in particular. Before undertaking the transfer of a technology, however, a detailed assessment of the people to be involved and their needs and capabilities must be conducted and the existing infrastructure evaluated. To better appreciate the social and organisational network within which the Evapocycle project will be undertaken it is necessary to have a sound understanding of the Cook Islands geography, history, governance, racial and business relationships. The effectiveness of the existing wastewater infrastructure and its effects on public health and ecosystem health are also important factors in determining the need for the introduction innovative on-site wastewater treatment technologies.

4.1 Cook Islands

4.1.1 Location and current population

The Cook Islands are a Polynesian island group comprising 15 islands in the Pacific Ocean between latitudes 14 degrees S and 22 degrees S, and longitude 159 degrees W and 164 degrees W. The main island, Rarotonga, is a volcanic island of 67 km2 with a population of 14,153. The other 14 islands accommodate a total population of 5416

(Dakers and Evans 2007, 105). A road network circumnavigates Rarotonga and serves the villages and most of the tourist developments as shown in Figure 4.1.

4.1.2 Geology

The geology of the Cook Islands is highly diverse and includes the following: the volcanic island of Rarotonga that reaches 658m above sea level: four raised coral islands with volcanic cores (Mangaia, Mauke, Mitiaro and Atiu), a near atoll with a volcanic core (Aitutaki, the second most populated island) one sand clay and eight atolls. The coastal fringes of Rarotonga consist of sediments derived from inland and sea deposition processes. Foothill terraces have formed from fans of strongly weathered volcanic alluvium while a narrow strip of beach deposits and coral debris surrounds the island. A depressed belt of swamp, underlain partly by coral sand and partly by sand gravels, occurs between the terraces and the coastal strip (Leslie 1980 cited in Dakers and Evans 2007, 105). Swampy land and sandy soil types in coastal areas present site limitations for conventional on-site septic systems.

Figure 4.1 Map Rarotonga, showing villages, main tourist resorts and the YWAM Base. Sourcewww.jetsave.co.ck/images/raromap3.jpg

4.1.3 Cook Islander history

The ancestors of contemporary Cook islanders were Polynesian. The population of traditional Cook Islanders at its highest was about 17,000 just before the first contact with Europeans over 200 years ago. During the 1800s, epidemics of mumps, measles, chicken pox, influenza and other contagious diseases caused a great reduction in the Cook Islander population. The population was further reduced by the Peruvian slave trade of 1862 to 1864. By 1900 the people were developing resistance to introduced diseases and, as health services improved, the population grew steadily to 10,082 in 1926, 12,246 in 1936, 16,680 in 1956 and 19,247 in 1966. The national population, including non-Cook Islanders permanently living on the islands reached its peak in 1974 just before the international airport opened. The opening of the international airport caused a population decline with over 80,000 Cook Islanders now living permanently in New Zealand, Australia and further a-field (Institute of Pacific Studies 2003,16).

4.1.4 Cook Island governance

Two hundred years ago the governance of Cook Islands society was coordinated by local tribal chiefs. From the 1820s missionaries played a powerful role in modifying the rules of government based on their Christian beliefs. Currently the dominant religion of the Cook Islands is Christianity. Sundays are reserved for going to church and time with the family, so there are no organised sporting activities, with the only golf club on Rarotonga open and most commercial business operations closed.

The latter part of the nineteenth century saw an emergence of powerful commercial influences which remain strong today especially in relation to tourism infrastructure development. At that time Cook islanders feared being taken over by France, a fate that had befallen their Tahitian relatives. Accordingly the Cook Islanders appealed for British protection, which was granted in 1888. At the turn of the 20th Century, following a partition by some leading chiefs, the Cook Islands was annexed to New Zealand in 1901 on the condition that the New Zealand Government promised that no

land would be sold, and that the Cook Islanders would be New Zealand citizens. The New Zealand administration reduced the role of the chiefs by putting powers over land, including property transfer and leasing, under a land court. Today, public beach parks are few, and public access to beaches on Rarotonga is being lost due to development. For most of the 1900s, lawyers were not allowed in the Land Court, except with the permission of the judge in a few special cases. This was changed in the 1980s, however this change may not have benefited the ordinary Cook Islander (Institute of Pacific Studies 2003,335).

In 1964, the Cook Islands Legislative Assembly opted for self-government in association with New Zealand, which gave Cook Islanders New Zealand citizenship and free mobility in New Zealand and Australia, but not the reverse. This non-reciprocal freedom to choose at any time among three countries is unique in the world. It gives some protection to Cook Islands culture which might have otherwise been swamped by New Zealand and Australian nationals (Institute of Pacific Studies 2003, 334). Since 1965 the former administrative role of the New Zealand government has been taken over by Cook Islander elected governments and the civil service (Institute of Pacific Studies 2003,16). The civil service is responsible for town planning (development control), public health and environmental management.

4.1.5 Race and business

The main commercial activity in the Cook Islands in the 1800s was generated by European and Chinese businessmen, almost all with Maori[1] wives, often the daughters of chiefs. Their offspring provided the next generation of businessmen. This characteristic of the corporate business environment in Rarotonga continues today. The major pearl outlets and tourist shops, hotels, retail outlets, the international airline, the trustee companies which make up the offshore banking industry, tourism related infrastructure, shipping and fuel supply are owned by Europeans or people of mixed ancestry. These commercial operators have significant interest in current

[1] The word Maori means indigenous or belonging to the place. At least some of the Maori of New Zealand originated from the Cook Islands in the 13th century. The Cook Islander "toka Maori" refers to the Cook Island Maori way of doing things. It is reflected in traditional Cook Islander dress, food, costumes, housing, body decorations, songs, dance, etc in their Maori way of life (Cook Islands Culture 2003, 290).

western style development. This has led to a degree of tension between commercially oriented business people and Cook Islanders who value traditional Cook Island culture. This tension was refected in a comment by the Deputy Prime Minister on television and in the Cook Islands News in February 2001 that: "Many Cook Islanders feel aggrieved-they leave because it's the same people that own the airlines, the same people that own the nightclubs" (Cook Islands Culture 2003, 191). In a leaked Cabinet paper, he urged the public to endorse 'sweeping legislation' to enforce a new economic direction. "Where ever you look, the same businesses in Rarotonga are into everything-retail trade, airlines, tourism accommodation, travel agents, restaurants and lately, shipping (Cook Islands Culture 2003, 191)

4.1.6 Tourism

In 1974 tourism activity increased in the Cook Islands with the opening of the international airport. Wealthy Westerners come to relax, to escape the modern world and to experience authentic traditional society. Most Western visitors, however, elect to stay in Western style accommodation that generates large volumes of wastewater. The tourist brochures promise beautiful lagoons and white sand beaches and portray an image of idyllic peace and calm. I was surprised to see that the night life on Rarotonga can be as fast and exciting as the days can be long and lazy. Traditional Cook Islands dance troops perform at 'island nights' most nights, except Sundays at the major resorts. The number of visitors to the Cook Islands in 2004 was approximately 94,000, and grew only marginally to 95,000 by 2006. However, the Cook Islands government has projected a visitor population of 16,500 by 2016 with 87% of visitors to Rarotonga and 10% to Aitukaki. Most tourists are from New Zealand and Australia seeking friendly and jovial hosts, fun island nights, relaxing white sand beaches and warm and beautiful lagoons for swimming, diving and snorkelling (Dakers and Evans 2007,106).

The Cook Islands economy is dependent on tourism, which in 2004/2005 generated 40% of GDP (Dakers and Evans 2007,106). A strong and vibrant tourism industry is itself dependent on the maintenance of good quality tourist accommodation in

pristine beach and lagoon environments. A study by CSIRO highlighted the extent to which Cook Islands economy depends on healthy and stable ecosystems. The study estimated that Rarotonga "could potentially avoid costs of NZ $7.4 million per year, or NZ $2,900 per household per year if watershed pollution across the entire island was prevented" (Hajkowicz cited in Dakers and Evans 2007, 106). The effective management of watersheds to recover at least some or part of these costs will require the effective management of septic leakage and discharges from piggeries. Defective septic tank systems and other sewage discharges will cause pollution of the lagoon. The study also notes that there are numerous other non-financial impacts which also have significant, possibly greater, value to many people namely "potential loss or harm to biodiversity and loss of recreational or cultural sites, damage to scenic beauty and non-financial human health impacts." (Hajkowicz as cited in Dakers and Evans 2007, 106). On average each tourist staying in conventional hotel accommodation will generate 180L of wastewater every day (AS/NZS 1547:2000, 141). There are currently 2101 tourist accommodation beds available on Rarotonga (Appendix 1). Full occupation would generate up to 378,180L wastewater each day.

4.2 Wastewater Infrastructure

Advice from Cook Islands Health Department officers confirmed that all development on the Cook Islands, including the larger resorts, has some sort of on-site wastewater servicing system. Most resorts are also located directly on the beach. Figure 4.2 shows a typical example, the Mona Sands Resort, built on the beach on the south eastern side of Rarotonga near the village of Titikavera. Many private residences and commercial premises are also built close to the beach.

Figure 4.2 Mona Sands Resort built on the beach.

(Source: Patterson 2008)

Cook Islands Health Department advice also indicated that a very high proportion of on-site wastewater systems on Rarotonga comprise a 2000L concrete septic tank with direct overflow into a soak hole. It is important to note that the 2000L concrete septic tanks produced on Rarotonga do not comply with the septic tank capacity requirements required by AS/NZS 1546.1 (AS/NZS 1547: 2000, 143). Under capacity septic tanks may lead to a failure to retain solids which would cause a blockage and failure of the ground disposal system. Figure 4.3 shows a recently installed (February 2008) Cook Islands Health Department approved septic tank with an overflow into a soak hole (white rocks). This septic tank soak hole is located

adjacent to the road table drain. The beach is located approximately 30m away across the road.

Figure 4.3 A recently installed Cook Island Health Department approved 2000L concrete septic tank and overflow soak hole.

(Source: Patterson 2008)

The continued use of conventional septic tanks with overflows to soak holes[2] on coastal properties will cause pollution of the lagoon. Septic tank wastewater contains high levels of nutrients that will contaminate ground water (Siegrist et al 2007, 29). Many coastal properties including the larger tourist accommodation developments have been built on highly permeable coral sands. Septic tank wastewater discharging

[2] AS/NZS 1547:2000 notes that soak holes are not suitable for highly permeable free draining coral sands (AS/NZS 1547:2000, 119).

into highly permeable coral sands can not be retained and receives little in-ground treatment before it reaches the ground water table. Untreated septic tank wastewater contaminates the ground water which in turn leaches into the lagoon. Leaching into the lagoon is accelerated during periods of heavy rainfall. In coastal areas the ground water table lies between 1 to 4 m below the natural ground surface as shown in Figure 4.4. Figure 4.4 shows the water table at approximately 1m in coral sand. The pollution of the lagoon from septic tanks in these conditions is difficult to detect. There is no obvious surface outbreak of offensive smelling wastewater apart from the occurrence of toxic algal blooms that correlate with high nutrient levels (Dackers and Evans 2007, 107).

Figure 4.4 Test hole showing ground water at approximately 1m

(Source: Patterson 2007)

4.3 Public Health and Ecosystem Issues

Traditionally, fishing was a main source of protein in the traditional Cook Islander diet. Men were responsible for the deep-sea fishing while the women gathered fish and other marine delicacies in the lagoon. Mitiore (grated coconut fermented with onion and seafood) is a delicacy, especially for the elderly. It is still used for feasts, but until 20 years ago it was eaten with every Sunday dinner (Cook Islands Culture, 2003, 123). Today, diets consist largely of both fresh foods and store goods. Some use bread and canned corn beef as staples. Takeaways and restaurants are popular. Family interaction involved in fishing, gardening and food preparation is much reduced, and cohesion and mutual respect is undermined (Cook Islands Culture 2003, 123). During my visits in early 2008, I was advised by a number of local residents that it was not safe to eat fish from the lagoon although fish caught outside the reef were still regarded as safe to eat.

An incident known locally as irritant syndrome occurred between November 2003 and May 2004 (Dakers and Evans 2007, 107). Many complaints were received from residents living on the southern side of the island ranging from skin rashes, itchiness, sore throats, running noses, asthma attacks, shortness of breath and conjunctivitis-like symptoms such as redness and burning in the eyes. A visiting World Health Organisation consultant suggested that these symptoms were a result of a toxic dinoflagellate bloom in the lagoon. High numbers of this dinoflagellate have been correlated with high nutrient levels in the water. As a consequence of ecological stress on the lagoon, the Cook Islands Ministry of Marine Resources, with technical assistance from the National Institute of Water and Atmospheric Research Ltd (Hamilton, NZ) implemented a water quality monitoring programme of streams and the lagoon to provide baseline data and to evaluate whether potentially toxic algae species were present in the Titikaveka lagoon area. The results of this study for the period December 2004 to April 2005 (Hall *et al.* 2006 cited in Dakers and Evans 2007, 108) found that water quality of the streams was highly variable, with potentially toxic levels of ammoniacal nitrogen with water quality measurements in

the lagoon showed in all sites some water quality parameters were at higher values than recommended for the healthy growth of coral reefs.

The problem of increasing nutrient levels was identified in a 1991 study commissioned by the Asia Development Bank (ADB) (Barrett Consulting Group cited in Dakers and Evans 2007, 108). This study identified three wastewater management issues on Rarotonga:

1. groundwater tables in most of the developed areas along the coast are extremely shallow; approximately 1 to 3 m below ground level for more than 60% of the populated areas;
2. a significant amount of development has recently occurred within 50m of the coastline; and
3. rainfall rates can be extremely high during storm periods resulting in saturated soil conditions.

The ADB study included measurements of key nutrients entering the Rarotonga lagoon. The study found that the nitrogen contribution along the coastline varied from 0.36 to 1.9 kg/yr for every metre of coastline for the 1991 study. The report also projected that these values would increase to 0.9 to 2.7 kg/yr/m by 2005 and advised that these levels of N (Nitrogen) loading would create grave ecological stress for near-shore coastal lagoons.

The 2005 Cook Islands Ministry of Marine Resources water quality monitoring programme confirmed that levels of nutrients remained high in the lagoon. This finding indicates that the pollution problem is worsening: a strong indication that the current management of sewage (containing high levels of nitrogen) is not effective and clearly not sustainable.

Coastal areas on Rarotonga are characterised by high ground water tables and coral sands. This is where most of the high wastewater generating tourist development has occurred as shown in Figure 4.1. The continued use of conventional septic systems

such as those currently being approved by the Cook Islands Health Department can not effectively prevent the contamination of the ground water and subsequent pollution of the lagoon.

This review of the social and cultural context within which the Evapocycle project was undertaken has indicated a number of important factors that may affect the effective transfer of Evapocycle technology to the Cook Islands:

1. The tourism industry makes a significant contribution to the Cook Islands economy. Tourism infrastructure development is predominantly along the coast in close proximity to the lagoon which is the major attraction.
2. Public Health and eco-systems health issues in relation to the lagoon indicate an increasing level of pollution of which poorly treated sewage is probably a major contributor. While there is a lack of scientific data about the causes of water pollution in the Rarotonga Lagoon, given the extent of wastewater discharge into the permeable coral sands, it is reasonable to posit that poor sewerage treatment is a major contributing factor.
3. All Tourist development on Rarotonga currently relies on the use of conventional septic tank systems.
4. There is a strong Christian presence that is generally supportive of YWAM.
5. There appears to be a degree of tension between local business and traditional Cook Islanders in relation to the benefits associated with extensive tourist infrastructure development and its perceived impact on traditional Cook Islands culture.

A need exists for a wastewater treatment system that can effectively manage large volumes of wastewater in locations with high ground water tables in coral sands. Evapocycle wastewater treatment technology has been proven in Australia to effectively operate under these conditions and so seems to have considerable potential to support sustainable development in the Cook Islands.

4.4 YWAM Project Rarotonga

4.4.1 YWAM Base Rarotonga.

The YWAM Base is located near the village of Takituma on the southern side of the island (see Figure 4.1). The aim of the Evapocycle Project described here was to provide wastewater treatment and disposal for the proposed YWAM Base at Rarotonga. The proposed base was designed to provide lecture and accommodation facilities for 80 students and 20 staff undertaking the three month Discipleship Training School (DTS). Two DTS are to be conducted annually. A preliminary meeting was held with the YWAM base director Mr Ene in Auckland in January 2007. During this meeting the YWAM base director presented an overview of the Rarotonga project and received a briefing on the Evapocycle technology in general and its potential application to the current project. Following a formal request from YWAM the IES Board authorised full project support to design and assist in the construction of an Evapocycle system including the supply of FSDS liners. The IES support was to be at no cost to YWAM with a view to providing a demonstration system for the purposes of assessment and general approval of Evapocycle wastewater technology in the Cook Islands.

The first step in this transfer of technology process was to identify any potential cultural barriers that would impact on the effective transfer of Evapocycle technology to the Cook Islands. The 'Balanced Score Card' assessment tool, based on the Kedia and Bhagat model discussed in Chapter 2 was used for the Cook Islands Project preliminary assessment. The Balanced Score Card incorporating the indexed Hofstede components allowed the Cook Islands as a recipient of the technology transfer to be assessed. A further dimension to this assessment was a parallel assessment with China where an Evapocycle project had commenced in 2006 and was yet to be completed. The results of this assessment indicated that the Cook Islands project has a good probability for success scoring +5 compared to a score of -1 for China. However the Cook Islands still had two negative results:

1. The Evapocycle is process-embodied and person-embodied technology that is more difficult than product-embodied technologies to transfer and diffuse between nations because cultural differences at the organisational level, as well as the societal, level play greater roles in such transfers.

2. Cook Islands was classified as having a generally feminine culture which would indicate that it may not be as effective as absorbing and diffusing imported technology in organisational contexts.

These possible barriers to the effective transfer of technology to the Cook Islands should remain in focus as the project unfolds.

The IES project in China has experienced a number of delays as a result of cultural and other barriers that have affected the effective transfer of Evapocycle technology to date. Based on IES current experience with the China project it would indicate the suitability of the 'Balanced Score Card' as a preliminary project assessment tool. The Balanced Score Card Report is attached at Appendix 2.

4.4.2 Site evaluation

The project site was inspected in April, 2007. The land is approximately 1ha in area and is flat with most of the eastern portion located below the crown of the road and subject to flooding. On the western side of the property there is a suitable building area on which two small houses had been constructed for YWAM staff. These houses were served by a single centrally positioned concrete septic tank connected to a rubble drain. Building works had also commenced on the main accommodation and lecture facilities building measuring 15m by 70m. Figure 4.5 shows the partially completed main building. A 5m wide drain had been constructed along the northern and eastern boundaries in an attempt to control flooding. The drain discharged into a 1m road culvert pipe that had been blocked by debris and silt accumulation.

4.4.3 Soil Types

A 1m by 1m test hole confirmed the soils at the YWAM site are highly permeable coral sand. The test hole also showed water table at approximately 1m as shown in Figure 4.4.

Figure 4.5 YWAM Base main building under construction April 2007.

(Source Patterson 2007)

4.4.4 Cook Islands Health Department Approval

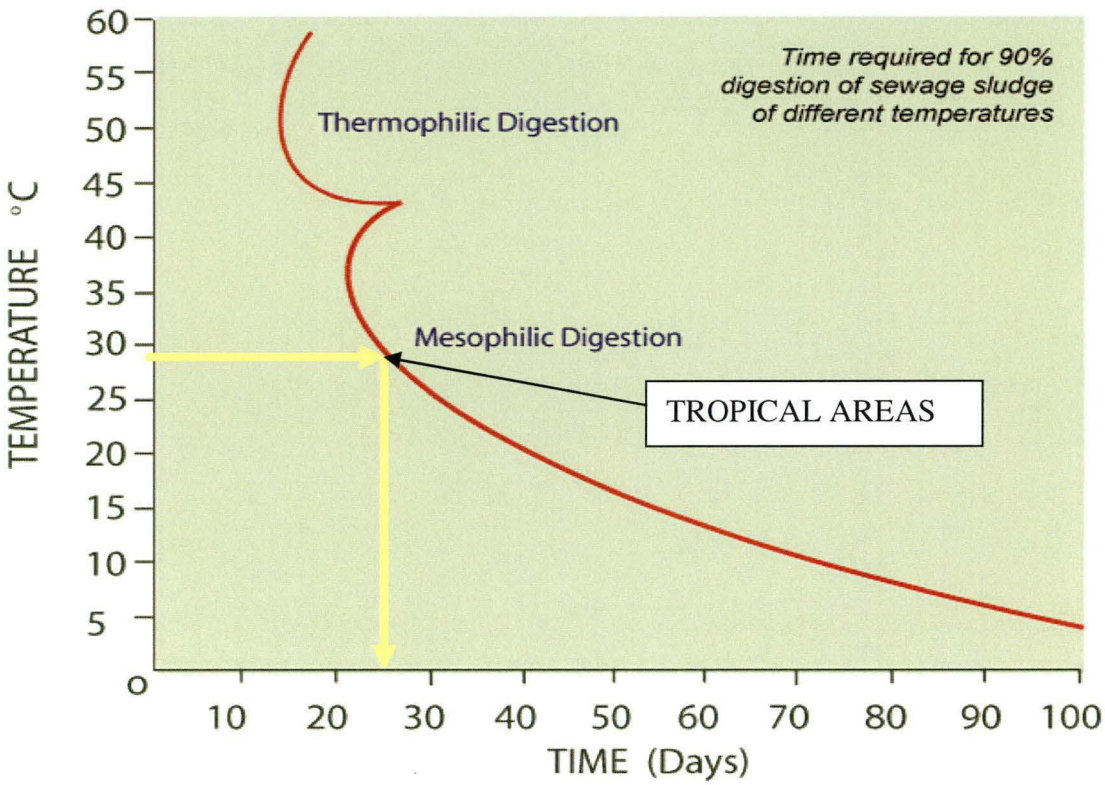
The YWAM project had previously received approval for a conventional septic tank system in 2005 from the Cook Island Health Department. This approval allowed building works to commence. The 2005 septic tank approval was for two 2000L concrete septic tanks located adjacent to the south western property boundary near the main road. The septic tanks discharged into a rubble drain approximately 2m by

12m. Part of this drain was located on the actual road reserve. The Cook Islands Health Department approved septic tank design, although typical for developments along the coastal strip, does not comply with the basic performance requirements of AS/NZS 1547:2000 (AS/NZS 1547:2000, 19-27) to ensure that basic health requirements are met and environmental degradation is avoided. The main system design deficiencies were insufficient primary treatment (septic tank) capacity and the inappropriate use of rubble drains in a coral sand soil type. For this reason, it was deemed that the Evapocycle system was considerably more sustainable on the grounds of both public health and ecosystem health.

4.4.5 Evapocycle design process

The Evapocycle design process consists firstly of identifying the type of development such as a residential school where students and staff live on site, as is the case with this project and the number of persons that may be accommodated. This information allows the typical wastewater flow allowance in L/person/day to be calculated (AS/NZS 1547: 2000, 141). An appropriate wastewater treatment and disposal system is designed to allow the effective management of the wastewater generated each day. Environmental factors such as temperature, rainfall, humidity, evaporation and soil types are also key design considerations, for example, the higher the temperature, the more rapid the breakdown (digestion rates) of the solids retained in the primary treatment units. In tropical areas such as the Cook Islands where the average daily temperatures range between 25 to 30 degrees Celsius, 90% of the retained solids will disappear (digested) in less than 30 days. Figure 4.6 shows the effect of temperature on solids digestion rates.

Figure 4.6 Effect of temperatures on solids digestion rates



(Source Imoff 1940, as cited in Patterson, 1986)

Faster digestion rates for solids allows for a reduced primary treatment capacity as smaller volumes of solids will accumulate over time.

For the YWAM Rarotonga project the AS/NZS 1547:2000 specifies that 100 residential students and staff will generate approximately 18,000L of wastewater each day (AS/NZS 1547:2000, 141). The capacity of the primary treatment units must therefore equal or exceed the combined volumes of the daily wastewater loading and the volume to allow undigested solids to accumulate for a period of at least 3 years before accumulated solids removal (desludging) is required. Accordingly, my primary treatment capacity design recommendation for the YWAM Base was 32,000L. This primary treatment capacity together with the higher tropical digestion rates will extend the accumulated solids removal period from 3 years to

approximately 10 years significantly reducing the required maintenance. This is in contrast to the Cook Islands Health Department approval that specified only a primary treatment capacity of 4000L (two 2000L locally produced precast concrete septic tanks) that would have provided less than 25% of the AS/NZS 1547:2000 specified volume and would require accumulated solids removal approximately every 3 to 4 months.

The primary treatment 32,000L capacity for the YWAM Base was provided by the installation of eight 4000L FSDS units. These were positioned in pairs as close as possible to the wastewater fixtures. The FSDS units were constructed using locally purchased concrete blocks that provided the supporting structure into which was positioned a heavy duty vinyl liner similar to those used in above ground swimming pools. The liners ensured that each FSDS unit was watertight. The concrete block FSDS supporting structures were built using semi skilled local labour and positioned at a specified depth, low enough to allow the entry of standard 100mm plastic sewer pipes (fall 1:60) with the top sections being 150mm above the maximum possible flood height to ensure that surface water could not enter the system. Figure 4.7 shows an FSDS 4000L liner positioned in a concrete block supporting structure.

Figure 4.7 shows an FSDS 4000L liner being positioned in a concrete block supporting structure

(Source Patterson 2007)

The key to the success of the FSDS is the heavy duty vinyl liners that are produced in Humanitarian Environmental Solutions (HES) factory in Port Macquarie (N.S.W.) to Australian Standard specifications. Each liner has a minimum rated life of 15 years. A further advantage of the pairs of FSDS configuration is that greywater from laundry and shower facilities can be kept separate and not initially combined with the wastewater from toilets known as black water. Black water contains high levels of pathogens (disease causing organisms) that is not suitable to be used for garden irrigation.

AS/NZS 1547:2000 still requires basic primary treatment for greywater which is achieved in the FSDS (AS/NZS 1547:2000,144). Treated greywater may then be used to irrigate gardens rather than using drinking water. The greywater from the laundry and shower facilities represents up to 40% of the average daily water usage or approximately 7,200 L. Any unused treated greywater is automatically directed to the Evapocycle for final treatment and disposal. This process is particularly important during the Cook Islands wet season when garden irrigation is not required. Final wastewater disposal is achieved in the Evapocycle. For the expected daily 18,000 L, two 20m Evapocycles will be required.

The final key design element of the YWAM Rarotonga Evapocycle and FSDS treatment and disposal system was the initial separation of grey water from the laundry and shower facilities to allow grey water recycling for garden use as required.

4.4.6 Cook Islands Health Department Approval for the FSDS and Evapocycle.

Both FSDS and Evapocycle systems were assessed by Cook Islands Health Department staff as requiring formal registrations (applications). Registration of FSDS as a primary treatment unit and Evapocycle as an advanced treatment unit would allow the general use of both FSDS and Evapocycle throughout the Cook Islands without the need for specific project approvals. This Health Department decision was unusual as each development project is different and may range from a single house to a 400 room international hotel, with specific wastewater designs being required for each project, therefore the general registration as an advance treatment unit is not possible and is an indication the Health Department staff have not understood the Evapocycle technology.

It was also indicated the Health Department that these formal applications required external assessment by both Australian and a New Zealand consulting engineers and that these assessments were likely to take at least four months. This administrative requirement would cause a significant delay in the project construction time that was scheduled to be completed to coincide with the YWAM World Conference that was to be held on Rarotonga in March 2008. The Health Department decision also indicated

that there were no suitably qualified local staff able to provide these assessments and there appeared to be no government policy to encourage the evaluation of innovative wastewater technologies that had been successfully developed in foreign countries. This is one barrier to the effective transfer of Evapocycle technology that will need to be addressed to enable future Evapocycle applications to proceed.

4.4.7 Installation commenced April 2007

It was decided by the YWAM Board of trustees to commence work on the FSDS concrete block supporting structures and to construct one 20m Evapocycle in anticipation of gaining Health Department approval prior to the base being opened in March 2008. This plan would allow me to provide the necessary supervision during my current visit. Close supervision is especially important in relation to the Evapocycle construction by untrained staff and it provides an opportunity for practical on the job training and to promote capacity building for the YWAM staff. The Evapocycle was to be located on the eastern side of the site adjacent to a large drain that ran parallel to the side road. As the area was flood prone an earth mound was first constructed to ensure that the Evapocycle would be positioned above any potential flooding as shown in Figure 4.8. The top of the earth mound was constructed approximately 150mm above the crown of the side road to eliminate any potential flooding even if the road culvert became blocked. Our intent was to ensure flood waters would spill over the road onto the adjoining property before the Evapocycle could be inundated.

Figure 4.8 shows the construction of the Evapocycle earth mound

(Source Patterson 2007)

Most Evapocycle construction materials were sourced locally. Construction of the supporting structure was achieved with unskilled labour using treated timber with an expected serviceable life of at least 40 years. Figure 4.9 shows locally manufactured treated timber being positioned to support the Evapocycle Core Treatment Zone.

Figure 4.9 Showing locally manufactured treated timber being positioned to support the Evapocycle Core Treatment Zone

(Source Patterson 2007)

Vital to the successful operation of the Evapocycle is the correct positioning of the impervious base liner and the careful placement of the prescribed core treatment zone prescribed material. This was achieved with a local back hoe as shown in Figure 4.10.

Figure 4.10. A local back hoe carefully places the core treatment zone prescribed material without damaging the base liner

(Source Patterson 2007)

Locally available materials such as coconut fronds and banana leaves were used instead of geo-textile fabric to create an artificial clogging zone media prior to the development of the zoogeal film adjacent to the central distribution line as shown in Figure 4.11. Selected drought tolerant plants were used to complete the Evapocycle evapotranspiration irrigation areas as shown in Figure 4.12.

Figure 4.11 Locally available materials such as coconut fronds and banana leaves used instead of geo-textile fabric

(Source Patterson 2007)

Figure 4.12. Selected drought tolerant plants were used to complete the Evapocycle evapotranspiration irrigation areas

(Source Patterson 2007)

The first 4000L FSDS complete with internal pump chamber was also installed. The Installation of the FSDS and the construction of one of the Evapocycles would assist with the Cook Islands Health Department approval assessments.

4.4.8 On going Health Department Approval process

Upon my return to Australia I commenced both FSDS and Evapocycle applications for registration by the Cook Islands Health Department. Each application requires

extensive documentation including engineering reports, performance reports, risk analysis reports and other detailed information regarding the construction and operation of both systems. In total 18 documents were submitted.

On 21 August 2007 formal advice was received from the Cook Islands Health Department that a study had been conducted of the 18 documents that I had submitted and indicated my application to register FSDS and Evapocycle in the Cook Islands was unsuccessful (Cook Islands Heath Department, 2007). A review of the comments contained in the rejection notification indicated a number of significant errors and omissions that had formed the basis of the Department's assessment and ultimate decision. For example the daily wastewater flow had been incorrectly identified as 180,000 L, ten times the actual design loading. From the number of basic errors in the Cook Islands Health Department report (Cook Islands Health Department 2007) it was clear that this assessment was made by either unqualified departmental officers or department officers with very limited experience in the area of wastewater design and assessment in accordance with the requirements of the appropriate wastewater standards.

On the same day (21 August 2007) the Cook Islands Health Department also wrote to Mr Ene indicating that the application to register FSDS and Evapocycle in the Cook Islands had been unsuccessful. It was further indicated by Department staff that they were prepared to meet with Mr Ene to plan a way head provided he supply a set of drawings in relation to the disposal of 'excess greywater'. The current YWAM application did not discuss 'excess greywater' as there was none. The only reference to 'greywater' was in relation to the proposed system's additional capability to reclaim and treat greywater to the required standard for use on gardens as required during the dry season. There was no indication of an additional or 'excess' greywater loading that required separate treatment in addition to that provided by the Evapocycle.

The rejection of the FSDS primary treatment system and Evapocycle land application disposal method came as a surprise given the many approvals by Australian Councils and other overseas authorities, together with confirmed evidence to indicate

successful FSDS/Evapocycle installation operation over many years. It is important to note that the technical information supplied with the Cook Islands Health Department applications included independent engineering certification of the FSDS together with a comprehensive report demonstrating exactly how Evapocycle complies with AS/NZS 1547:2000.

The rejection of the YWAM application to install the FSDS/Evapocycle system also prompted immediate discussions between the YWAM base traditional land owner Mr Tui Ngariki Short and Cook Islands Health Department officers. Meetings were held on 25 August 2007 on-site at the YWAM base and on 1st September 2007 at the Cook Island Health Department offices. During this meeting it was agreed to consider a trial Evapocycle installation based on the existing FSDS and Evapocycle systems constructed at the YWAM base in conjunction with the findings of the New Zealand consulting engineer's report that was currently being prepared.

The rejection of these applications by the Cook Islands Health Department was an indication of the limited local capacity to assess innovative wastewater technology. A further cultural dimension also became apparent through the involvement of the traditional land owner who participated in a number of meetings with Heath Department staff to arrange approval for a limited trial of the system.

4.4.9 Approval for a Trial Evapocycle System

On 31 October 2007, The Health Department advised Mr Ene that the Department agreed to a trial for 15 people on the YWAM Base until such time that Health Department staff were satisfied that Evapocycle could effectively manage any additional loading, subject to the following conditions;

> 1. Permitted number of occupants. *'Until we receive a guarantee from the designer of the Evapocycle accepting liability or until we (Health Department Staff) have observed the performance of the Evapocycle before, during and after a high rainfall event of 1000mm in one day the maximum number of people that you (YWAM) are permitted to accommodate in the building served by the Evapocycle is 15.'* (Cook Islands Health Department 2008) This

calculation is based on each person producing up to 180 L of wastewater per day.

2. Stormwater drain. A site inspection had revealed that the existing Evapocycle is less than a metre from a storm water drain on the southern end and only 3 metres from the drain at the northern end. It was noted that as the Health Department had not received any guarantees that all wastewater going into the Evapocycle will be evaporated, we are concerned that the proximity of the mound (Evapocycle) to the drain may pose a health risk. The following measures were required;

a. Move the Evapocycle a sufficient distance from the drain and to a sufficient height so that it is not subject to flooding, OR

b. Modify the storm water drainage so that it does not overflow into the Evapocycle during heavy rainfall events.

3. Monitoring programme. Quarterly reports are required stating the number of people you have accommodated each day during the quarter together with daily water meter readings. This latter condition will require the installation of a water meter.

4. Greywater Irrigation System. *'Please have (Name deleted [a Professional Engineer])) calculate and illustrate (plan view, not necessarily to scale) the dimensions of the sub-surface irrigation area you intend to use for your greywater, as well as the location of the distribution box(if any). We do not issue Completion certificates for sub-surface irrigation systems that are not constructed to AS/NZS Standards.*

The action by the Cook Islands Health Department staff in determining these approval conditions would be unacceptable in Australia. My concerns with the Cook Islands Health Department approval are as follows:

1. In relation to the permitted number of occupants condition, a clear choice is given i.e. a guarantee (certification) accepting liability is provided by the system designer **OR** agree to the Health Department limitation of 15 persons together with the associated monitoring programme. This choice allows the designer of the system to elect to take responsibility for the successful operation of his or her designed system. This effectively excludes the Health Department officer from any further input. Upon completion wastewater systems that I have designed may be certified as being in compliance with the original design. This certification carries Professional Indemnity insurance in the Cook Islands for $2,000,000. In choosing to certify the YWAM wastewater system I effectively removed the requirement to agree to the Health Department's 15 person limit and other conditions.

2. The 180 L per person daily wastewater flow allowance (condition1) is not in accordance with the Cook Islands draft Public Health (Sewage) Regulations 2007. These draft Regulations specify a 220 L per person daily wastewater flow allowance. A 180 L per person daily wastewater flow allowance is recommended by AS/NZS 1547:2000, however the Cook Islands draft Public Health (Sewage) Regulations 2007 Section 2.11 (Wastewater Flow Design Allowances) indicates that the occupancy allowances and design flow allowances in AS/NZS 1547:2000 shall not apply in the Cook Islands.

3. The Cook Islands Health Department's stormwater drain requirements (Condition 2) appear to have no legal basis in relation to prescribed set back distances prescribed in the Cook Islands draft Public Health (Sewage) Regulations 2007. Section 13 (Section 3.1) specifies the relevant setback distances as 2m from any land boundary, 3m from any building and 5m from any water surface such as a lake or river. Stormwater drains are not mentioned. This information is also contained in the Cook Islands New Zealand engineers report dated 16 September, 2007.

4. The requirement for a daily water meter readings (Condition 2) is unreasonable because of the requirement will require the installation of two new water meters on the YWAM base. One water meter for the new development and the other for the existing houses which have their own existing septic tanks. The draft Public

Health (Sewage) Regulations 2007 Section 2.11 Table 7: Occupancy Allowances Note 5 indicates in the event that the designer does not design for the predicted flow from the full potential occupancy, it will be necessary to record wastewater discharge flows and submit to Public Health. This requirement takes account of the actual amount of wastewater generated and applied to the Evapocycle system. Simple water meter readings into the premises will include any water used for garden watering which may be up to 40% of the actual freshwater usage. A sensible condition would be to require wastewater flows to be measured.

5. Perhaps the greatest concern I have with the Cook Islands Health Department conditions of approval is the requirement to have the Health Department's nominated engineer design a greywater irrigation system in order to gain Health Department Approval (Condition 4). The engineer in his capacity as the paid technical advisor to the Cook Islands Health Department should not be included as a 'condition of approval'. This would require Mr Ene to approach the engineer in his private capacity as a wastewater design consultant and provide formal instructions to provide a consultants report, including design calculations and plan, to enable Cook Islands Health Department approval to be obtained. This situation is illegal in Australia. A suitable Health Department condition would simply state that a greywater design in accordance with the prescribe Standards from a suitably qualified person be submitted for Cook Islands Health Department approval.

I discussed this matter with the, Senior Crown Counsel with the government of the Cook Islands Crown Law Office. The Senior Crown Council, who is also a YWAM Trustee Board member, indicated that such action was also not considered legal in the Cook Islands and the Health department officer appears to have acted illegally.

4.4.10 Final Installation work.

I returned to the Cook Islands to complete the FSDS/ Evapocycle construction in January 2008. At that time Rarotonga was experiencing at Category 1 Cyclone accompanied by very heavy rainfall. Figure 4.13 shows most of the YWAM base site inundated by floodwaters except for the new building, the adjacent FSDSs and the Evapocycle.

Figure 4.13 The YWAM base site inundated by floodwaters except for the new building, the adjacent FSDSs and the Evapocycle.

(Source Patterson 2008)

This photograph is proof that the whole FSDS/Evapocycle installation was correctly constructed above the highest possible flood level. All flood waters had receded within 12 hours.

On 31 January 2008, prior to my final certification of the YWAM Base FSDS/Evapocycle wastewater treatment and disposal system, I asked Mr Tui Short to request copies of the both the Australian and a New Zealand consulting engineer's reports that were required as part of the Cook Islands Health Department FSDS/Evapocycle approval process. It was important that any technical matters identified in either of these reports were adequately addressed prior to my final certification.

On 5 March 2008 the Cook Islands Health Department advised Mr Short that it had not received a written report from the Australian engineer and that his only comment that was incorporated into the New Zealand engineers report dated 20 August 2007, a

copy of which was provided. It is important to note that this report had not previously been made available and predates both the Health Department's formal notification on the 21 August 2007, that our applications were unsuccessful and the New Zealand engineer's second report dated 16 September2007.

The previously undisclosed New Zealand engineer's first report (20 August, 2007) covered a number of aspects including;

1. Status of the Public Health (Sewage) Regulations 2007. The Public Health Department's (Ministry of Health) current policy for approving the sanitation services for a proposed development is based on the current draft public Health (Sewage) Regulations 2007.

2. FSDS Primary treatment capacity. The existing primary treatment design capacity was found to be adequate. However it was considered unlikely that the existing FSDS primary treatment tanks will meet the structural standards set by the Standard (AS/NZS 1546 Pt 1), and

3. Section 9 of the proposed public Health (Sewage) Regulations 2007 clearly indicates that registration under the public health regulations is for treatment technologies and not land application systems such as Evapocycle.

The advice provided by the Cook Islands Health Department New Zealand engineer clearly indicated there is no legal status of the Public Health (Sewage) Regulations 2007 as they had not been enacted by the Cook Islands Parliament. This means that the Health Department rejection of the proposed YWAM FSDS/Evapocycle wastewater treatment system was done without any legal authority.

The Cook Islands Health Department New Zealand engineer considered it unlikely that the existing FSDS primary treatment tanks will meet the structural standards set by the Standard (AS/NZS 1546 Pt 1). Thc structural suitability of the FSDS units had been Engineer certified as required by AS/NZS 1546.1:1998 with a copy of the Engineer's report (R. Brown) being supplied with the application. It was of concern to

note that the FSDS Engineering Certification by Mr R. Brown appears to be missing. The Cook Islands Health Department New Zealand engineer's report (20 August, 2007) acknowledges receipt of two application forms and twelve additional documents. In the Health Department's rejection advice dated 21 August 2007, receipt is acknowledged of eighteen documents in addition to the two formal application forms. Document numbered '14' *Appendix A to FSDS Application "Field Septic Disposal System (FSDS) Certification Standards compliance AS/NZS 1546.1:1998"* Mr R. Brown's Certification Report. Six supporting documents were missing.

The YWAM application identified Evapocycle as a land application system with a detailed report confirming Evapocycle's compliance with AS/NZS 1547:2000 also being supplied with the application. This is clear advice to Health Department staff from their consulting engineer that Evapocycle is a land application disposal method that is site specific and that the Cook Islands Health Department direction to require general registration of Evapocycle under Regulation 9 was incorrect.

I returned to the Cook Islands in March 2008 to supervise the final plumbing connections and start system operation. This visit was timed to coincide with the official hand over of the land and opening of the building. Major site flood prevention works had been completed with the low lying areas being built up to match the levels of the FSDSs and Evapocycle. Figure 4.14 shows L to R Chris Wiremu (YWAM Auckland), the author, Eddie Ene and Paula Moala (YWAM Tonga) adjacent to the Evapocycle. Note the extensive area of land fill.

Figure 4.14 Showing L to R Chris Wiremu (YWAM Auckland), the author, Eddie Ene and Paula Moala (YWAM Tonga) adjacent to the Evapocycle

(Source Patterson 2008)

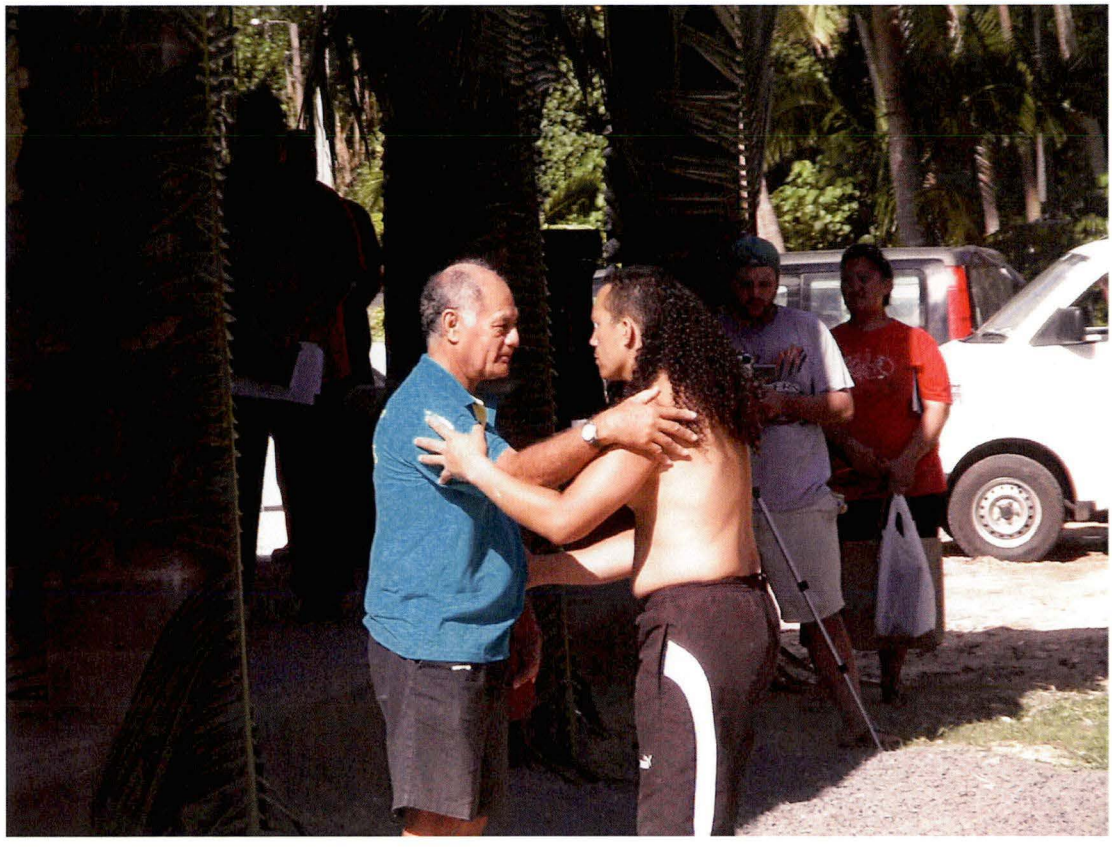
The official YWAM Base opening ceremony land hand over from one of the traditional Cook Islands land owners Mr Tui Short (left) to Mr Chris Wiremu (YWAM Auckland) is shown in Figure 3.15. Mr Wiremu was born in the Cook Islands and now lives in Auckland. Following the official opening ceremony 45 residential students from Hawaii moved into the accommodation.

4.4.10 System Certification

The final as constructed YWAM FSDS/Evapocycle system consisted of eight 4000L FSDS and one 20m Evapocycle. This system is capable of serving a resident population of 50 DTS students and Staff. An additional 20m Evapocycle may be

constructed when student and staff populations exceed 50 persons. The YWAM system was formally certified on 24th March 2008.

Figure 4.15 The official YWAM Base opening ceremony land hand over from one of the traditional Cook Islands land owners Mr Tui Short (left) to Mr Chris Wiremu (YWAM Auckland)



(Source Patterson 2008)

4.5 Discussion

Tourism is an important part of the Cook Islands economy. Extensive tourism infrastructure has been developed along the environmentally sensitive coast line that is generating large volumes of wastewater. The Cook Islands has no centralized sewerage system, with the island being totally reliant on conventional on-site septic wastewater systems. The effective operation of conventional on-site wastewater treatment systems is difficult when site limitations such as high rainfall and ground

water tables are combined with coral sand soil types. Partially treated wastewater is escaping via the ground water into the lagoon and has resulted in risks to public health and ecosystem health in Rarotonga. Evapocycle wastewater treatment technology, if applied, will help reverse this situation and assist in the long term sustainability of the tourism industry. A trial Evapocycle wastewater treatment system was installed on the YWAM Base on Rarotonga and is currently demonstrating the effectiveness of this new wastewater technology. The Evapocycle project also demonstrated that the Evapocycle system can be constructed using local labour and materials. However the Cook Islands Health Department project approval process proved to be problematic. Difficulties were identified with inadequately trained and experienced local Health Department staff not able to provide timely and effective technical advice. This is a barrier to the effective transfer of Evapocycle technology to the Cook Islands. This problem should have been anticipated as a clear indication was provided in the initial balanced score card assessment that the Evapocycle is a processed-embodied and person-embodied process that is more difficult to effectively transfer to developing countries. It was also identified in the balanced score card assessment that the Cook Islands was classified as having a generally feminine culture which would indicate that it may not be as effective as absorbing and diffusing imported technology in organisational contexts.

Principle 9 of the UN's Rio Declaration suggests that states should cooperate to strengthen endogenous capacity building for sustainable development by improving scientific understanding through the exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfers of technologies, including new and innovative technologies. This capacity building is difficult without effective mechanisms for effective exchange of information and transfer of appropriate technologies. The successful trial of Evapocycle at the YWAM base will assist the Cook Islands Health Department staff to gain a better understanding of this innovative technology operating under local conditions. A significant barrier still remains with the absence of suitably qualified Health Department staff able to assess future applications for dissimilar projects.

The successful trial also demonstrated that the effective transfer of this technology through capacity building within the local community was possible. Local materials were found to be suitable and local labour employed was effective in the construction of the system. This project is the first stage in the absorption process where the basic FSDS and Evapocycle construction techniques were explained and practiced. Further knowledge development in relation to system design and operation is still required with this support being provided by IES on an on-going basis. The YWAM base director has expressed interest in forming a company in the Cook Islands through which further projects can be undertaken. This will assist to facilitate the effective commercialisation of the technology.

The final and perhaps most important step in the technology transfer process is the feedback analysis stage. This analysis is done by both the supplier and the recipient organisations. As part of this feedback analysis a survey was conducted to evaluate how Cook Islands residents view the impact of development in general and wastewater management in particular. An important element of the survey was how the residents saw their future. The survey is discussed in detail in Chapter 5.

The effective transfer of Evapocycle technology will assist in the solving of the wastewater management problems and associated environmental issues as a result of development and help make development more sustainable. More effective wastewater management will remove a barrier that may be currently restricting development especially in environmentally sensitive areas. The question must be asked however, 'Is further development desirable?' I shall return to this question in Chapter 6.

Chapter 5

Exploring questions of environment and development in the Cook Islands: The Field Work

Following the successful construction and commissioning of the YWAM Evapocycle project the final step in the transfer of this technology was to obtain an understanding of the broader cultural issues associated with the use of Evapocycle to help sustainable development in the Cook Islands. This understanding will assist in the feedback analysis stage of the transfer of this technology within the context of the Cook Islands. Feedback analysis should be undertaken by both supplier and recipient organisations to enable an effective review the technology transfer process following the demonstration project stage and to identify the lessons learnt. My role as the technical consultant for IES involved the close supervision and training throughout the project construction and commissioning phases allowing a number of important lessons to be learnt regarding the procurement of local materials, adaptation of various local construction techniques and a good appreciation of the effects the tropical climate may have on project time lines. However, in my role as a reflective practitioner, I was keen to gain a greater understanding of how Evapocycle was viewed by the wider Cook Islands community, in particular how development was regarded in general and how the existing tourist developments in particular were regarded by the wider Cook Islands community, especially in relation to environmental issues. On this basis, I hoped to better understand some of the cultural context in which Evapocycle technology was proposed to be implemented. Understanding this context was especially important because the wide spread adoption of Evapocycle technology in the Cook Islands may have the dual effect of both limiting the existing negative impacts on public and ecological health concerns related to the lagoon and effectively removing a barrier to more tourist development. But, is more tourist development desirable? This wider question directs this analysis toward some of the less immediate, more ethically charged and potentially unintended effects of technological development that all too often have been left out of purely technical considerations of the merit of technological innovations.

5.1 Field research method

5.1.1 Research Method

The semi-structured qualitative interview[1] was selected as the most appropriate research method in achieving the aim of better understanding some of the social and cultural dimensions of environment and development issues in the Cook Islands. Approval of the Southern Tasmanian Social Sciences Human Research Ethics Committee was obtained[2]. Invitations to potential participants, together with a 'Participant Information Sheet' (see Appendix 3) were extended to a number of Cook Island organisations including community group, business associations and Government Departments. This interview group was chosen to obtain a broad cross-section of views from people with commercial interests linked to tourist development to those people who may have experienced life style changes as a result of the tourist development occurring. The views of Government employees with responsibilities associated with the development approval process are also important. The participation Information Sheet outlined the aim of the study, who was conducting the study, who had been invited to participate, what the interview involved and how the conditions of confidentiality and anonymity were to be maintained. Prior to the conduct of the interviews each participant was asked to sign a consent form indicating that their involvement in the project was informed and voluntary (see Appendix 4). Twelve interviews were conducted on Rarotonga between 16th to 22nd January 2008 in a number of locations including the participant's work place, private homes and the YWAM Base. Participants are identified only by their interview number 1 to 12. Table 5.1 shows the gender, approximate age, resident status and ethnic background of each participant.

As a reflective practitioner and active participant in the YWAM Evapocycle project I consider the relatively informal style of a semi-structured interview allowing face to face discussion, rather than formal questions and answers, more appropriate in the context of

[1] The term 'qualitative interviewing' is usually intended to refer to in-depth, semi-structured or loosely structured forms of interviewing (Mason 2002, 62)

[2] UTAS Ethic Ref No H9851.

the Cook Islands to allow the participants an opportunity to freely express their views. The interviews were also conducted at a place and time of the interviewee's own choosing to create as a relaxed atmosphere as possible. The semi-structured interview also allows scope to explore other participant views that become apparent during the base line question discussion that have relevance to development, sustainability or environmental themes. The content of the responses, both what is said and what is not said also enables key themes to be identified. This methodology also allows a degree of triangulation[3] between information provided in the literature and the personal experiences of the participants especially in relation to the environmental effects caused by development on the lagoon's eco-system. Finally this research methodology will provide an insight into how Cook Islands see their future and the potential role the Evapocycle technology might play in the shaping of their vision.

The 12 interview questions were designed to generate discussion in relation to Western-style tourist developments and their effect on traditional Cook Islands culture, the environmental impact of this development and how the participants see the long term future of the Cook Islands (see Appendix 5). Each interview was recorded on tape and transcribed. Responses to each question were summarised for each of the 12 interviewees with the results recorded in a spreadsheet (see Appendix 6). The tabulated spread sheet was then examined to identify key themes. This thematic analysis aims to distil key features and points of commonality and differences in the interview sample. It is also important to acknowledge that the views of this sample group may not represent those of the greater Cook Island community. The findings should only be regarded as the first step in the development of a better understanding of the cultural context in which the transfer of this technology is to take place.

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[3] Triangulation allows the use of different methods or sources to corroborate each other (Mason 2002, 33).

Table 5.1 Gender, approximate age, resident status and ethnic background of each participant

Interviewee	Gender	Age (years)	Cook Island resident	Cook Islander	Other South Pacific ancestry (Samoa, Tongan)	Other Country (USA and Canadian Expatriates)
1	Female	30-40	YES		YES	
2	Male	40-50	YES	YES		
3	Male	40-50	NO			YES
4	Male	40-50	NO			YES
5	Female	40-50	YES	YES		
6	Female	50-60	YES	YES		
7	Male	20-30	YES		YES	
8	Male	20-30	YES		YES	
9	Male	20-30	YES		YES	
10	Male	60+	YES			YES
11	Male	60+	YES	YES		
12	Male	40-50	YES		YES	

(Source Patterson Interviews 2008)

5.2 Discussion

There was general agreement among participants that development generally and tourist development in particular has resulted in increased income and was seen as positive for the Cook Islands economy. However many were aware of the negative impacts on Cook Islands culture and the environment associated with development. Negative cultural impacts described included a shift from the traditional agricultural based activities to tourism and other service industries. This shift has resulted in younger people in particular becoming physically less active and developing a preference for Western style fast foods. Traditional community access to beach areas is becoming increasingly restricted due to the positioning of many tourist developments on or close to the beach. Environmental issues associated with the lagoon eco-system and public health is becoming increasingly more apparent. Participants aged 50 and over with Cook Islander heritage were able to provide valuable insight into the environmental changes that have

accompanied post-war development, especially following the opening of the International Airport in 1974. Consider, for example this response from a female Cook Islander in her 50s.

RP: Do these tourist developments cause problems with the beaches or lagoons?

6: Yeah, most definitely, and there have been some really, really... I could tell you some nasty stories, just down the road at Titikaveka, from first hand experience, from people who've worked around now. One place in particular has mended its ways – OK? – but they literally ... a well known place down the road ... on very bad weather when it was flooding, coming out of their stream which goes straight out to the lagoon, you could get raw sewerage coming, get this massive overflow happening from their tanks from their overflow areas and that was happening for a number of years, in fact sometimes if the wind's really bad and you go past you'll still get the smell effect. Now supposedly they have totally turned around and mended their ways, and I'm talking about a fancy posh hotel that you pay lots of money for, there is more then one here. They have their sewerage and things we went away so tourists aren't aware they are not up to standard - I would not, personally, I would not swim there. We have fish poisoning and that has happened... the last time, and we were talking about this just recently, 1993, was the last time we went and got fish out of our lagoon to eat, and would have been then. Since then we have not been able to. Well it was after that... like mum used to go every morning, she'd go down, my mum's great at spear fishing, she'd go down, she'd get one little... she's very particular, she'd go like Patuki the fish for the cats (she had nine cats, three dogs) the cats would like this fish. Dad and I would like to have a 'U'umoemoe each for breakfast. And she'd literally do that, she'd go down, she'll shoot those fish and she'd bring them back. So, you know, this is a good way to use your environment, ok, it's not overfishing or anything. Her and Dad have retired, they retired now so she takes in all the stray animals, so here they were having free fish, and they would have fish, pretty much every morning for breakfast – very good for your health, especially in the age bracket, as you're getting older – you've got what you need there, you're feeding animals that are strays otherwise, and she'll make sure she get them neutered or spayed or what-

have-you. So she's looking after these lost little souls and its not costing, and quite often she might often get something for Tim as well. Then one time she fed the cats and suddenly she had paralysed cats and it was terrible. She was wondering around wondering what happened to the cats and they were literally, they had become paralysed. As you know animals naturally go and hide to die and she found them under the hedge and dragged them out. She managed to revive hers but a lot of people lost because animals were fed from the sea. They lost animals because if you didn't find it the animal, they would just dehydrate, gone. I mean I had the same experience with one of the cats when Mum left and I was looking after Dad for a couple of years because she was busy doing stuff in New Zealand. I had a dog and a cat get fish poisoning on me and that cat took sixteen days to get better. I had to hand feed the jolly thing, it's really serious. Occasionally you'll get a person actually die of it. Lots of people get really sick. At first they said oh it was just one particular fish, so people would still fish the other fish and it was only in one area and it just got worse and worse. Over a decade later you have a generation that doesn't even particularly like eating fish because they haven't been brought up with it, ok, you've got... I'm a principle at a school so I'm talking with children all the time, if you go back a generation and those kids would have been being brought up on fish most likely. Now you have a place where you've got people like my Mum and Dad who are living on little pensions and if you're living on the local pension you're living on $60.00 a week, and the cost of living's expensive here... power and phone... so you've got people who are now having to purchase their meals where once upon a time they wouldn't have been purchasing their meals, huge, huge costs... Mum having to buy food for nine cats and three dogs, boil up bones and things where that was free, its absolute... and health department wise, health wise you have, as I say, a generation now being brought up on anything but local lagoon fish and lagoon fish have poison in them and so what do you have?... And then of course tourism, more fast food people making money more eating places, we have all those same health problems that are happening everywhere in New Zealand, America, Australia, I'm sure it's the same where you have obesity problems, diabetes everywhere it's got worse and worse people eating fast food, junk food, the kids are used to eating lots of red meat instead of eating

their own shell fish and shell food and ... no it's absolutely devastating, very hard on the poor people.

RP: Thank you for that... that's

6: Yeah, shocking. Plus I get rashes...

RP: Rashes?

6: From swimming down at the lagoon, it's the other reason I don't...I used to paddle down there. If we do go paddling there as soon as I get home I have to wash down because I have sensitive skin.

Consider also this response from a male Cook Islander aged over 60.

RP: This interview number 11 and sir, thank you very much for participating, there are a number of research questions as we've discussed, how you'd like to answer them. The first question is how do you view western style tourist developments generally in the Cook Islands?

11: Oh well I can answer that I think two ways, one is the economic return to us is very important.. Natural resources we've got very few, but in terms of our uniqueness is our beaches, our sea, our lagoon, as well as the greenness of the Island, the mountains, as well as the people. So that's very important, that's looking at it from the economic side, but in terms of the actual, try to keep, you know, in this condition as long as possible, that is what we are battling against, with the advent of tourists coming in it's expanding, and what we used to have a conscious system of looking after the you know the lagoon and the sea, and looking after the land, but the advent of commercialism and of tourism, which is money, that is now being eroded. We have to take stock and actually look at preserving this for future.

RP: Good, so that sort of leads into the second question, the tourist developments are appear to effect traditional Cook Islands village culture?

11: Absolutely, it's changed so much. It's now our number one industry in the Cook Islands and it's already one of the most important revenue earners. Well the effect of tourism well the impact on our way of living has been tremendous and over the last ten years, you know, the mind set of people have changed from a conservative more or less mind set of looking after, you know the, looking after our valleys, and looking after our water resources, looking after the ground water. Because traditionally ground water is so important to us and also the beaches and the lagoon because the lagoon is what we call traditionally a bowl. A bowl is a wooden bowl and a wooden bowl is really a food bowl, you know, people feed from that. Now the advent of tourism, we knew that there was going to be some changes, we were aware of the life of the people, for example we have observed in Tahiti and also in Hawaii we've seen the changes, you know, all changed, and that has impacted us in terms of education and in terms of our worship, our Christian worship, in terms of the land tenure system, in terms of the economic system, and in terms of actually, one of the sad things that tourism or really can't blame it on tourism, but in terms of the just the general feeling of people we're are turned from a subservient way of living and overnight the impact of tourism has moved us very quickly into more or less a commercial type of life. That has impacted, because people weren't really ready for it, we were forced into it and there were many people could not adapt, what you call it, people suffered from it, and that actually generated the migration and that is why there are fifty, sixty thousand in New Zealand and only eighteen thousand, if there is, here, and they are still migrating, still migrating, because that brought about the awareness that hate, there are places that I can work and get better education and get grow over there and leaving behind our effective so in terms of the work force we have a situation. The outer islands are more effected where you have like we look at the wine glass we would look at the young generation there is a big bowl of them at the top then the actual working group that is from the age of 17 down to the age of 13, very small because they've migrated. Then you have the old people at the bottom of it. So it's not only our cultural way of living but in fact our man power, the one we really need to beat

us at this time has gone, you can imagine the problem that is why we are struggling here. That's why we are bringing in Fijians and Philippinos and what-have-you in order to fill in that narrow gap between the age of 17 to 40. And with that of course is also impact upon on our culture with these people coming in so it's a chain reaction right through the way.

The lessons learnt from these passages indicate that there have been significant social and cultural changes as a direct result of development. Macro changes have included a change from an agricultural to a commercial focus that has caused significant migration of the 17 to 40 age group to overseas countries seeking employment. The micro effects include traditional dietary changes as a result of fishing from the lagoon being no longer safe.

In relation to the management of wastewater generated from the tourist developments most responses indicated that there was inadequate management and there was a general perception that no method of wastewater treatment appeared to be effective. There appeared to be general lack of understanding as to who was responsible for the management of wastewater systems. The majority had no idea about alternative wastewater technologies or how these alternative technologies could be used.

The general view of the future was bleak. According to accounts given by the majority of participants, the year 2050 would be characterised by higher density of tourist developments, extreme water shortages and greater levels of pollution of both the ground water and the lagoon. There were differences in the general appreciation of how development has impacted on the Cook Islands culture and environment between the Cook Islanders other participants from other South Pacific nations and the USA and Canadian expatriates. The Cook Islanders having lived most of their lives on Rarotonga providing more comprehensive responses in relation to the social and cultural changes that have occurred over the past 20 to 30 years. There appeared to be a consensus that the current cultural and environmental negative impacts associated with development

need to be addressed in order to ensure the economic benefits remain for future generations.

In relation to the future of the Cook Islands there appears to a dilemma that needs to be addressed by the current generation to deal with the negative impacts on traditional Cook Islands culture and the environment created by how development has been managed in the past. The current erosion of traditional Cook Island culture and the environmental damage to the lagoon are clear indicators that the current development management methods are not effective, creating a situation that is not sustainable in the longer term. The sad irony is that tourism development that has been based on the natural attraction of a pristine environment and the rich cultural heritage of the Cook Islands is causing the destruction of that pristine environment and serious erosion of their rich cultural heritage.

I believe developers have a moral obligation to not contribute to the erosion of traditional culture or environmental degradation. The effective transfer of wastewater technology that reduces the pollution levels in the ground water and lagoon ecosystems is a positive step. However, this improved wastewater technology may also assist in the removal of one barrier to further development especially in remote environmentally sensitive areas such as the outer islands of Aitutaki which are currently being restricted due to wastewater issues.

As a wastewater practitioner and, through IES, owner of the Evapocycle Patent, I can exercise discretion over where this technology is used. I would be delighted if Evapocycle were used to replace the existing septic systems of tourist developments and help clean up the lagoon which may recover in time. However, as an advocate of 'sustainable development', an agenda which incorporates ethics as encapsulated in the Rio Declaration, I would not be prepared to see Evapocycle used to allow development that was not in the interest of traditional Cook Islanders now and in the future. That said there are some difficult questions to ask about whether an outsider ought to retain this kind of IP-based control over local development options. For example, in April 2007 I was asked by a developer to conduct an appraisal of the partly constructed Hilton Hotel

development located on the inland side of the coast road approximately 10 km west of the YWAM Base (see Fig 4.1 Map). The development consisted of 400 accommodation units, restaurant and other facilities on a 10 Ha site. The Hilton project began in 1999 and proceeded to a building 'lock-up' stage[4] before construction work been suspended due to a land dispute. Since that time the conventional sewerage system had suffered extensive deterioration and required replacement. Evapocycle was seen as an innovative cost effective sewerage treatment alternative. The land dispute involved the proposed ring road to replace the existing coast road that would redirect all traffic around the back of the 10Ha site and provide unrestricted access, without the need to cross the public road, to the beach and lagoon for the hotel guests. The new ring road would effectively isolate approximately 250m of beach frontage that currently may be accessed from the public road. I asked the developer's representative how the local people viewed the proposed detour. He explained that it would only add another two minutes to their journey time and the jobs the development would create will be of great benefit to the community. To further restrict the free access of Cook Islanders to the beach I consider unacceptable and, on this basis, I felt I had a moral obligation not to assist with this development.

[4] A building at lock-up stage has a completed external structure which is ready for an internal fit out of bathroom fittings, cupboards and other fixtures.

Chapter 6

Conclusion

6.1 Chapter Overview

This chapter provides a short precise of each chapter, followed by a discussion of the significant findings of this research and recommendations for further research.

This thesis seeks to offer a contribution to academic understanding of the role of technology transfer in underpinning sustainable development in developing countries. To this end, Chapter 1 provided the background to this research in relation to questions about development and sustainable development. Ecological modernisation was examined in relation to the linking of ecological and economic agendas, through the promotion of eco-efficient innovation.

Chapter 2 drew upon academic literatures to develop a model of technology transfer for sustainable development in developing countries. It was argued that the resulting model of technology transfer is a useful tool for organisations and practitioners in identifying likely cultural constraints that may inhibit the effective transfer of the technology from developed to developing countries. This assessment tool is useful and important in the planning phase for a demonstration project in the developing country.

Chapter 3 introduced the Evapocycle wastewater system as an example of innovative environmental technology, suitable for application in developing countries to solve the sewage pollution problems associated with many developments.

Chapter 4 sketched out the key cultural, economic and environmental features of the Cook Islands and identified a number of development related environmental and cultural problems caused by the existing development. The YWAM Cook Islands development Evapocycle wastewater case study was introduced and the system design, government approval, construction and commissioning of the Evapocycle at the YWAM Base was

described. The successful trial demonstrated that the effective transfer of this technology through local capacity building was possible. Problems were identified with the current approval mechanisms; however it is believed that following the success of the trial demonstration together with public pressure to solve the existing lagoon pollution problems, it will facilitate improved approval processes in the future. The final stage of the project process was to obtain feedback analysis to evaluate the technology transfer process and any lessons learnt.

Chapter 5. Part of the feedback analysis was a field work survey to seek the views of a twelve Cook Island residents from varying ethnic backgrounds to provide an insight into how people living in the Cook Islands view development in general and how they see their future and think about questions of sustainability. An analysis of this research provided a greater understanding in relation to the potential role the Evapocycle technology might play in the shaping of their vision. The research findings indicated there appears to be general agreement that development is positive for the Cook Islands economy, however there are negative aspects associated with development that are impacting on Cook Island culture and the environment.

6.2 Discussion

A number of challenges have been identified for the Cook Islanders that need to be addressed before this country can move to more sustainable paths of development. The serious pollution of the lagoon is a real threat to increasing tourism. For example, if swimmers get sick or die it will damage tourism and without tourist dollars how will the economy remain viable? Perhaps the greatest challenge is how to eliminate continued pollution from existing sources while also controlling the rate of new development. How much is too much?

As a reflective practitioner it was rewarding to be part of a successful project team that demonstrated the effective transfer of innovative wastewater technology into a developing nation. This technology has the potential to be effective in reducing the

negative impacts caused by the poor management of sewage from the existing tourist developments. My concern, however, relates to the use of this technology that may facilitate development that may cause the erosion of traditional Cook Islands culture that is not in the interest of future generations of Cook Islanders.

A discussion in relation to future generations must also include the impact of global warming. This is particularity important for the Cook Islands, which are characterised by extensive areas of low lying coastal and island development that will be adversely affected by any rise in sea level. The flooding caused by a cyclonic surge in January 2008, created by a combination of a high tides and cyclonic rain was shown in Figure 4.13 is an example of what may be expected to become more common in the future. Evapocycle technology, unlike conventional septic systems that rely on in-ground absorption, allows for the Evapocycle to be constructed on built up earth mounds that may be positioned well above expected flood levels. This will ensure that Evapocycle wastewater systems will continue to operate effectively in contrast to conventional sewerage systems that would be flooded causing a situation dangerous to the health of the inhabitants of the building and also environmental degradation with potentially widespread consequences.

Further research is required to identify the range of negative impacts that may be associated with future development and introduce effective strategies to combat these problems. These are matters for the Cook Islanders to be determined in accordance with their vision for a sustainable development future. These determinations will include questions of IP and the involvement of international experts. Until such determinations are made effective control will be applied to the future use of Evapocycle technology. For example the retrofitting of existing defective wastewater systems will be a priority. The use of Evapocycle for developments such as schools and hospitals which have a clear benefit for current and future generations will also be supported by IES.

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Appendix 1
Tourist Accommodation Rarotonga

RESORTS AND VILLAS	TARIFF/DOUBLE/NIGHT	BED NUMBERS	BEACHFRONT
TE VAKAROA VILLA	$317- $695	9	YES
MURI BEACH HIDEAWAY	$180-$290	10 4	YES
ARE MOE S/C UNIT	$910/WEEK /DOUBLE	2	SHORT WALK
AMBALA GARDEN LODGE	$100-$175	12	SHORT WALK
THE BEACH PLACE	$300	2	YES
RAROTONGA LAGOON VILLAS	$195-$275	6	YES
AROKO BUNGALOWS	$150-$130	33	FEW STEPS
CAPTAIN JAMES RETREAT	$171	4	20 METRS
ISLAND TIME VILLAS	$195-$210	12	100METRS
RENDEZVOUS VILLAS	$595	4	YES
AQUARIUS RAROTONGA	$50-$125	16	
MAKAYLA PALMS	$240-$320	6	SHORT STROLL
ATUPA ORCHID UNITS	$70-$95	14	
HELICONIA VILLA	$550	2	YES
SUNSET RESORT	$290-$575	20	YES
MURI BEACH CLUB HOTEL	$399-$599	60	YES
KURA'S KABANAS	$120-$200	20	YES
LAGOON LODGES	$245-$545	62	EASY ACCESS
MURI BEACH VILLA	$895	6	YES
THE CAPTAINS RETREAT	$300-$350	10	YES
DOROTHY'S MURI BEACHFRONT	$100	4	2 MIN WALK
IRO'S BEACH VILLAS	$290	4	YES
HIBISCUS HOMESTEAD	$145	4	3 MIN WALK
MURI BEACH COTTAGES	$132-$144	10	YES
APARTMENTS KAKERA	$380-$600	13	EASY ACCESS
STANLEYS MANSION	$700	10	4 MINS DRIVE
BLACKROCK VILLAS	$275	12	YES
ARORANGI BEACHFRONT BUN	$135-$235	4	YES
VAI VILLAS	$220-$275	4	YES
AROA BUNGALOW	$100	2	80 METRS
SOKALA VILLAS	$480-$690	14	YES
MURI BEACHCOMBER	$295-$355	70	YES
SUNHAVEN BEACH BUNGALOWS	$195-$300	18	YES
KING'S BEACH VILLAS	$170	4	YES
RAROTONGA BEACH RESORT	$250-$550	314	YES
TIARE VILLAGE	$70- $44	34	FEW MINS
SUNRISE BEACH BUNGALOWS	$100-$110	16	YES
WHITESANDS BEACH VILLAS	$300	18	YES
MURI BEACH RESORT	$175-$270	10	YES
RAINA BEACH APARTMENST	$150	10	YES

Source Rarotonga Accommodation Hotel and Resorts Directory
www.rarotonga.islands-resorts.com (12June 2008)

Appendix 1
Tourist Accommodation Rarotonga

SEA CHANGE VILLAS	$495-$895		**34**	YES
SANDS VILLAS		$499	**18**	YES
PUAIKURA REEF LODGES	$155-$220		**30**	OVERLOOKING BEACH
RAROTONGA BEACH BUNGALOWS	$495-$595		**15**	YES
PALM GROVE	$235-$370		**70**	YES
PACIFIC RESORT	$370-$655		**150**	YES
ARIANA BUNGALOWS	$70-$100		**22**	150 METRES
RUMOURS LUXURY VILLA	$1000-$1200		**16**	20 metres
CASTAWAY BEACH VILLAS	$225-$348		**28**	YES
ROYALE TAKITUMU VILLA	$469-$599		**20**	YES
MOANA SANDS	$280-$335		**34**	YES
CLUB RARO RESORT	$135-$165		**187**	OVERLOOKS BEACH
EDGEWATER RESORT	$215-$410		**457**	YES
CROWN BEACH RESORT	$435-$660		**72**	YES
BACKPACKERS INTERNATIONAL	$30-$8O		**63**	200METRS
			2101	

Source Rarotonga Accommodation Hotel and Resorts Directory
www.rarotonga.islands-resorts.com (12June 2008)

Appendix 2

Report: The Conceptual Model-Balanced score card Assessment Tool.
Cook Islands Assessment

1.1 Introduction

To indicate the likely success of efficient transfer of technology from a developed to a developing country the Conceptual Model principles on a balanced score card, will be used as the basis for the analysis of the transfer of innovative Evapocycle wastewater technology from Australia (Supplier) to the Cook Islands (Recipient). The conceptual model discussion will also included experience with a similar Evapocycle project in the Peoples Republic of China (Recipient) to compare how cultural constraints from society in a developing country with a different cultural background may affect the effective transfer of Evapocycle technology.

1.1 Cook Islands IES/YWAM and China IES/China Joint Venture Projects background.

International Environmental Solutions (IES) is the Australian based supplier organisation. IES established joint venture partnership agreements for Evapocycle projects in the Cook Islands and China. These are known as IES/YWAM Cook Islands joint venture and the IES/China Joint Venture. The joint venture partnerships effectively allow key Evapocycle technology components such as the patent rights together with the design and certification responsibilities to remain under the effective control IES.

1.2 Cook Islands Project.

YWAM (Cook Islands) is the recipient organisation in the Cook Islands. The YWAM (Cook Islands) Evapocycle project aim was to provide effective on-site wastewater treatment and disposal for the new 100 person YWAM Base at Rarotonga and has been described in detail. All Australian manufactured components including FSDS liners and

associated plumbing fittings together with design advice, in country training and final certification was provided by IES at no cost to YWAM.

1.1.3 China Project.

A joint venture company was formed between IES and Mr Jingru Zhong a Chinese national resident in Guangzhou, China. Mr Zhong is also a Director of IES. The aim of the project was to provide effective on-site wastewater treatment and disposal for a 200 room 5 star resort for the Chinese Department of Customs in Guangzhou.

2.1 Conceptual Model Data

2.1.1 Developed to Developing Nations.

Australia is a developed country with a very high HDI and is ranked number three in the world behind Norway and Finland and ahead of Canada, Ireland and Sweden. Cook Islands is not rated by the UN HDR Report (UN HDR 2007/2008), however other South Pacific nations in the region Fiji (HDI 92) and Samoa (HDI 77) have been classified with medium HDI. China is also classified as having a medium HDI 81. Both Cook Islands and China may be considered as developing nations. The HDIs for Australia, China, Fiji and Samoa are shown in Table 1.

Table 1. Human Development Index Ratings / 177 countries

Country	HDI Rating/ 177 Countries
Australia	3
China	81
Fiji	92
Samoa	77

(Source, UN HDR 2007/2008)

2.1.2 Type of Technology Principle 1.

Appendix 2

Evapocycle technology is essentially process-embodied with some components such as the Field Septic Disposal System (FSDS) liners being product-embodied. There is also a person-embodied element associated with design advice, training and certification responsibilities. The main concern IES identified with process-embodied technology is associated with the transfer of FSDS and Evapocycle blueprints or patent rights. IES is the owner of the Evapocycle patent which has been registered in both the Cook Islands and China. Ownership of the Evapocycle patent will not change with the right to use the technology being granted to the recipient organisation through a legally binding licence agreement. Evapocycle system technical control will remain with IES through the specialist design advice and final system certification. Final system certification provides a product guarantee that can only be granted by the design consultant appointed IES. A degree of Evapocycle system product protection will be afforded by the requirement to use FSDS liners produced in the HES factory at Port Macquarie in N.S.W. Due to the expensive vinyl welding machinery required to produce the FSDS liners. Unauthorised FSDS liner production is considered unlikely in the Cook Islands, however this is not the case in China.

2.1.3 Differences in organisational culture Principles 2-5.

Hofstede's components translated into Uncertainty avoidance (UAI)/ Individualism (IDV)/ Power-distance (PDI)/Masculinity (MAS) Indexes

Index Data is available for Australia and China, however index data was not available for small South Pacific nations such as the Cook Islands, Fiji and Samoa. Cook Islands has strong cultural ties with New Zealand. The Cook Islands was Annexed to New Zealand in 1901 and Cook Islanders have New Zealand citizenship. English is the international language of the Cook Islands, with the legal and administrative system and many other cultural influences being based on English-derived models, often through New Zealand variants. The ancestors of all Cook islanders were Polynesian and over 80,000 Cook Islanders have chosen to live in New Zealand, Australia and the United States (Institute of Pacific Studies 2003, 13-14 cited in (Cook Islands Culture 2003,16).

Appendix 2

Accordingly, the Index Data available for New Zealand will be used to represent the Cook Islands.

Table 2 shows the UAI, IDV, PDI and MAS Indexes Data for Australia, China and New Zealand (Cook Islands).

Table 2 UAI, IDV, PDI and MAS Indexes Data for Australia, China and New Zealand (Cook Islands).

Country/Society	UAI Index	IND Index	PDI Index	MAS Index
Australia	**51**	**90**	**36**	**61**
China	**40**	**20**	**80**	**66**
New Zealand (Cook Islands)	**49**	**79**	**22**	**58**

(Source: Clearly Cultural Uncertainty avoidance/ Individualism/ Power - distance/Masculinity Index 2008)

The data presented in Table 2 indicates;

1. UAI index, Australia (51) and New Zealand(49), share a relatively low concern for uncertainty avoidance. China (40) has an even lower concern.
2. IND index, Australia (90) and New Zealand (79), may be considered as individualistic societies with a high scores on the scale of Hofstede scale compared to China (20) showing a low degree of individualism.
3. PDI index for China (80) is very high compared to the PDI indexes for Australia (61) and New Zealand (58), share a relatively low PDI.
4. MAS index for Australia (61), China (66), and New Zealand (58) all share a moderately masculine position.

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2.1.4 Abstractive cultures Principle 6.

The IND index for Cook Islands/New Zealand (79) would indicate that the Cook Islands has a generally individualistic culture and may be regarded as likely to be more abstractive and therefore more effective in their ability to absorb and diffuse imported technology than China with a IND (20) that indicates a generally collective culture.

2.1.5. Differences in negotiated orders Principle 7.

Continued negotiation between IES/YWM Cook Islands project teams was simple and straightforward. Technical expert communication was directly to the YWAM Base Director in relation to all project matters. There were clear areas of responsibility based on skill sets of each organisation as shown in Table 3.

With the China Joint Venture project however, although there were similar clear areas of responsibility based on skill sets of each organisation were in place, the actual number of negotiators was greater for both organisations. Three IES Directors were involved in negotiations with three China Joint Venture Directors. A number of significant Australian/Chinese cultural differences began to emerge. For example, in China to enable a significant project such as the China Customs Department Resort to proceed a number of verbal endorsements or assurances are required from Chinese Government officials at various levels. It is common practice to 'hire' a government official as a 'private consultant' for an agreed sum of money to ensure that a particular project approval is obtained. If the Chinese Government official is not 'hired' as a 'private consultant' the likelihood of a timely approval is remote. If this type of activity occurred in Australia it would be regarded as an attempt to bribe an official to gain favour (timely approval) and would most likely result in one or both parties being charged. Having worked as a senior Health Officer for both state and local government authorities, the 'hiring' of government officials as 'private consultants' in order to gain a timely approval I regard as unethical. I have made my position clear to the China Joint Venture partners that I will have no involvement with so called 'hired' technical consultants. This

situation has created a further difficulty in that there is a disconnect between myself as the IES technical consultant and the Chinese technical approving officers. This has caused confusion through the Chinese Joint Venture Directors attempting to negotiate Evapocycle technical issues with the approving officers.

Table 3. IES (Supplier) and YWAM/China JV (Recipient) Responsibilities

IES (Supplier) Responsibilities	YWAM/China JV (Recipient) Responsibilities
In country Patent Protection for FSDS and Evapocycle Technologies	
Formal contracts as required	
System Design	
Installation Training	
Financing system components from Australia	
Final System Certification	
Technical assistance with Local authority approvals	
	Local Authority approval
	Site preparation and construction
	Financing locally available components and materials
	System operation
	Maintenance

2.1.5 Adsorptive capacity of the recipient organisation Principle 8.

As IES and both recipient organizations are newly formed companies the key components of transformation and exploitation were not included in this assessment.

Appendix 2

Perhaps the greatest factor in determining the adsorptive capacity of the recipient YWAM and China Joint Venture organisations is the lack of the existence of a reasonably sophisticated technical core. This aspect is being addressed through the on-the-job training which will facilitate the development of the required skill sets necessary for each recipient organisation to manage their assigned responsibilities. Experience with different projects will enhance each recipient organisation's absorptive capacity. Critical system design and certification responsibilities will remain with IES until such time as the recipient organisation is completely competent in the skill sets.

2.1.6 Use of modern information and communication systems Principle 9.

The IES/YWAM teams regularly communicate via e-mail and telephone. Three on-site visits to supervise key construction phases of the project also occurred allowing face to face communication and the timely demonstration of important construction techniques. Communication between IES and the China JV has been limited to on-site visits. Difficulties in pre-visit communications through an English speaking third party resulted in training opportunities being missed through poor co-ordination with the construction team. Little use is made of the e-mail on technical matters due to language difficulties.

3.1 Applying the Conceptional model data and other information to the balanced score card.

3.1.1 Results

The tabulated data and other information are shown in Table 4. The YWAM Cook Islands compliance score is +5 compared to the China JV who scored -1. The score card for the Cook Islands contained a number of negative results including:

1. The Evapocycle is process-embodied and person-embodied technology that is more difficult than product-embodied technologies to transfer and diffuse between

nations because cultural differences at the organisational level, as well as the societal, level play greater roles in such transfers.

2. Cook Islands was classified as having a generally feminine culture which would indicate that it may not be as effective as absorbing and diffusing imported technology in organisational contexts.

The complete balanced score card is shown in Table 4.

Appendix 2

Table 4. Balanced Score Card

	Proposition (1-8) Kedia and Bhagat (9) Araujo	Recipient Organisation (Developing Nation) YWAM Cook Islands	Compliance (+ or -)	Recipient Organisation (Developing Nation) China JV	Compliance (+ or -)
1	*Process- and person-embodied technologies are more difficult than product-embodied technologies to transfer and diffuse across nations because cultural differences at the organisational level, as well as the societal, level play greater roles in such transfers*	Evapocycle technology is processed-embodied	-	Evapocycle technology is processed-embodied	-
2	*Transfer of technology is easier between two organisations that are similar in terms of their societal/national culture-based tendencies to either avoid or embrace uncertainty generated in their organisational contexts due to such transactions*	Similar/ relatively low UAI	+	Similar/ relatively low UAI	+
3	*Organisations located in individualistic cultures are more successful than organisations located in collective cultures in their propensity to absorb and diffuse imported technology.*	Individualistic	+	Collective	-
4	*Technologies that might introduce significant changes to the distributions of power, status (real or symbolic) and rewards in the recipient organisation of the developing country that emphasises power distance are least likely to be effectively transferred*	Relatively low PDI	+	High PDI	-
5	*Masculine cultures are more effective than feminine cultures in absorbing and diffusing imported technology in organisational contexts*	Feminine	-	Masculine	+
6	*Abstractive cultures are more effective than associative cultures in their ability to absorb and diffuse imported technology*	Abstractive (Individualistic)	+	Associative (Collective)	+
7	*Differences in the negotiated orders of the cultures of the organisations involved in the transfers and diffusion of technology across nations affect the effectiveness of such transfers*	Little Difference	+	Significant Difference	-
8	*Cosmopolitan organisations in societies that also have a sophisticated technical and strategic management orientation are more effective than local organisations in systematically managing technological transfers*	Little Difference	+	Little Difference	+
9	*The use of modern information and communication technologies will positively influence a recipient organisations ability to acquire knowledge to assist in the effective transfer of technology.*	YES	+	Limited	-
	TOTAL		**+5**		**-1**

Source (1-7) Kedia and Bhagat (1988), (8) Araujo (2007)

Appendix 3

PARTICIPANT INFORMATION SHEET (PROFORMA)
SOCIAL SCIENCE/ HUMANITITES
RESEARCH

PROJECT 'Development and wastewater management in the Cook Islands'
RESEARCHER Robert Patterson

Information Sheet
If you are a member a member of an organization that has an interest in the management of wastewater in the Cook Islands, please consider taking part in an interview in this research project.

What is the aim of the study? To examine the management of wastewater in the Cook Islands in the context of wider issues of sustainable development.

Who is conducting the study? The researcher is Mr. Robert Patterson who is a Masters Student at the School of Geography and Environmental Studies at the University of Tasmania. The project is approved by the University of Tasmania.

Who is being invited? A number of Cook Islanders and expatriates interested in the management of wastewater and sustainable development in the Cook Islands.

Why be involved? The management of wastewater is generally important to ensuring that patterns of development in the Cook Islands are sustainable , and specifically important to the environmental health of Rarotonga Lagoon and the health and well being of Cook Islanders.

What does the interview involve? The one-to-one, semi-structured interview at a place and time of you're choosing between 16th and 21st of January, 2008 and will take about 30 to 40 minutes. The interview will be audio-recorded for the preparation of transcripts.

What kinds of questions will be asked? You will be asked about your views about the way wastewater is being managed on Rarotonga and what the future holds in relation to the environment of the lagoon and possible increased tourist developments.

How can you participate? If you wish to participate or seek clarification on any aspect of the project please contact the researcher using phone or e-mail details at the bottom of this page. A decision not to participate in the research will be taken as final and confidential.

Will your comments be confidential and anonymous? Yes. Questionnaires, recordings and transcripts will be kept under (physical and/or electronic) lock within the university premises. They will be coded (i.e. be without names) to maintain anonymity. While some of your comments may appear in publications arising from the research, they will not be associated with your name or identifying information. If you have any concerns about any comments you make during the interview you are free to tell the researcher, either at the interview or subsequent to it, to exclude them from the interview transcript. A participant may also request that hand written-notes of the interview be taken rather than an audio-recording. All material provided by you

will be kept for 5 years after the completion of data collection and will then be destroyed by physical shredding and permanent erasure of electronic files.

Do you need to sign anything? You will be asked to sign a consent form before the interview confirming that you have read and understood the material in this Information Sheet. The researcher will also sign, undertaking to maintain your anonymity and confidentiality.

Will there be any risk or discomfort? Given the protections of confidentiality and anonymity, no specific risk above everyday level is foreseen for participants in this study. The interview can be suspended or permanently ended at any point if you feel uncomfortable for any reason. You are free to request during or at any point after the interview that all or part of the information provided by you be erased or returned to you.

Can you withdraw if you want to? Participation in this study is voluntary. You are free to withdraw at any time without adverse effect by simply informing the researcher. This decision will be taken as final and confidential.

Can I have access to results from the study? Those participants who indicate this preference may review part or the entire transcript of their interview. A limited number of copies of subsequent publications will also be made available on request.

Are there any possible benefits from participation in this study?

If we are able to take the findings of this small study and link them with a wider study, the result may be valuable information for others and it may lead to the implementation of measures that better protect the environment of the Rarotonga Lagoon.

CONTACT DETAILS – RESEARCHER
Mr. Robert Patterson
Phone 61 428 951 723
E-mail robpatterson@hartzview.com.au

Concerns or complaints: This study has been approved by the Tasmanian Health and Medical Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study should contact the Executive Officer of the HREC (Tasmania) Network on phone 61-3- 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants.

Thank you for taking the time to consider this study.
If you wish to take part in it, please sign the attached consent form.
This information sheet is for you to keep.

Appendix 4

CONSENT FORM

Title of Project: **'Development and wastewater management in the Cook Islands'**

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1. I have read and understood the 'Information Sheet' for this project.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves a one-to-one, semi-structured interview at a place and time of my choosing and will take about 30 to 40 minutes. I further note that the interview may be audio-recorded for the preparation of transcripts. However, I reserve the right to have written notes only taken. I also note that the subject of the interview will generally focus on the management of wastewater and its importance of future protection of the Rarotonga Lagoon and the health and well being of the residents living along the coast road surrounding the island.
4. I understand that participation involves no specific risk above everyday level. Given the protections of confidentiality and anonymity, I acknowledge that no specific risk above everyday level is foreseen to me as a participant in this study. I reserve the right to suspend or permanently end this interview at any point if I feel uncomfortable for any reason.
5. I understand that all research data will be securely stored on the University of Tasmania premises for five years [or at least five years], and will then be destroyed [or will be destroyed when no longer required].
6. Any questions that I have asked have been answered to my satisfaction.
7. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
8. I understand that the researchers will maintain my identity confidential and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, and if I so wish, may request that any data I have supplied to date be withdrawn from the research.

Name of Participant:

Signature: Date:

Statement by Investigator

☐ I have explained the project & the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Appendix 4

Name of Investigator

Signature of Investigator

Name of investigator **Robert Patterson**

Signature of investigator _____ Date _____

Appendix 5

RESEARCH INTERVIEW QUESTIONS

1. **How do you view western style tourist developments generally in the Cook Islands?**

2. **Do these tourist developments affect traditional Cook Island village culture?**

3. **Do these tourist developments cause problems with the beaches or the lagoon?**

4. **How do you know there are problems?**

5. **How is wastewater from these developments currently managed?**

6. **Who is responsible for the management of wastewater?**

7. **Are you aware of alternative wastewater management systems?**

8. **Do you see any difficulties in using these alternative wastewater management systems?**

9. **The year is now 2050. What do you imagine the Cook Islands will look like? What do you think you might see:**

   a. **On the Beaches?**
   b. **In the Traditional Villages?**
   c. **The Lagoon?**

10. **If the wastewater management is not effective what might you see:**

    a. **On the Beaches?**
    b. **In the Traditional Villages?**
    c. **The Lagoon?**

Appendix 6
Response Summaries

INTERVIEWEE	1.HOW DO YOU VIEW WESTERN STYLE TOURIST DEVELOPMENT IN THE COOK ISLANDS?
1) F/ 30-40 / RES/ OSP	IT'S DEVELOPING TOO QUICKLY SLOW DOWN
2) M/40-50/RES/COOK	IT'S NOT WESTERNERS THEMSELVES , BUT THE EFFECT THEY HAVE ON THE CULTURE DEVELOPMENT CAN BE GOOD, BUT THE PACKAGE CAN BE WORRYING
3)M/40-50/EXPAT	DOING GOOD JOB COMPETITIVE WITH OTHER ISLANDS
4)M/40-50 EXPAT	KNOWLEDGE LIMITED NEW DEVELOPMENT EG, SHERATON HAVING DIFFICULTIES UNDERSTAND SUCCEEDING
5) F 40-50 RES /COOK	PROS AND CONS USE OF FOREIGN MATERIALS LOOKING LIKE TRADITIONAL MATERIALS GOOD
6)F 50-60 RES/COOK	WE NEED TOURIST DEVELOPMENT, BUT ECONOMIC AND ENVIRONMENTAL ISSUES NOT LOOKED AT A SLOW CHANGE OCCURING
7) M/20-30 RES/OSP	"DEVELOPMENT IS GOOD NOW IS VERY GOOD"
8) M/20-30/RES/OSP	GOOD MORE MONEY DEVELOPED COUNTRY AND FOR OLD PEOPLE, AND CHILDREN
9) M/20-30 RES/OSP	SORRY CAN'T THINK OF ANYTHING
10)M/60/RES/EXPAT	GENERALLY BIG ECONOMIC VALUE AND FEW DRAW BACK INVIGORATES COMMUNITY BECAUSE OF VARIOUS SERVICES AND ENTERTAINMENTS "PROVIDED BY THE COMMUNITY TO THE BENEFIT OF THE COMMUNITY"
11)M/60+/COOK/RES	BIG ECONOMIC VALUE WITH DRAWBACKS BUT INVIGORATES THE COMMUNITY
12) M/40-50/RES/OSP	BENEFITS AND "DISBENEFITS" ABOUT 50/50, ENVIRONMENT POOR AND POLLUTION IN LAGOON

Appendix 6
Response Summaries

2 DO TOURIST DEVELOPMENTS AFFECT TRADITIONAL COOK ISLAND VILLAGE CULTURE?
YES AFFECTING THE YOUGER GENERATION WHO ARE EXPOSED TO WESTERN INFLUENCES ETC OLDER GENERATION THE CULTURE STILL RUNS FAIRLY DEEP HOPING TO ENCOURAGE YOUNGER ONES TO GO INTO PERFORMING ARTS TO ASSIST THE TOURIST INDUSTRY

THERE IS A LOSS OF INTERDEPENDENCE OF TRADITIONAL LIFE

DOES NOT AFFECT TRADITIONAL LIFE

TWO WAY PULL ON TRADITION BETWEEN NEEDS OF TOURISM AND LOCALS

YES TOURIST TRADE THE CENTRE AND ALL ADJUST TO THAT

"DEFINITELY MOST DEFINITELY" MONEY FOR EVERYTHING EVEN TRADITIONAL FAMILY ACTIVITIES NO GIVING OF CROPS OR PRODUCE MAKES SENSE IN A WESTERN CONTEXT
"AH AH RIGHT NOW I DON'T KNOW" FOOD FROM OVERSEAS, DEVELOPMENTS ESPECIALLY BENEFIT TOURISTS

YES, THEY BRING THERE OWN CULTURE AND CHANGE OUR WAYS THE TOURISTS FRIENDLY

AFFECTS CULTURE BUT SOMETIMES GOOD SOMETIMES BAD

IS AN EFFECT, BUT THE TRADITIONAL CULTURE IS QUITE DILLUTED ANYWAY CORE CULTURE BASIS STILL HERE, BUT SMALL PART OF CULTURE TODAY EXCEPT PERHAPS IN OUTER ISLANDS

ABSOLUTELY MUCH CHANGED OVER TEN YEARS PEOPLE CHANGED FROM LOOKING AFTER VALLEYS, WATER RESOURCES, GROUND WATER CHRISTIAN WORSHIP CHANGED ISSUES WITH LAND TENURE AND ECONOMIC SYSTEMS CHANGED PEOPLE SUFFERED, GENERATED MIGRATION TO NZ NEED TO BRING IN MIGRANTS AGED 17-40 (FOR WORKFORCE)

"BIG TIME, BIG TIME" POLLUTION IN GENERAL EXACERBATED BY TOURISM AND LIFESTYLE ADVERSLY AFFECTED DEVELOPMENT GOOD FOR TOURIST, BUT NEEDS TO MAKE EVERYONE HAPPY

3.DO THESE TOURIST DEVELOPMENTS CAUSE PROBLEMS WITH THE BEACHES OR THE LAGOON?
YES THE BEACH AREA IS PUBLIC, BUT THE DEVELOPMENT BUILT SO CLOSE THAT ACCESS TO THE BEACH ITSELF BECOMES DIFFICULT

IT'S NOT THE TOURIST IT'S THE DEVELOPMENT ITSELF ACCESS TO BEACH A PROBLEM EXCESSIVE DEVELOPMENT BIGGER SEWERAGE SYSTEMS DIRECTLY INTO THE LAGOON VEGETATION REDUCTION AROUND THE LAGOON
NO COMMENT DOES NOT KNOW

TALKS WITH LOCALS SUGGEST YES

"A LOT" ENVIRONMENT AFFECTED MORE DEVELOPMENT ETC

DEFINITELY COULD GIVE EXAMPLES FROM FIRST HAND EXPERIENCE
EG RAW SEWERAGE INTO THE LAGOON FROM POSH HOTEL WE WENT AWAY BUT THE TOURISTS!!!!!!!
NO KNOWLEDGE POISON FISH AND CHEMICALS

TOURISTS COME AND DISAPPER FROM THE BEACH AND POLICE HAVE TO BE CALLED

IMPACT OF LARGE SEWAGE SEPTIC TANKS NONE PROPERLY PLANNED EG SHERATON
CAN'T TAKE CHILDREN FISHING
LARGE SEWAGE, SEPTIC TANKS BECAUSE ALL RESORTS NEAR LAGOON AND NONE HAVE BEEN PROPERLY PLANNED AND THOSE COMING EG SHERATON NOT PLANNED AT ALL

DEFINITELY NOT JUST TOURISM BUT PROBLEMS WITH EROSION, AGRICUTURAL SPRAYS, LAGOON GROUND WATER POLLUTED BY SEPTICS AND ANALYSIS DATED 1995

YES IT DOES,

4. HOW DO YOU KNOW THERE ARE PROBLEMS?
NOT ADDRESSED

FISH POISONING, SEWERAGE AND READING ABOUT IT

TALKS WITH LOCALS SUGGEST YES

DOES NOT KNOW DETAILS BUT UNDERSTANDS
SEEPAGE INTO LAGOON DEAD FISH FOUND
WARNINGS TO LOCALS DON'T SWIM
VISUAL INSPECTION, RASHES, ALGAE, AND WHAT
PEOPLE SAY
NO KNOWLEDGE HEARD ON TV A PROBLEM WITH
WASTEWATER

LAGOON SURVEYS ANALYSING THE WATER
HORRENDOUS, EG HIGH NITRATES, SICKNESSES ++
EXPERIENCE, WHEN I WAS SECRETARY MINISTRY OF
WORKS AWARE OF ANALYSIS RESULTS)

PERSONAL EXPERIENCE, TOURISTS COMPLAINING HOW THE SEWAGE WHENIT RAINY SEASON
THEY SMELL THINGS AND SEE THINGS FLOATING

5. HOW IS WASTERWATER FROM THESE DEVELOPMENTS CURRENTLY MANAGED?
" NOT TOO SURE REALLY", UNDERSTANDS THERE IS TRADITIONAL SEPTIC DISPOSAL
AND SUGGESTS TRUCK COMES ALONG AND SUCKS IT OUT

NOT KNOWN PROBABLY LOCAL HEALTH AND MANAGEMENT

NOT KNOWN BUT LOCALS TELL ME A PROBLEM

MANAGEMENT INADEQUATE BECAUSE MANY HOTELS DON'T HAVE PROPER SEPTIC TANK /SEWERAGE SYSTEMS

SOME HOTELS/RESORTS TRYING TO USE NEW TREATMENT SYSTEMS BUILDERS COMPLAINING AND DON'T WANT TO GO TO WORK BECAUSE THE SMELL IS SO BAD.
NO KNOWLEDGE

INADEQUATE SEPTIC SYSTEMS, HIGHER POLLUTION LEVELS NEAR RESORTS, POINT SOURCES
EG PIG FARMS

BUT GENERAL TREND SEEMS NOTHING WORKS THIS MAY BE BECAUSE OF HOW PUT IN

6. WHO IS RESPONSIBLE FOR THE MANAGEMENT OF WASTEWATER?

NOT SURE BUT ALL POINTS TO THE GOVERNMENT

NOT KNOWN PROBABLY LOCAL HEALTH AND MANAGEMENT

FEDERAL BOARD, LOCAL BOARD, WHERE HE RESIDES

ENVIRONMENT AND HEALTH DEPARTMENT

MINISTRY OF HEALTH DEPARTMENT

NO KNOWLEDGE

PUBLIC HEALTH, MARINE RESOURCES, MINISTERS OF HEALTH DEPARTMENT OUR PEOPLE

MINISTER OF HEALTH, ENVIRONMENT, MINISTER OF WORKS, DEVELOPERS HAVE TO TAKE RESPONSIBILITY TOO

POLITICAL GUYS AT THE END OF THE DAY, HEALTH DEPT MORE TOURISTS EACH YEAR AND MORE COMPLAINTS

7 ARE YOU AWARE OF ALTERNATVE WASTEWATER SYSTEMS?
NOT BEFORE, BUT NOW AWARE OF NEW SYSTEMS, BUT NOT HOW THEY WORK

YES BIOLITICS (QUEENSLAND)

NOT AWARE

PERSONAL EXPERIENCE WITH SEPTIC PUMP OUT ON OWN PROPERTY AND KNOWS ABOUT FILTRATION LIMITED EXPERIENCE
NOT AWARE MUCH, BUT HEARD LOCAL DESIGNS NOT ACCEPTED, BUT MAYBE OVERSEAS DESIGNS ACCEPTED

AWARE OF OTHER SYSTEMS EG BIOGAS SYSTEMS

NO KNOWLEDGE

DOES NOT SEEM TO BE

PROBLEMS IN LARGE ENGINEER SOLUTIONS, NOBODY AGREES ON WHICH ONE SHOULD BE SELECTED

AWARE OF SYSTEMS, MANY DID NOT WORK, DUE TO LACK OF EXPERTISE

8 DO YOU SEE ANY DIFFICULTIES IN USING THESE ALTERNATIVE WASTEWATER MANAGEMENT SYSTEMS?
DIFFICULTY IN UNDERSTANDING BUT NEWER ONES EG EVAPOCYCLE BRILLIANT
TRYING TO LOOK AT NEW SYSTEMS

NOT AWARE

NO KNOWLEDGE COOK ISLANDS (EXPATRIATE)

REFER PREVIOUS QUESTION

INSTALLATION AND MANAGEMENT OF THE SYSTEMS AND GETTING THEM TO WORK
PROPERLY IS A PROBLEM
LAGOON FISH POISON PROBLEM NOW

NO CONCENSUS, NEED CLEARLY DEFINED SYSTEM, SOCIAL POLITICAL WAY OF
IMPLEMENTING LIKE TAX BEAKS ETC AND PUBLIC EDUCATION
SYSTEMS DONT WORK, MANY DUE TO LACK OF EXPERTISE

NOTHING SEEMS TO WORK WHEN IT RAINS THE WATER WASH FROM THE TOP DOWN
TO THE UNDERGROUND AS FAR AS 2 METRES AND THEN IT WASHES IT EVAPOCYCLE
REALY SAFE "I BELIEVE IT'S THE ANSWER FOR OUR LONG TERM PROBLEM"

Appendix 6
Response Summaries

9 THE YEAR IS NOW 2050. WHAT DO YOU IMAGINE THE COOK ISLANDS WILL LOOK LIKE? WHAT DO YOU THINK YOU MIGHT SEE: ON THE BEACHES,IN THE TRADITIONAL VILLAGES AND THE LAGOON?

"HOPEFULLY NOT ANOTHER SINGAPORE" WISHES COOK ISLANDS WOULD STAY COOK ISLANDS, HOWEVER CAN SEE MAIN ROADS TRAFFIC JAMMED 32KMS OF ROADS AND NO LAWS FOR NUMBER OF VEHICLES ON ISLAND TRADITIONAL VILLAGES UNLIKELY TO CONTINUE AS EACH VILLAGE MERGES WITH THE NEXT, PLUS MOST DEVELOPMENT ALONG MAIN ROAD IS FOR TOURISTS "THE LAGOON 2050 PRETTY SAD NOT PRETTY AS RIGHT NOW, BEACH ERODING AND POLLUTION GETTING INTO LAGOON
NO TREES, LAGOON DEAD, NEED TO IMPORT WATER, BUT WE COULD GO FOR A HEALTHY ENVIRONMENT

UNLESS SOMETHING IS DONE, UNDERSTANDS THERE WILL BE A PROBLEM

IMPLEMENT SOMETHING AND MONITOR IT IF NOT CONTAMINATION WILL OCCUR

TWO PICTURES, "ONE COULD BE A REAL MESS" TWO PEOPLE REALISE WE'RE DOING TOO MUCH PERHAPS SLOW DOWN DEVELOPMENT
A LITTLE MORE BALANCED DEVELOPMENT

ANY CHILD BELOW THE AGE OF 20 WILL HAVE A HORRIBLE WORLD TO FACE ALL CORAL DAMAGED BY POLLUTION

SEE DIFFERENCE OVER LAST 5 YEARS SINCE I CAME MORE DEVELOPMENT

EUROPEANS COME AND STAY AND DEVELOP COUNTRY

NOT IRREVERSIBLE NEED DIRECTION AND VISION, CAN GET FUNDING AS ONE OF SMALLEST NATIONS IN WORLD

VERY CONCERNED, ISSUES ARE WATER SUPPLY, LAGOON (THERE WAS ABUNDANCE OF FISH BEFORE , BUT NOW HARDLY ANY
POISONING GALORE, CORAL DYING, SOLID WASTE LEAKING INTO UNDERGROUND TUNNELS WHICH FLOW INTO LAGOON
LAND-NEED TO HAVE WATER CATCHMENT TANKS AND USE GROUND WATER HOWEVER LARGELY POLLUTED BECAUSE OF SEPTIC TANKS NEED AN ANSWER
15 YEARS AGO VERY BLEAK FUTURE
DENSER BUILDINGS, MORE TOURISTS, MORE POLLUTION, WILL AFFECT NEW GENERATIONS . SUPPORTS EVAPOCYCLE BECAUSE HE KNOW IT WORKS

10 IF THE WASTEWATER MANAGEMENT IS NOT EFFECTIVE WHAT MIGHT YOU SEE: ON THE BEACHES, IN THE TRADITIONAL VILLAGES AND THE LAGOON?
CORAL DEAD, NO FISH, NO SWIMMING THIS IS ALREADY HAPPENING WITH PIGGERIES CLOSE TO THE LAGOON TOURIST ACCOMMODATION ALLOWED FROM PRIVATE HOUSES WITH NO UPGRADING OF WASTEWATER DISPOSAL

SCENARIO 1)LAGOON DEAD, ALREADY DYING, TOURISM SUFFERS, SCENERY NO GOOD, LOSS OF CULTURE AND IDENTITY
SCENARIO 2) HOLD BACK NEGATIVE TREND AND HAVE BEST OF BOTH WORLDS, SENSIBLE DEVELOPMENT REWIRING OUR CULTURAL BEHAVIOUR, WILL DEPEND ON KIND OF PEOPLE WE WANT IN FIFTY YEARS
I IMAGINE THERE WILL BE A PROBLEM UNLESS THE RIGHT FACILITIES ARE PUT IN PLACE

NATURAL GROWTH MEANS IF YOU DON'T REACT AND IMPLEMENT REGULATIONS OR NEW TECHNOLOGY THE CONTAMINATION WILL OCCUR NOT JUST IN THE LAGOON, BUT INLAND WATER AS WELL
INCLUDED IN PREVIOUS QUESTION A REAL MESS IF NOTHING DONE

POLLUTED BEACHES TRADITIONAL VILLAGES ADVERSLY AFFECTED, LAGOON HEAVILY POLLUTED

MORE DEVELOPED REALISES NEED TO FIX PROBLEM NOW BEFORE CHILDREN GROW UP

TOURISM DEAD IF THESE ISSUES NOT ADDRESSED WHY WOULD TOURISTS COME IF CAN'T SWIM IN LAGOON

MORE 3 STOREY BUILDINGS FOR 200-300 EVERYONE CLOSE TO BEACH BECAUSE MAIN INCOME FROM THIS PLACE IS TOURISM EVREYBODY COMES WITH WITH A DIFFERENT WAY TO MAKE MONEY " A BIT SCARY BECAUSE THEY ARE NOT LAYING THE PROPER FOUNDATION IN OR TO SEE THIS DEVELOPMENT
I CAN SEE THAT IF WE DON'T TACKLE THIS PROBLEM IT WILL AFFECT OUR NEW GENERATIONS I BELIEVE EVAPOCYCLEIS THE ANSWER