Sustainable Integrated Water Resources and Wastewater Management in Pacific Island Countries

National Integrated Water Resource Management Diagnostic Report

COOK ISLANDS

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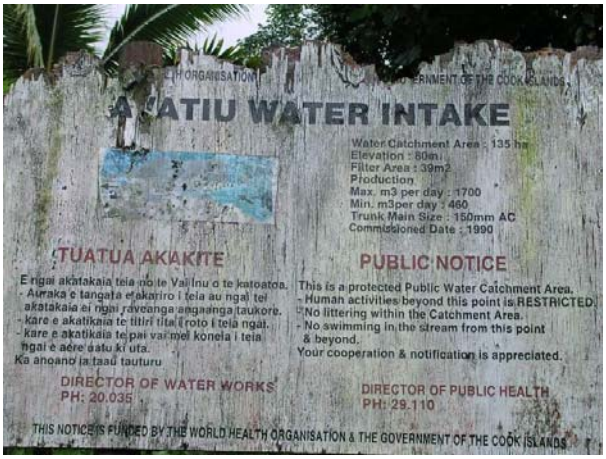

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LIST OF ACRONYMS

ADB	Asian Development Bank
ASR	Aquifer Storage and Recovery
AUSAID	Australian International Aid and Development Agency
CBDAMPIC	Capacity Building to enable the Development of Adaptation Measures in Pacific Island Countries
CEAP	Cyclone Emergency Assistance Programme
CIDA	Canadian International Development Agency
CIANGO	Cook Island Association of Non Governmental Organisations
CIMRIS	Cook Islands Ministry of Marine Resources Institutional Strengthening Project
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
ENSO	El Niño Southern Oscillation
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographical Information System
GPS	Global Positioning System
GWP	Global Water Partnership
HYCOS	Hydrological Cycle Observation System
ICM	Integrated Catchment Management
IPCC	Inter-governmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature and Natural Resources(World Conservation Union)
IWRM	Integrated Water Resource Management
IWP	International Waters Project (2001-2006)
MFEM	Ministry of Finance & Economic Management
MMR	Ministry of Marine Resources
MoW	Ministry of Works (Rarotonga)
NGO	Non-governmental organisation
NIWA	National Institute of Water and Atmospheric Research Ltd (NZ)
NZAID	New Zealand International Aid and Development Agency
OMIA	Office of the Ministry of Island Administration
PIC	Pacific Island Country
PICCAP	Pacific Islands Climate Change Assistance Programme
PWA	Pacific Water Association
RAP	Pacific Regional Action Plan
SIDS	Small Island Developing States
SOPAC	Pacific Islands Applied Geoscience Commission
SPCZ	South Pacific Convergence Zone
SPREP	South Pacific Regional Environment Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
WHO	World Health Organisation
WWF	World Water Forum
WSC	Water Safety Committee

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EXECUTIVE SUMMARY

Integrated Water Resource Management (IWRM) offers a systematic approach to address the sustainable development, allocation and monitoring of water resources for Pacific Island Countries (PICs). The key concept of IWRM is that it provides a framework to integrate societal, economic and environmental considerations in water resource management. It recognises that all water use is interdependent and therefore should be managed in an integrated manner.

The Cook Islands are located in the Pacific Ocean between latitudes 14° S and 22° S, and longitudes 159° W and 164° W. They are a Polynesian island group comprising of 15 widely dispersed islands, surrounded by an exclusive economic zone of 1.8 million square kilometres. Like many PICs, water supply issues are dominant in the management of water resources, and attention generally has focused on the areas of greater population, mainly Rarotonga. The islands source potable water from two main sources. In the Southern Group of islands which includes the main island of Rarotonga (volcanic origin), surface water is sourced from springs and streams within catchments valleys. In the Northern Group of islands (coral atolls), water is sourced from rainwater and groundwater.

For the Cook Islands the key water resource management issues that would benefit from an IWRM approach are:

- The lack of a **legal and policy framework** for water resource management. Under the present system government departments and other organisations are unsure of each others roles in the area of water resource management and there is possible duplication and/or omission of roles. It also leads to mistrust on the motives behind integration in the management of water resources.
- **Capacity building** in the area of integrated management. This is not a lack of capability among people currently concerned with water management; the majority are tertiary level trained with an excellent understanding of the key water management issues. The issue is that these people are inundated with projects in many different areas related to water and there are not enough staff to take on new initiatives.
- Poor **waste water treatment** in septic tank systems and the subsequent transfer of nutrients in groundwater and through into the lagoon system. Associated with this is the governance of waste water treatment coming under the Ministry of Health so that it is not treated as an environmental issue.
- **Leakage and wastage of reticulated water** are major issues for Rarotonga where water supply is funded directly through government expenditure (i.e. no water charging either by volume or connection). The funding system also makes infrastructure investment vulnerable to change through political and government budgetary constraints.
- Climatic **vulnerability of water supply**, particularly to drought. The simple nature of the reticulation systems on Rarotonga and Mangaia mean they are less likely to be vulnerable to flooding but they are vulnerable to drought. Water demand management can help lessen the demand but there is still a need to hedge supply sources against extremely low flows in the source streams.
- **Land use practices affecting stream water quality**, and indirectly the lagoon. This is particularly a problem for piggeries adjacent to streams. There is also a concern over wetland taro cultivation above water supply sources.
- The **land use tenure system** is detrimental to agricultural investment in water smart irrigation systems and other technology that might lessen agriculture's water impact.

Some of these issues are being addressed through current projects (e.g. water reticulation leakage, water demand management, piggery impact on streams) but there are still many issues that would benefit from IWRM. However there is considerable potential for IWRM to be a reality in the Cook Islands. The country has the advantage of being relatively small, with a moderate to high rainfall and without greatly increasing population pressures. The largest requirement is a political and community will for integration between agencies so that IWRM can lead to achieving sustainable growth in harmony with the Cook Islands' culture and environment

1. INTRODUCTION

The constraints and needs of small island developing states (SIDS) to achieve sustainable water management have been articulated in the SIDS Session Statement formulated at the 3rd World Water Forum (3WWF). The statement refers to three priority issues:

1) Inadequate water resources management in climatic extremes due to: the small nature of small island water resources; natural climate variability; and lack of human capacity.
2) Inadequate water and wastewater service providers due to: lack of human capacity; excessive water demand through water wastage and loss; and poor cost recovery.
3) Inadequate water governance and awareness due to: poorly resourced and highly fragmented colonial administration structures coupled with strong traditional governance practices.

The common water resources management and water use efficiency issues throughout the Pacific Island Countries (PICs) can be summarised as follows:

- An increasing demand for water (potable, irrigation and industrial) coupled to a rise in population, increased tourism and/or expanding development.
- Inadequate and inefficient capture, storage and distribution of water resources (small catchments, inadequate rainfall forecasting, poor watershed management, poor infrastructure).
- Pollution and associated reduction in water quality as a result of:
    - Poorly controlled urban and industrial expansion and development
    - Inappropriate domestic waste disposal
    - Inadequate sanitation and drainage infrastructures
    - Inappropriate agricultural practices (erosion of soils, excessive use of agrochemicals, deforestation).
- Climatic threats to water supplies (e.g. drought, flooding, storm surge, sea level rise).

Integrated Water Resource Management (IWRM) offers a systematic approach to address the sustainable development, allocation and monitoring of water resources for PICs. The key concept of IWRM is that it provides a framework to integrate societal, economic and environmental considerations in water resource management. It recognises that all water use is interdependent and therefore should be managed in an integrated manner.

At the heart of IWRM is recognition of the interdependence of land use, stream and ground water quality and lagoon/marine water quality. Changing the balance of one (e.g. overextracting water from a stream, or changing from rural to urban land use) will upset the balance in another area.

Fenemor et al, 2006 have attempted to define the word "integrated" in an Integrated Catchment Management (ICM) context that uses four different connotations:

1. Integration between science and policy so that the science being carried out is closed linked into policy requirements and vice versa.

2. Integration between the local community, science and policy so that community is linked into the planning and execution of both science and policy.

3. Integration between different scientific and technical disciplines to tackle multidimensional problems.

4. Spatial integration throughout a watershed so that the cumulative impact of different actions can be assessed.

This definition has a science rather than management context. For IWRM a fifth connotation can be put forward: integration between different agencies to provide more effective water resource management.

The GEF funded IWRM project attempts to address the issues listed above through a coordinated and holistic approach to water resources management covering all key areas of the Pacific Regional Action Plan on Sustainable Water Management (Pacific RAP). The Global Water Partnership (GWP) have outlined thirteen key IWRM change areas that can be grouped under the enabling environment, institutional roles and management instruments (see Table 1).

Table 1: IWRM change areas as defined by GWP (2004).

IWRM change area	***Actions***
The enabling environment	
Policies	Setting goals for water use, protection and conservation
Legislative framework	The rules to follow to achieve policies and goals
Financing and incentive structures	Allocating financial resources to meet water needs
Institutional roles	
Creating an organisational framework	Forms and functions
Institutional capacity building	Developing human resources
Management instruments	
Water resources assessment	Understanding resources and needs
Plans for IWRM	Combining development options, resource use and human interaction
Demand management	Using water more efficiently
Social change instruments	Encouraging a water-oriented civil society
Conflict resolution	Managing disputes, ensuring sharing of water
Regulatory instruments	Allocation and water use limits
Economic instruments	Using value and prices for efficiency and equity
Information management and exchange	Improving knowledge for better water management

Many of the tools outlined in table 1 are currently being used in Pacific states; IWRM offers a framework to coordinate these activities and allow integration between different management agencies for better water resource management.

As an example of the need for effective water resource management in the Cook Islands, an economic evaluation of watershed pollution in Rarotonga has estimated avoidable cost from improved watershed management at NZ$7.4 Million per year (3% of GDP in 2003), with a highest estimate stretching to NZ$17.7M (Hajkowicz and Okotai, 2005). The figures were derived from estimates of the cost of different categories in the absence of pollution; the major categories

being healthcare, water treatment and alternative supply augmentation, and loss of tourism income (Hajkowicz and Okotai, 2005).

1.1 Objectives of this report

1) Provide a summary of IWRM needs, issues and current initiatives for the Cook Islands.
2) Collate information related to water and wastewater in the Cook Islands for future use by the National IWRM Focal Point and SOPAC.
3) Provide a reference document on the state of IWRM in the Cook Islands to February 2007.

1.2 Scope of this report

This report covers three aspects of IWRM: water supply; treatment of wastewater and water quality in the fresh water and marine environments. In covering these three elements, issues of land use, human impact on the environment, and ecosystem services are covered. The information in the report is derived from interviews by Dr Davie with key stakeholders and previously written reports and scientific papers.

2. GENERAL OVERVIEW

Figure 1: Location of the Cook Islands in the Pacific Ocean.

The Cook Islands are located in the Pacific Ocean between latitudes 14° S and 22° S, and longitudes 159° W and 164° W (Figure 1). They are a Polynesian island group comprising of 15 widely dispersed islands, surrounded by an Exclusive Economic Zone of 1.8 million square kilometres. The country consists of two main island groups: the Southern Group of Rarotonga, Aituki, Atiu, Mangaia, Manuae, Mauke, Mitiaro, Palmerston and Takutea and the Northern Group of Manihiki, Nassau, Penrhyn, Pukapuka, Rakahanga and Suwarrow (Figure 2 and Table 2).

Figure 2: Map of the Cook Islands, including Avarua (capital).

Table 2: Geographic characteristics of the 15 islands within the Cook Islands (Source: AusAID, 2004; Binnie, 1984; Thompson, 1986).

Island	Area (km^2)	Population (2001)*	Distance from Rarotonga (km)	Geomorphic structure	Annual rainfall (mm)
SOUTHERN GROUP					
Rarotonga	67	12,188	0	High volcanic	2100 (airport) 3063 (Totokoitu)
Mangaia	52	744	203	Makatea**	1904
Mauke	18	470	278	Makatea	1574
Atiu	27	623	215	Lagoon/hills	n/a
Mitiaro	22	230	263	Makatea	1828
Aitutaki	18	1,946	220	High volcanic/lagoon	1944
Manu'ae	6	0		Atoll	n/a
Takutea	1.3	0		Atoll	n/a
Palmerston	2	48	500	Atoll	1988
NORTHERN GROUP					
Penrhyn	10	357	1365	Atoll	1868
Manihiki	5	515	1204	Atoll	n/a
Rakahanga	4	169	1248	Atoll	2352
Pukapuka	1.3	664	1324	Atoll	2816
Nassau	1.3	72	1160	Sand cay	n/a
Suwarrow	0.4	1	950	Atoll	n/a

* Population is total population, including visitors (source Cook Islands Census)
** Makatea is a general term for raised coral limestones resting on small volcanic cones

The Cook Islands is a self governing country which maintains a free association with New Zealand. The total population in the 2001 census was 18,027 with a resident population of 15,017. Rarotonga is the major populated island (9,451 resident in 2001) with the remainder of the Southern Group having 25% of the resident population and the Northern Group 12% (Census, 2001).

The islands of the Southern Group differ widely in form, structure and relief, which makes it difficult to deduce a generalised geological history that is consistent for the whole group (Wood and Hay, 1970). The group includes a high mountainous island of Rarotonga, four raised coral islands with volcanic cores (Mangaia, Mauke, Mitiaro and Atiu) one atoll (Manuae) one near atoll with a volcanic core (Aitutaki), and a sand-cay on a coral foundation (Takutea). Several of the islands are isolated submarine mountains, but those between Aitutaki and Mauke form a distinct chain that trends northwest parallel such as the Austral Group to the southeast (Wood and Hay, 1970).

The Northern Group consist of atolls, with one exception, Nassau that is a sand cay (small island of sand) on a coral reef foundation. These islands are widely scattered and their surrounding bathymetry shows that some are parts of submarine ranges of volcanic mountains, and others are summits of single volcanic cones rising some 4500 to 6700 m above the ocean bed (Wood and Hay, 1970).

Soils in the Cook Islands vary according to geological providence. For example on Atiu, twelve different soil types have been identified based on the topography and parent materials in Atiu (Campbell, 1982). On the low-lying atolls soils are very limited in depth and quality. Most of the high island of Rarotonga is ruggedly mountainous, with narrow valleys having small but fertile pockets of soil. Interior upland soils are dark red, clay-rich materials typically produced in tropical climates by weathering of basaltic volcano bedrock. These upland soils are generally less fertile due to nutrient deficiencies (Mataio and Syed, 1993; McKean and Baisyet, 1994). The coast consists of makatea or upraised coral reef, of limited fertility. Between the mountains and the coast, however, there is a ring of fertile volcanic soil where the majority of people live and most agriculture takes place (Aregheore, 2006).

Cook Islands agriculture has gone through a number of changes in recent years, following primarily market based prices in their export markets, such as Australia and New Zealand. This has seen a major decline in citrus and pineapple production and a shift away from full time agriculture into part-time farming. Livestock farming has always been small scale and has stayed relatively static apart from goat numbers which have declined from 6,500 in 1995 to 1000 in 2005 (Aregheore, 2006).

The vegetation for the Cook Islands is lush tropical on Rarotonga and the fertile southern group of islands. Vegetation on the coral atolls is sparse; mainly pandanus and coconuts. The inland area of Rarotonga (above 400m) contains many species of plants unique to the Cook Islands. These include the ascarina (*kaiatea ko'u*), the glossy tongue fern and the Rarotongan freycinetia (*kiekie*), a plant similar to pandanus (*ara*).

The Cook Islands' climate is tropical and moderated by trade winds. The country experiences two distinct seasons: the dry months from April to November and the wetter humid months from December to March (Figure 3 and Table 2). The 1929-92 average rainfall at Rarotonga airport was 2100mm, with a maximum in 1967 of 3000mm and a minimum in 1982 of 1100mm (Clement & Bourget, 1992). Rainfall in the northern group of islands is generally higher than for Rarotonga (Table 2) with a similar distribution through the year (Figure 4).

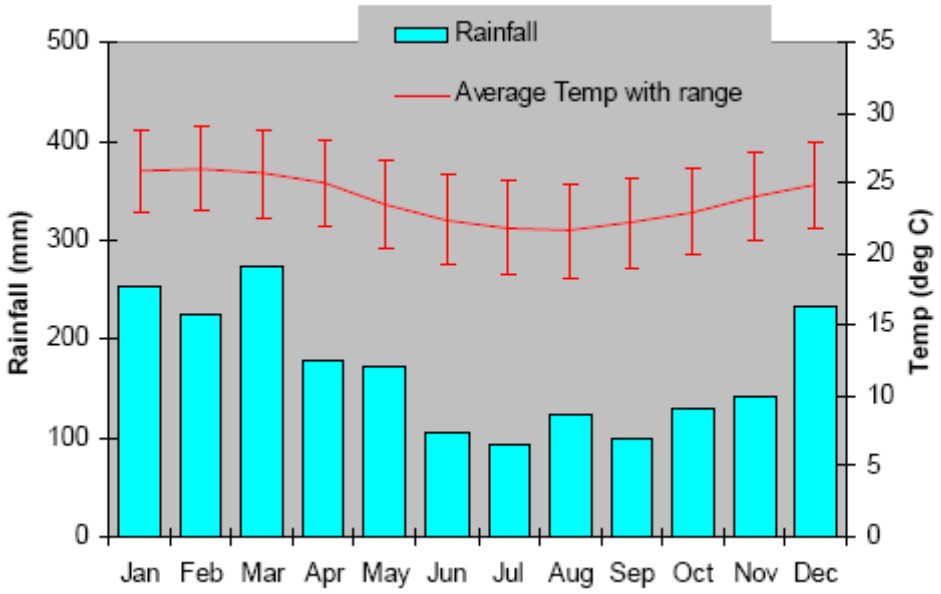

Figure 3: Average climatic information for Rarotonga.

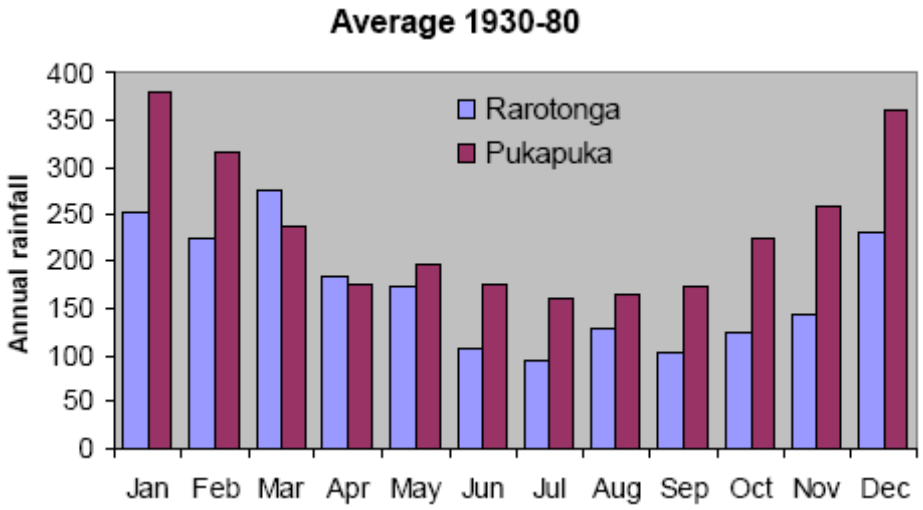

Figure 4: Comparison of average rainfall on Rarotonga (southern group) with Pukapuka (northern group). Data from NZ Met Service (1981).

Natural hazards threaten the Cook Islands in the form of cyclones, storm surge, drought, coastal flooding, river flooding, tsunamis, earthquakes and landslides. The biggest natural hazard is from tropical cyclones (typhoons or hurricanes) e.g. Cyclone Heta (category 5) in January 2004 caused widespread damage to infrastructure in the Cook Islands along with Samoa, Tonga and Niue. Drought is linked into the El Nino Southern Oscillation (ENSO) with significant droughts on Rarotonga occurring in 1982, 1987 and 1997-98 (El Niño years). Drought occurs through the lack of, or very low, rainfall during a rainy season (Dec – April). El Niño linked drought is not a nationwide phenomena, the norm is that at the time of an El Niño event the Southern Group of islands suffers drought while the Northern Group has enhanced rainfall. A La Niña event causes the reverse effect.

The Cook Islands' economy is one of the strongest in the South Pacific. In 2005, the country's GDP per capita was NZ$12,878. The Cook Islands' economy is based on tourism, pearl exports, marine resources, agriculture and offshore banking industries. Tourism remains the country's highest income earner, followed by the pearl and agriculture sectors. The economy is also supported by foreign aid from New Zealand. Rarotonga is the most developed island and has the highest population. Aitutaki is the second most developed island, mainly through tourism. The other islands suffer greatly through isolation, all of them being 170-1000km from Rarotonga and up to 1100 km away from each other (Evans, 2006).

The Cook Islands sources its potable water supply from two main sources. In the Southern Group of islands which includes the main island of Rarotonga, surface water is sourced from springs and streams within catchments valleys, while in the Northern Group of islands, water is sourced from rainwater and groundwater.

Table 3: Summary of the main geographic information for the Cook Islands.

Capital:	Avarua on Rarotonga
Population:	18, 027 (2001)
Land Area:	240 sq. kilometres
Max Height above Sea-level:	652 metres (Te Manga on Rarotonga)
Exclusive Economic Zone:	1.8 million sq. kilometres
Rainfall:	Average of 2, 040 mm per annum (see table 2)
Mean Temperature:	24° C
GDP per Capita:	NZ$12, 878 (2005)
Currency:	New Zealand dollar (NZ$)
Languages:	English, Maori
Government	Semi-independent country in Free Association with New Zealand
GDP per sector (2005)	Agriculture & fishing – 13%; Services (including tourism) – 63%; Industry – 9% Public administration - 13% Other - 2%
Land use	Permanent crop - 13% Arable – 17% Other - 70%

3. INTEGRATED WATER RESOURCES MANAGEMENT SITUATION FOR THE COOK ISLANDS

3.1 Water Resources Management

The Cook Islands have a long history of water management. An example is on the island of Mangaia which originally had a water management system based on rank. The island was divided into 6 catchments with a chief at the top of each catchment. A set of dams and terraces controlled the flow of water through the catchment to members of the family. This form of water management was dismantled when missionaries arrived in the 19th century and people were encouraged to live on the coastal fringe, but indicates the manner that water management can influence societal structures and vice versa (AusAID, 2004).

3.1.1 Types of freshwater resources

The Cook Islands sources its potable water from two main sources. In the Southern Group of islands which includes the main island of Rarotonga (volcanic origin), surface water is sourced from springs and streams within catchments valleys. In the Northern Group of islands (coral atolls), water is sourced from rainwater and groundwater.

A recent AusAID project has provided detailed water resource information for all the outlying islands. This work, carried out by Tony Falkland, details the water resources available, provides water quality assessments and outlines water resource management issues and for each island. It then goes a step further by providing recommendations for immediate, short term and long term improvements to the water supply on each island (e.g. Falkland, 2000 for Mangaia). This is a tremendous resource for the Cook Islands' water resource development.

Desalination and wastewater reuse are not practised in the Cook Islands. The only form of water importation is through bottled drinking water although the main source of this is two bottling plants on Rarotonga (with some additional importation from New Zealand). During drought years (e.g. 1998) water tankers have been used to transport water to hotel complexes from other parts of Rarotonga and some drinking water transported to outlying islands.

A recent NZAID project (2006) has supplied new water tanks to all households on the island of Mangaia. This is in addition to an AusAID funded project to upgrade the reticulated water supply on Mangaia. In this way the island is not dependent on a single water supply source. Other islands have received water tanks as part of a Canadian funded rainwater harvesting project.

3.1.2 Types of freshwater uses

Like many PIC's, water supply issues are dominant in the management of water resources, and attention generally has focused on the areas of greater population, namely, the high population centres and Rarotonga in particular.

Binnie (1984, 1987) report Rarotonga per capita water consumption figures of approximately 1200 litres per capita per day, which is extremely high when considering a reticulated water supply system. A more recent report lists the average water demand on Rarotonga at 10,645m_3 per day; approximately 900 litres/person/day (PICCAP, 1999). However there is no indication where this figure comes from. Given there is no accurate assessment of water abstraction on Rarotonga and no studies on water use by sector the figures in PICCAP (1999) must be treated with extreme scepticism.

Although Beetham (1988) makes the comparison with Singapore and Auckland (⅓ to ¼ of Rarotonga figures) this not a completely fair comparison as Auckland and Singapore have no significant use of their reticulated water for agriculture. New Zealand's total water consumption is around 1500 litre per capita per day (Taylor & Smith, 1997); the major difference being that in New Zealand water for use in agriculture is supplied separately from domestic water, and the infrastructure cost borne by individual users. It is also worth noting that the 1200 litres per person per day figure includes the very high leakage rates (see below). Once the leakage has been reduced through infrastructural renewal (currently underway) the figure should reduce substantially.

In contrast to Rarotonga, water usage on Atiu has been estimated at between 100-150 litres per person per day (B. Parakoti, pers. comm).

There is no doubt that agriculture, through the watering of small vegetable plots and gardens accounts for the majority of water usage on Rarotonga. Clement & Bourget, (1992) estimate that agriculture could use up to 80% of the water supplied through the Rarotonga reticulation system. PICCAP (1999) splits Rarotonga water demand into 34% domestic, 35% agriculture, 10% commercial and 21% tourism usage; although these figures must be treated with some scepticism (see above).

Tourism is the largest "industry"; Clement & Bourget, (1992) estimated that it accounted for 26% of potable water (i.e. discounting agriculture) on Rarotonga and this is likely to have grown since then. Other industries, such as fish processing and the airport, were estimated to account for 13% of potable water.

3.1.3 Majors Issues and Concerns

Leakage and wastage of reticulated water are major issues for Rarotonga. Binnie (1984) estimated leakage losses at 16% of total demand. A later study in 1985 showed reticulated losses of 40% in Avarua (Binnie, 1985). Clement & Bourget, (1992) repeated the test in 1991 and found leakage and wastage losses as high as 70%. The large-scale infrastructure of old steel and galvanised pipes has caused problems with corrosion and leakage. Replacement of the old pipes by uPVC is in progress to alleviate these problems.

Clement & Bourget, (1992) in a pilot study of water metering in Avarua found that 48% of the consumption was from only 11% of the metered households. Visits to these properties showed poorly maintained home systems including washers worn out and in some cases taps left on overnight. Water wastage is a serious issue for Rarotonga that could be alleviated through water metering and charging directly for water consumed. Studies around the world have shown a drop in water consumption of around 20% when metering and charging are introduced; a significant amount, especially during drought years. There appears to be resistance to a user pays principle for water on Rarotonga but elsewhere in the Cook Islands there is recognition of its importance. An AusAID document on water supply for Mangaia indicates that the Mayor of Mangaia was in favour of paying for water, likening it to electricity (AusAID, 2004).

The reticulation system upgrade currently occurring on Rarotonga should significantly reduce leakage losses which has been the priority of the Ministry of Works, rather than metering and charging (Pers. Comm., B. Paratoki, 2007). The upgrade will also include sector metering so that significant usage and/or loss within pipeline sectors can be detected. This will allow some limited demand management but does not place responsibility down to individuals.

The water user with the highest priority on Rarotonga is tourism. This is achieved through the major hotels being linked directly into the ring main while domestic users take water from submains. Most large hotels have large storage tanks which they fill directly from the ring main. When water pressure is low the major hotels maintain their pressure for longer than domestic users. This arrangement is due to the high water demand from hotels that would drop the water pressure significantly from a submain, to the detriment of neighbours. The consequence, although not necessarily deliberate, is that large tourist hotels have priority to other users during periods of drought.

Overall the quantity of water resource of the Cook Islands could be considered adequate during normal years but stressed during drought years. The reliance on rainfall storage and streams (without significant storage) makes this likely to continue into the future. It could be improved through either demand management (e.g. metering and charging) or provision of extra storage (e.g. storage dams or groundwater).

Septic tank systems are widely used throughout Rarotonga, comprising of a septic tank and a soakaway. The septic sludge (septage) is collected for treatment at a centralised plant. Elsewhere in the Cook Islands septage is spread on vacant land or on fields at the request of farmers. There is only one reticulated sewerage system on Rarotonga, which was installed in the early 1950s following relocation of houses to accommodate the airport. This sewer system collects sewage from the residents and is fed into septic tanks for treatment. The septic tanks were replaced in 1994 with an Enviroflow proprietary sewage treatment plant. However the plant was neither maintained nor operated correctly, and fell into disuse. The raw sewage currently bypasses the plant and flows into the sea. Water quality issues from septic tank leakage and nutrient laden groundwater reaching the lagoon are major issues that have been linked into significant health concerns, e.g. Takitumu Irritant Syndrome in 2003-04 which is believed to be from algal blooms in the nutrient rich lagoon waters (Hajkowicz & Okotai, 2005).

There are problems with coliforms and sediment in the drinking water where surface water is sourced (Rarotonga and Mangaia); a result of land use practices in the water catchment area. In particular this stems from livestock adjacent to streams above the water supply intakes; growing of taro in a controlled wetland and some growing of cassava on steep inland slopes.

3.1.4 Measures to manage impacts and concerns (IWRM approaches)

Rarotonga is the only island in the Cook Islands with a hydrometric network. This was established in 1999 with assistance from the National Institute of Water and Atmospheric Research Ltd (NIWA) and funding from the New Zealand Overseas Development Agency. This hydrometric network gives an ability to understand the amount of water available for reticulated supply and as longer term records are established, to learn water management lessons from previous years. The hydrometric network is being extended through the HYCOS programme (2007-200 with EU funding) to include more rain gauges and another streamflow gauge on Rarotonga.

The original 5-year hydrometric network project also included data collection and training of staff (Mason, 1999; 2005). Since 1999 Rarotonga has had 3 continuous recording sites at the site of water intakes for the reticulation system (Avatiu in the North, Matavera in the East, and Totokoitu in the South). At each of the weir sites there is a rain gauge installed nearby. In addition to this there is an automated rain gauge installed on the top of Te Kou, one of the Rarotonga mountain tops. Both rain gauges and weirs have loggers attached which record at 15 minute intervals. The weir sites are gauged approximately every 3 months to determine and accurate rating curve (relating water level to streamflow). Preliminary analysis of the rainfall record from June 2005 until June 2006 suggests that Te Kou (representing the upper catchment) collected 20% more rainfall than the gauge at Avatiu, indicating that volumetric calculations need to consider rainfall variation throughout the catchment area. The only long term rainfall record is from the meteorological station at Rarotonga Airport.

Water quality monitoring is carried out by the Ministry of Works (MoW) at their intake sites and the Department of Public Health within the reticulated water system and in the lagoon. The MoW do not have a systematic water quality monitoring network. When they carry out monitoring (approximately quarterly) it is for Nitrate, Phosphate, Iron, Aluminium, Hardness, pH, Coliforms and E. Coli. An attempt was made to have regular water samples sent from the outer islands for testing in Rarotonga but this has not been successful (no samples had been received by January 2007).

On the islands that depend on rainfall for potable supply water conservation is a fact of life and practiced constantly. On Rarotonga water conservation is not widely practiced and there are many wasteful water uses and misuses, e.g. leaks from taps, taps left running constantly. There are no continuous water conservation policies and no particular incentive to conserve water except from a social and/or environmental conscience. During periods of drought public awareness campaigns are carried out by the Ministry of Works to limit consumption.

On the rainfall dependent islands the incentives for water conservation are self evident. The MoW has prepared maps of Rarotonga delimiting the catchment areas above each water supply intake. This was done in preparation for legislation formally setting aside these areas as water supply reserves. The legislation has never eventuated (to January 2007) so there are currently informal water supply reserves (figure 5). These informal reserves have no legal standing although they are taken seriously by the local population. It is important to note that the restricted activities do not include land use; the land owners and land users within the catchment area have no restrictions placed on them. In practice the majority of the catchment area is covered in forest although there is more pressure for taro growing further up the valleys as the coastal plain is taken for housing and tourism.

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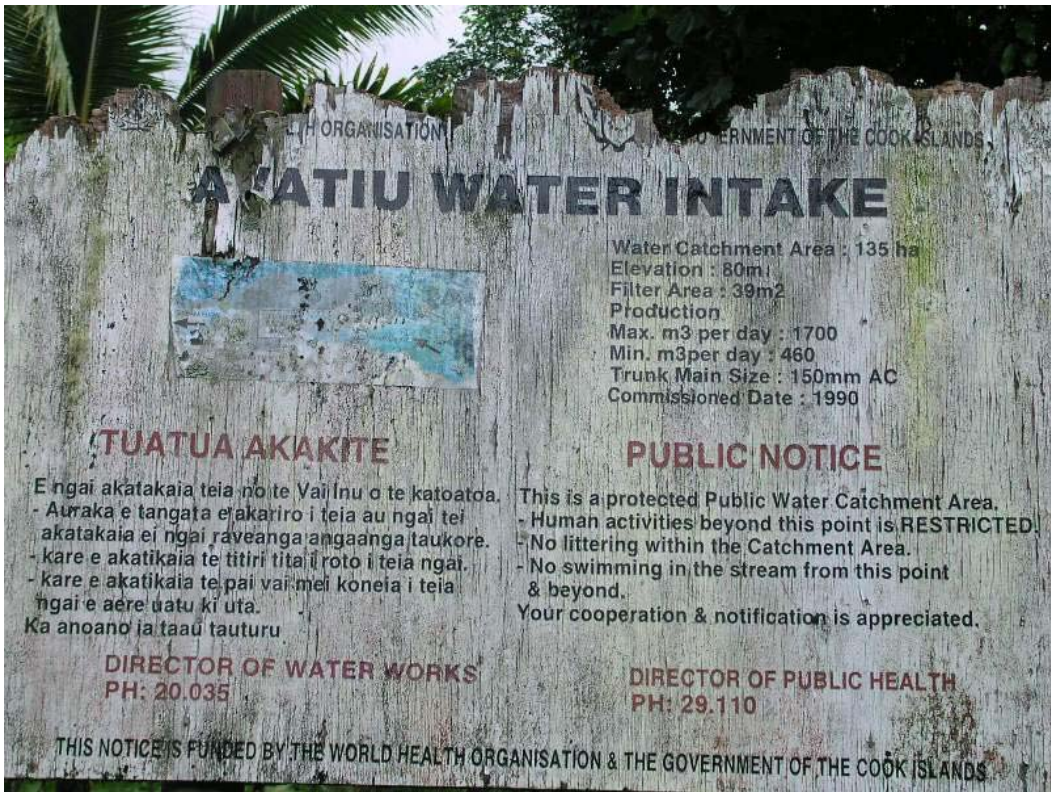

Figure 5: Sign below the Avatiu water intake (at start of popular cross island trek) detailing the informal water reserve.

On the coastal plain (below the water intakes) there are no buffer areas surrounding rivers and streams. A major problem arises due to pigs, goats and poultry being kept immediately adjacent to rivers and their excreted waste washing into streams during rainfall. This causes a major eutrophication problem for the receiving lagoon and potential health risks for lagoon users. A NZAID project (CIMRIS) is addressing this area in the Takitumu region through working with pig farmers to reduce the input of contaminated water into the lagoon.

A recently started NZAID project has set up a National Water Safety committee to implement a national water safety plan. This is coordinated by MoW and has the primary focus on ensuring a surety of supply for Rarotonga. It is envisaged that in future more emphasis will be placed on other islands.

The Cook Islands is being used as a case study in an NZAID-funded regional programme on water demand management run by SOPAC. This project covers cost-reflective pricing; the value of metering; reticulation leakage detection and repair programs and pressure reduction; and communication strategies, including community education.

3.2 Island Vulnerability

3.2.1 Types of disasters with major issues and concerns

The Cook Islands, as with many PICs are vulnerable to natural disasters and possible future climate change affecting infrastructure and tourism revenue. The largest natural disaster risk is through tropical cyclones. Between 4 February and 8 March 2005, the Cook Islands experienced five damaging cyclones within a period of five weeks, four of which were assigned a severity rating of Category 5 and caused damage to homes and essential public infrastructure. Damage done during cyclones is caused by high winds and flooding (largely sea flooding onto land during storm surges). Stream and river flooding has caused damage to water reticulation infrastructure but this is reasonably quickly rectified. The simple nature of the reticulated supply intake system makes for relatively little damage. The reliance on gravity feeds is also beneficial as there is no dependence on electricity supply which could be damaged during a cyclone.

Another issue for water supply on Rarotonga is the sediment input into the reticulation system during high flows (not necessarily from cyclones). The current filters are easily blocked by excess sediment levels which results in brown and murky water entering the reticulation system. The Water Works Division of the Ministry of Works has plans to replace the current intake filters on Rarotonga with a series of settling tanks and new filters. Drought, although a relatively infrequent occurrence, places considerable stress on the water resources of Rarotonga and the other islands. The islands that rely on rainwater tend to be well set up for water conservation, although a lack of rainfall during drought has been known to result in drinking water importation. Recent NZAID, AUSAID and Canadian funded projects on rain water harvesting in the outer islands have provided modern large size tanks for households.

The only historic data on incidences of droughts and floods is the Rarotonga rainfall record. The hydrometric network on Rarotonga has not been operational long enough to provide hydrological analysis of droughts and floods. The occurrence of tropical cyclones tend to be more frequent during an El Niño event, when warmer than normal sea surface temperatures occur between latitudes 10 and 15 degrees South (°S) and there is an eastward migration of the South Pacific Convergence Zone (SPCZ) in the vicinity of the Cook Islands and French Polynesia. During an El Niño event the southern Cook Islands experience a reduction in rainfall, to as little as 60% of normal, while in the northern Cook Islands rainfall increases to as much as 300% above normal (ADB, 2006). This can be seen in the number of low rainfall months recorded in a year and decade at Rarotonga airport (figure 6). Most of the low rainfall months are concentrated in the

latter part of the period of observation, indicating that the frequency of drought has increased since the 1930s. The years with a high number of months below the five percentile coincide with El Nino events (ADB, 2006).

Apart from the sewerage scheme near the Rarotonga airport the pollution problems are by and large from diffuse sources and difficult to summarise as individual disasters. There is a definite water pollution concern, particularly in the lagoon.

On the outer islands that use groundwater, normally from freshwater lenses within the atoll, there have been reported cases of saltwater intrusion (e.g. Mitiaro and Aitutaki) but these have not been systematically dealt with. It is unclear whether this is an increasing problem. There have been no particular problems with landslides or other sediment generating mechanisms caused by storm events. This is by and large due to the unaltered nature of island interiors (e.g. forest covered). The authors could find no evidence that sea level rise or storm surges have had an impact on aquifers. This may become a problem on low lying outer islands dependent on groundwater. The data on mean sea level at Rarotonga show no particular rising trends (Figure 7). There is large inter-annual variability in sea level. The exceptionally high sea levels shown in the figure are all associated with the occurrence of tropical cyclones (ADB, 2006).

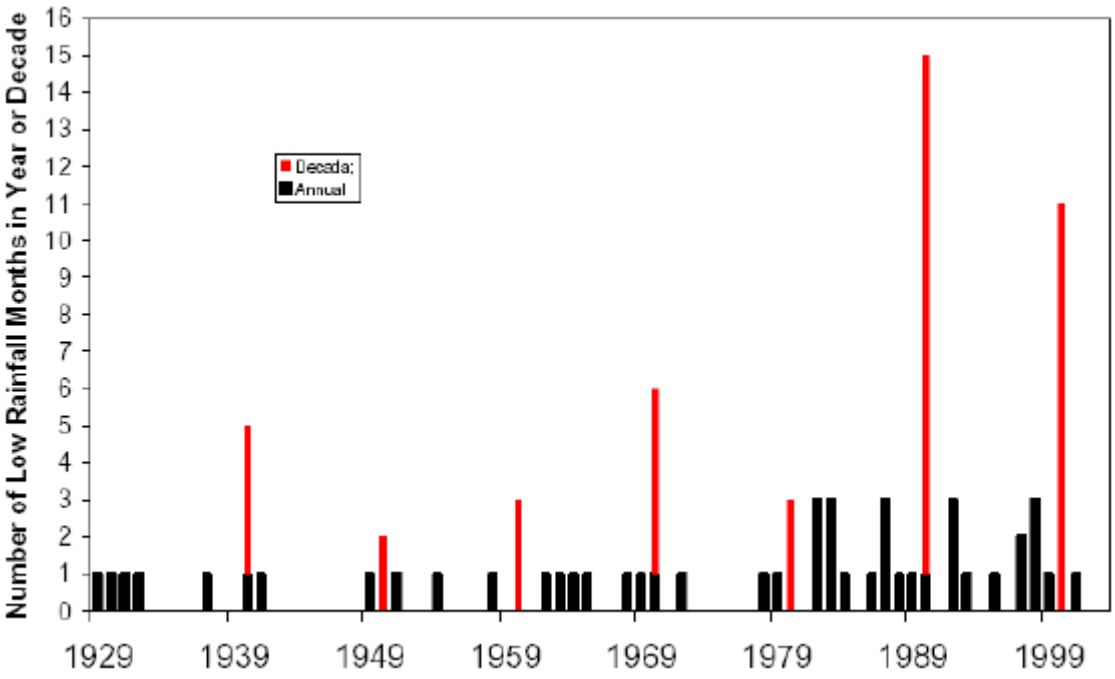

Figure 6: Daily Number of low rainfall months at Rarotonga airport (Source: ADB 2006).

3.2.2 Measures to manage impacts and concerns (IWRM approaches)

Climate scenarios, based upon Global Circulation Models, suggest that in this region of the Pacific extreme events will increase, along with significant impacts upon the people and their environment (see table 4). For example, from table 4 it can be seen that daily rainfall totals have a current recurrence interval of once in every 38 years; by the year 2100 this may have dropped to once in every 11 years. This increase in frequency of major rainfall events could have severe impacts on infrastructure in the Cook Islands.

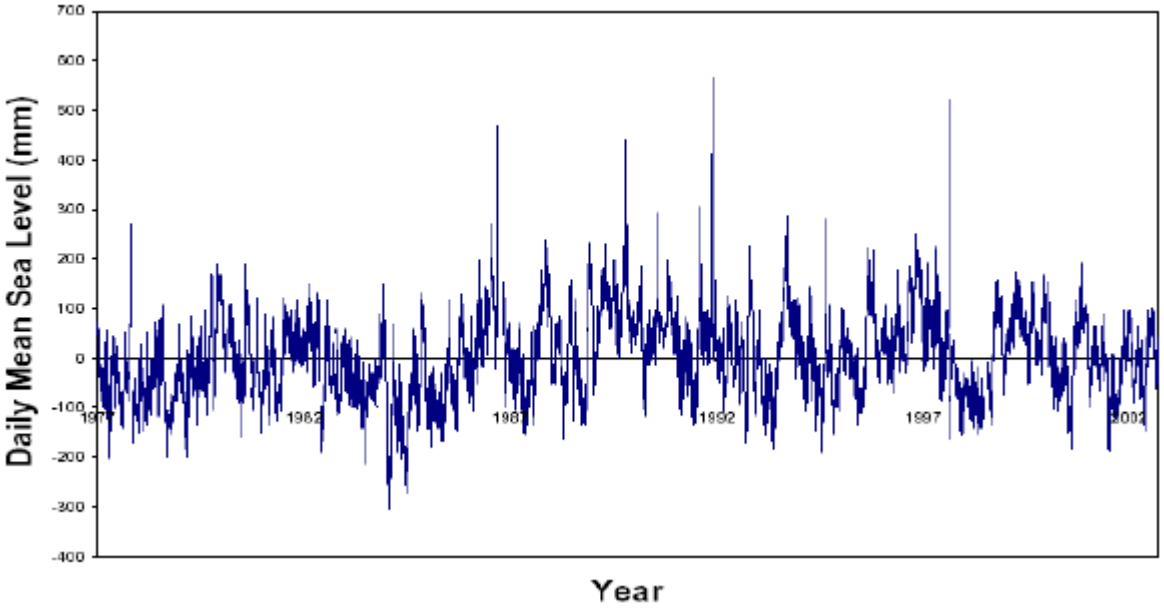

Figure 7: Daily Mean Values of Sea Level for Rarotonga (1977 to 2002) (Source: ADB 2006.)

Table 4: Predicted specific extreme events for Rarotonga (Source: ADB, 2006). RP=return period; LO = Likelihood of occurrence (probability).

Event	Present		2025		2050		2100	
	RP	LO	RP	LO	RP	LO	RP	LO
Rainfall – Daily Total at least 300 mm	38	0.03	26	.04	19	0.05	11	0.09
Rainfall – Hourly Total at least 100 mm	91	0.01	57	0.02	25	0.04	13	0.08
Height of Sea Surge – Extreme at least 6 m above mean sea level	10	0.10	8	0.13	7	0.15	5	0.21
Wind Gust - Extreme at least 42 m/sec	29	0.03	16	0.06	14	0.07		
Maximum Temperature – Daily at least 34 °C	29	0.03	14	0.07	9	0.12	3	0.29

[1] A likelihood of 0 equals zero chance while a likelihood of 1 equates to a statistical certainty that the event will occur within a year.

The Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (2003) outlined that for small island states in the Pacific region, the following scenarios could be identified with some confidence.

(i) ***Rise in sea level***. Sea level may rise 0.5metre (in a best-guess scenario) to 1metre (in a worst case scenario) by 2100.

(ii) ***Increase in surface air temperature***. Air temperature could increase 1.6º– 3.4ºC by 2100

(iii) ***Changes in rainfall***. Rainfall could either rise or fall by about 20% from current rates in 2100 leading to more intense floods or droughts.

(iv) ***Increased frequency of more El-Niño like conditions***. The balance of evidence indicates that El Niño conditions may occur more frequently, leading to higher rainfall in the central Pacific and northern Polynesia.

(v) ***Increased intensity of cyclones***. Cyclones may become more intense in the future, with wind speeds increasing by as much as 20%; it is unknown whether cyclones will become more frequent.

In July 2005, the Asian Development Bank (ADB) approved a loan for a Cyclone Emergency Assistance (CEA) Project for the sum of US$2.85 million. The loan was to mitigate the social and economic impact of the cyclone damage by providing the necessary concessional resources to assist the Government implement a comprehensive recovery program. A major focus within the CEA work is on disaster planning and mitigation. The objectives of the CEA project are:

1) To strengthen disaster and recovery management, including damage assessment, aid management and operational coordination;
2) To establish financial controls required to ensure good governance in the management of the rapid disbursement of recovery funds;
3) To develop a far-reaching and a systematic approach to mitigating the country's vulnerability to adverse weather conditions;
4) To establish institutions and environmentally sustainable infrastructure with capacity to impede the reoccurrence of a disaster with harmful effects on communities and key infrastructure.

It is the third of these objectives that fits closest with an IWRM approach in the Cook Islands; this includes an assessment on the affects of climate change on the Cook Islands.

3.3 Awareness

The Cook Islands Environment Act of 2003 has raised the profile of the environment and environmental services. Health concerns such as fish poisonings in Titikaveka lagoon and Takitumu district airborne irritant syndrome in 2004 (Hall et al, 2006) have highlighted the fragile nature of the Rarotonga environment and the large impact that humans are making. The recently launched National Sustainable Development Plan for the Cook Islands has set as it primary strategic objective: *"to build a sustainable future that meets our economic and social needs without compromising prudent economic management, environmental integrity, social stability and the needs of future generations* " (p10 Te Kaveinga Nui – National Sustainable Development Plan 2007-2010). There is a gradual political will to improve water resource management in an integrated sense but it is not at such a stage as to be top of a political agenda.

3.3.1 Type of awareness campaigns, advocacy initiatives currently being undertaken in the area of water resources management

One of the main projects from the International Waters Project (IWP) in the Cook Islands was the Takuvaine Water Catchment Project. This was a community based initiative (coordinated by the Environment Service) to work with land owners and land users in an important water catchment area for the Rarotonga water supply. The Takuvaine project was set up as a demonstration project to protect the water supplied from the Takuvaine water catchment and intake area (see figure 8). The major output from the project has been a catchment management plan derived through extensive community and landowner consultation. Included in the management plan are the rules for a ra'ui (prohibition of certain practises) within the catchment that will soon become

law. The Takuvaine project has been an important IWRM initiative, raising awareness of the links between land use practises and water quality in the reticulated supply and then setting out a plan to change practises.

A second advocacy initiative currently underway is within the CIMRIS project and targets livestock farming (and particularly pigs) adjacent to streams in the Takitumu district. The project is working with land users raising awareness of the impacts their practises may be having on the downstream users and the receiving lagoon.

Government ministries (MoW and Health in particular) are involved in information campaigns around water conservation and water quality. On World Water Day an information pack on water is sent to all schools. Members of staff from the ministries frequently speak to school audiences on water resource management issues.

Awareness raising was a component of the Aitutaki CBDAMPIC ("Capacity Building to enable the Development of Adaptation Measures in Pacific Island Countries") water project. The main aim of the project was to gather information on water infrastructure and consumers; provide rainwater harvesting facilities and monitor water quality on the island as part of climate change awareness. The presence of a group of water professionals on the island allowed an opportunity for community meetings on water conservation and strategic thinking on water usage with climate change.

Figure 8: Signs at road entrance to Takuvaine.

3.3.2 Major Issues and Concerns

Despite most Cook Islanders having a close association with the land there appears to be a poor association between land management and freshwater and coastal water quality. The Takuvaine

project demonstrated that the linkage could be made but it was not intuitive to the land users and a considerable amount of time had to be spent persuading land users of their impact on water quality.

A second major issue is the waste water treatment using septic tank systems. At present all issues concerning septic tanks (apart from treatment of septage) is administered by the Department of Health. This administrative structure puts the major emphasis on health risks associated with faecal contamination with little emphasis on the leaching of nutrients (particularly nitrogen and phosphorus) from septic tanks into the shallow groundwater and then out to the lagoon. Hall et al., (2006) have shown that nutrient levels in the Titikaveka lagoon (southern Rarotonga) were at higher values than recommended for the healthy growth of coral reefs. The likely source of these elevated nutrient levels is groundwater containing leachate from septic tanks (n.b. this is surmised, the authors have no scientific evidence of this at this stage). It is important that there is a general awareness that septic tanks can contribute extra nutrients to receiving waters (i.e. groundwater and then the lagoon), thereby creating a secondary pollution problem; it is not just a concern from faecal pollution.

The lack of civil society involvement in water resource management (i.e. beyond government departments) is an issue of concern for IWRM. In promoting general societal involvement the link between land management, waste disposal and water quality needs to be strongly advocated.

3.3.3 Measures to manage impacts and concerns (IWRM approaches)

The Takuvaine project was successful in implementing a ra'ui and management plan for the Takuvaine catchment through a mixture of community involvement and targeting the landowners as well as land users. The distinction between these two groups is an important cultural context for the Cook Islands. Another success of the Takuvaine project was using community champions to promote the key messages (e.g. Mama Terii Simpson, see details at: http://www.sprep.org/iwp/IWPChamp/champ_ind.htm). Overall awareness of the integrated nature of land, freshwater and the marine environments is low and projects such as Takuvaine need publicity and replication for the full effect to be felt.

The other community awareness project of note is within CIMRIS; working with livestock farmers in the Takitumu district. This is a recent initiative and its success cannot be judged yet. It is the kind of project that needs further backing. The lack of examples of community involvement and awareness building in the Cook Islands highlights the need for promoting this within an IWRM approach.

3.4 Technology

The majority of islands in the Southern Group maintain a reticulated water supply from various sources. In the Northern Group there is a total reliance on rain water (Table 5). There is no treatment of drinking water apart from simple filtering at source. There are problems with coliforms in the drinking water where surface water is sourced (Rarotonga and Mangaia); a result of land use practices in the water catchment area. The presence of coliforms in the water supply results in advice from Government authorities that drinking water should be boiled or bought separately (e.g. in plastic containers). This advice is general; i.e. it does not vary dependent on a monitoring programme that detects coliforms at a particular time.

Table 5: Water supply systems for all of the Cook Islands.

Island	Area (km^2)	Water supply system	Water quality
SOUTHERN GROUP			
Rarotonga	67	Reticulated supply from stream sources	Coliform concerns
Mangaia	52	Reticulated from stream and boreholes	Coliform concerns
Mauke	18	Reticulated from boreholes	Good quality (no saline intrusion)
Atiu	27	Reticulated from wells and independent household rainwater harvesting (old boreholes redundant)	Good quality (no saline intrusion)
Mitiaro	22	Reticulated from cave sources	Salinity problem
Aitutaki	18	Reticulated from galleries	Salinity problem (variable)
Manu'ae	6	n/a	n/a
Takutea	1.3	n/a	n/a
Palmerston	2	Rainwater	
NORTHERN GROUP			
Penrhyn	10	Rainwater	
Manihiki	5	Rainwater	
Rakahanga	4	Rainwater	
Pukapuka	1.3	Rainwater	
Nassau	1.3	Rainwater	
Suwarrow	0.4	Shallow well	

3.4.1 Types of water supply systems

The largest development of water resources has taken place on Rarotonga where there is the highest population and greatest knowledge of the water resources. Water from streams on Rarotonga is collected using gravel bed filters and feeds into a gravity driven ring main system that encompasses all of the coastal plain settlements. There are 12 intakes for the ring main, each of which is fed directly into the ring main. A series of cross mains and submains feeds from the ring main to all the households and businesses on the coastal plain (figures 8 & 9).

The system of water reticulation on Rarotonga is a gravity fed distribution system, taking essentially untreated water from 12 streams and feeding into an extensive pipe network (see Figure 9). 99% of residences on Rarotonga (rural and urban although it is difficult to distinguish the two) are connected to the water reticulation system. The exception is for residences at an elevation too high for gravity feeding through the reticulated supply (approx. 30 m above msl); these houses are reliant on rainwater.

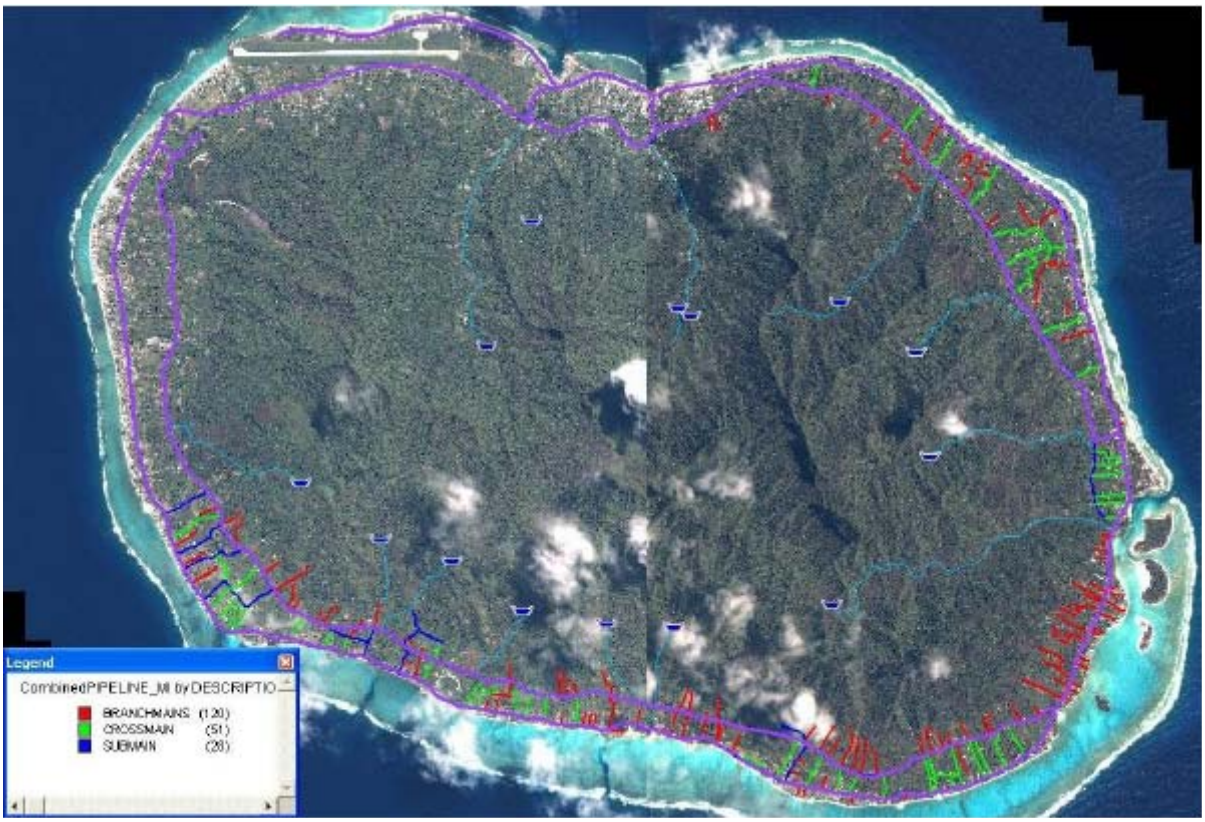

Figure 9: Water reticulation system for Rarotonga showing intakes (blue basins) and the ring main (purple). The system is not fully complete as the ring main has not been fully upgraded yet (January 2007) at which time all pipelines are GPS located.

Figure 10: Enlarged view of the water reticulation system in south-west Rarotonga showing the branch-main (red), sub-main (blue), and cross-main (green) connections running from the ring main (purple).

None of the water reticulation systems (see Table 5) have treatment facilities beyond simple gravel bed filters.

Rarotonga is currently engaged in a large-scale refurbishment of its water reticulation pipe network (funding from Cook Islands Government); this will be around 70% completed by the end of 2007. Atiu has had a recent upgrading of it's water reticulation network (2002-03); installing nine new elevated water tanks, replacing four of the oldest pumps on the island and re-boring two supply sites at Ukaveu and Tekapi. An investigation into the feasibility of using solar pumps on Mauke (Zieroth, 2005) recommended that they replace the current diesel used to extract groundwater. This has not been implemented.

On the Northern Group, where rainwater is used this is almost always at the individual household scale. There are no figures available for the percentage of population on reticulated vs individual rain tank supply.

There is no particular method used for estimating future demand. The population of the Cook Islands has been static for a considerable length of time, growth has occurred mostly through tourism developments. Current planning for water supply management is concentrating on reducing leakage within the reticulation system to guarantee surety of supply with no apparent regard for future change. At present water supply meets demand for the majority of years and there is no particular issue with quantity.

3.4.2 Types of wastewater/sanitation systems

All wastewater throughout the Cook Islands is treated through septic tanks or other soakage systems. There is one reticulated sewerage system on Rarotonga that feeds into a centralised septic tank. The septic tank is no longer functional although the reticulated sewerage network is still accepting waste. Consequently untreated sewage is being discharged into the lagoon from this system.

Elsewhere in the Cook Islands there is a variable standard of septic tanks, ranging from simple soakage pits (long drops) to double or triple tank systems. Tile drainage from the tanks is rarely practised. Hotels, even resorts of large size, also use septic tank systems. On Rarotonga liquid waste from septic tanks (septage) is collected and transferred to a single treatment facility on the south-west of the island. This is relatively new treatment facility (constructed 2004), prior to this septage was spread onto agricultural land (as is practised on outer islands).

3.4.3 Majors Issues and Concerns

There are six major issues concerning potable supply and waste water treatment in the Cook Islands.

1) The current reticulated water supply systems serves a dual purpose; supplying households with water for drinking, washing etc. and supplying water for agricultural gardens (the major water use by volume). The water quality for washing and agricultural purposes is excellent but is not guaranteed of being up to potable standards (largely through coliform contamination). Considerable investment in filtering and possibly treatment would be required to bring it up to potable standards. In doing this you would have to ask whether it is worthwhile if it remains a dual supply (i.e. you would be supplying very clean and expensive water for irrigating gardens and washing).

2) Rarotonga and Mangaia have an issue with sediment being transferred into the reticulation system following heavy rain. This leads to discoloration and customer dissatisfaction. Ministry of Works have plans for settling tanks and storage at each of their intakes to lessen this impact.

3) Various agencies currently monitor water quality on Rarotonga (and the outer islands) but there is little coordination between the agencies. On Rarotonga the Ministry of Public Health monitors water quality through the reticulated supply. The Ministry of Works monitors water quality at its sources for the reticulated supply. The Ministry of Marine Resources monitors water quality in the lagoon and in conjunction with the Environment Service monitors some streams. None of these monitoring systems are coordinated, nor it seems are the results available for the public to make easy assessment of water quality. In January 2007 several candidates for a bi-election on Rarotonga expressed a desire for a co-ordinated water quality monitoring service. This is a sensible suggestion but thought also needs to be given as to how the information is disseminated to the public.

4) There is a lack of ownership of waste treatment by government agencies. The central septage treatment plant is owned and operated by the Ministry of Works and functions adequately. The Ministry of Public Health administers septic tanks, but understandably this is from a health perspective rather than an environmental performance standard. This means there is no particular drive for a centralised waste treatment facility or high quality septic tank technology, which would be likely to considerably improve water quality in the lagoon and streams, as there is no agency with this type of remit. There is little doubt that the poor treatment of waste presents a significant threat to ecosystem health.

5) During periods of drought there have been water shortages on Rarotonga and other islands. There are several options for minimising this risk: minimising leakage in the reticulation system (currently being addressed for Rarotonga); demand management to lessen demand and wastage; investigation of groundwater supplement of the reticulated supply during times when the surface supply cannot match demand.

6) There is an understaffing issue in the general area of water resource management. The Ministry of Works (which is concerned with water supply on Rarotonga only) has 4 staff dealing with planning and maintaining water supply. On the outer islands this function is fulfilled by OMIA who are similarly understaffed. Waste water treatment is covered by the Department of Health rather than an environmental concern. The lack of staff means that those who work in the area are forced to spend the majority of time “fighting fires” rather than planning and implementing those plans.

3.4.4 Measures to manage impacts and concerns (IWRM approaches)

In terms of information management the Ministry of Works has excellent GIS data on the water reticulation system, source areas (including catchment areas) and intakes for Rarotonga and also many of the outlying islands. The current water reticulation upgrade on Rarotonga has given an excellent opportunity to gather information (via GPS) on the network. This is now stored on a comprehensive GIS system. This information is available to other agencies although there are no easy mechanisms for sharing and availability to the general public (e.g. via websites).

The NZAID funded CIMRIS project on Rarotonga is addressing some water quality issues, particularly those concerning pig farming and piggery waste entering the lagoon via streams.

There are guidelines available for the construction of septic tanks in new houses but there is no monitoring of performance of old septic tanks or drive to improve old septic tank systems.

Water conservation measures are only implemented during periods of drought when either rainwater harvesting is ineffective or stream sources start to produce less. There has been no attempt to measure the effectiveness of these schemes and there is no co-ordinated approach to running them. The Cook Islands would benefit from greater water demand management, particularly in the area of leakage and waste control. Leakage within the network is being addressed by pipe upgrades on Rarotonga. Effective water demand management should raise the drought security standard without requiring extra infrastructure.

3.5 Institutional Arrangements

3.5.1 Types of Institutional Arrangements

There are several organisations involved in water management in the Cook Islands. These are listed below with a brief description of their involvement in water management.

The ***Department of Water Works*** within the Ministry of Works is the agency responsible for planning, installation, operation and maintenance of public water systems in Rarotonga and selected outer islands including Atiu, Mangaia, and Aitutaki.

The Public Health Division of the ***Ministry of Health*** is the agency responsible for monitoring and surveillance of the biological quality of public water supply schemes, managing and approving septic tanks and running awareness programmes for communities on public health issues including water-borne diseases.

The ***Ministry of Marine Resources*** is responsible for the management of coastal waters around the Cook Islands. They are interested in lagoon pollution from surface water runoff and sewage runoff from land-based activities including agriculture and tourism. They also have a well-equipped laboratory for chemical, physical analysis of coastal, surface and groundwater.

The ***Vaka Councils*** are the local government institutions responsible for development and administration of districts within Cook Islands. They have a mandate for representing their communities and essentially provide a vehicle for taking community issues up to the Government.

The ***Cook Islands Association of NGOs*** (CIANGO) is responsible for community development projects. It is widely recognized by International donors and has secured funding for a number of community projects. CIANGO has a key role in water management through their relationship with communities, government agencies, donors, expertise in writing project proposals for funding and links with all local NGOs and community based organisations in Cook Islands.

The ***Ministry of Finance & Economic Management*** (MFEM) is the agency responsible for preparing the national budget and thus has an impact on capital and recurrent funding for water management projects.

The ***Office of the Ministry of Island Administration*** (OMIA) is the agency responsible for overall coordination and monitoring of water management projects in outer islands, and for coordination of development plans including those affecting the water sector.

The ***National Environment Service*** is the agency responsible for environmental issues and concerns including pollution, conservation, waste management, climate change and Environmental Impact Assessments for development projects.

The ***Meteorological Office*** is responsible for issuing weather forecast and monitoring of long-term weather patterns and Climate Change issues. They have strong technical capacity for monitoring and predicting effects of Climate Change on water resources in the Cook Islands.

The common theme in reviewing the water sector in the Cook Islands is that water management and water sector policy generally is not advanced. There is no single national water management legislation in place except for scattered provisions that address the supply of water to the public, e.g. Rarotonga Waterworks Ordinance of 1960, superseded by the Ministry of Supportive Services Act 1973-74, see table 6. In the absence a national legislative framework, water supply projects especially on the outer islands have been historically implemented without full assessment of their viability, sustainability and impact on the local community and environment. There is no national policy on water, sewerage or sanitation and there is no effective regulatory framework in which the public utilities operate to control and manage water. In this vacuum government departments are unsure of each others roles and there is possible duplication and/or omission of roles.

Table 6: Cook Islands legislation and regulations relevant to water resource management.

Act or regulations	Relevance to water resource management	Notes
Ministry of Supportive Services Act 1973-74	MoW mandate to supply reticulated water	Originally for all islands but restricted to Rarotonga since 27 reforms in 1990s
Land Use Act 1979	Established local fisheries committees to manage fisheries	
Prevention of Marine Pollution Act 1998	Prevention of marine spillages	Not linked to land spillages affected marine.
Environment Act 2003	Established National Environment Service	Prevent, control and correct pollution of air, water and land
Public Health (Sewage) Regulations 2007	Establishing sanitary inspectors and standards for septic tanks	Still in consultation phase.

The Department of Public Health state on their website that “they are demonstrating their commitment to improving sewage treatment in the Cook Islands by implementing a four-year strategic plan”. The plan includes training in on-site waste management for sanitary inspectors and health inspectors to improve the enforcement of regulations, the establishment of wastewater testing capabilities to ensure compliance with sewage treatment standards, revised sewage treatment standards, more frequent communication with the community regarding sewage treatment issues and improved storage of sewage infrastructure information on Geographical Information System database. This is a good initiative but still has strong emphasis on waste water treatment as a health issue where there is also a need to recognise it as an environmental issue.

There is no commercialisation within the water sector – water is provided free in Rarotonga and the outer islands – and there is generally a lack of capacity including human and technical resources in the water sector, both government and private sector.

The operation of water supply facilities in the outer islands is now subsidised by the National Government, with any consultation regarding water supply generally channelled from the respective Island Secretary. Government priorities are attempting to redress past socio economic imbalances within the Outer islands with initiatives based on equity and the alleviation of poorer standards, which help to justify strengthened and cooperative efforts by aid funding agencies.

Changes in governance arrangements from a centralised approach have taken place, e.g. the devolution of responsibility from central government to island councils such as the island Council of Aitutaki where Mayors have been elected to allow communities to have a greater say and responsibility in managing local affairs. Furthermore, there is greater awareness of the fragility of the island system and the interdependence between urban and rural land use, water supply, health and environmental issues. This includes the impact of wastewater at the household and island level.

In Rarotonga, for example, a Catchment Protection Committee (Takuvaine) has been established to promote awareness of the importance of land use activities in the catchments and the effects on water quality and environmental health downstream (see section 3.3).

A Water Safety Committee (WSC) has recently (2006) been set up with NZAID funding and the involvement of AUSAID and WHO. The objective of the WSC was initially to ensure sustainability of water supply on Rarotonga. This has now been widened to a national basis to include the outlying islands, although there is an initial emphasis on working on Rarotonga. The committee is structured along IWRM lines with the recognition if the interdependence of land use, water quality, water supply and community liaison (Figure 11). In order to minimise duplication of roles it is recommended that the WSC forms the IWRM committee used in any GEF project.

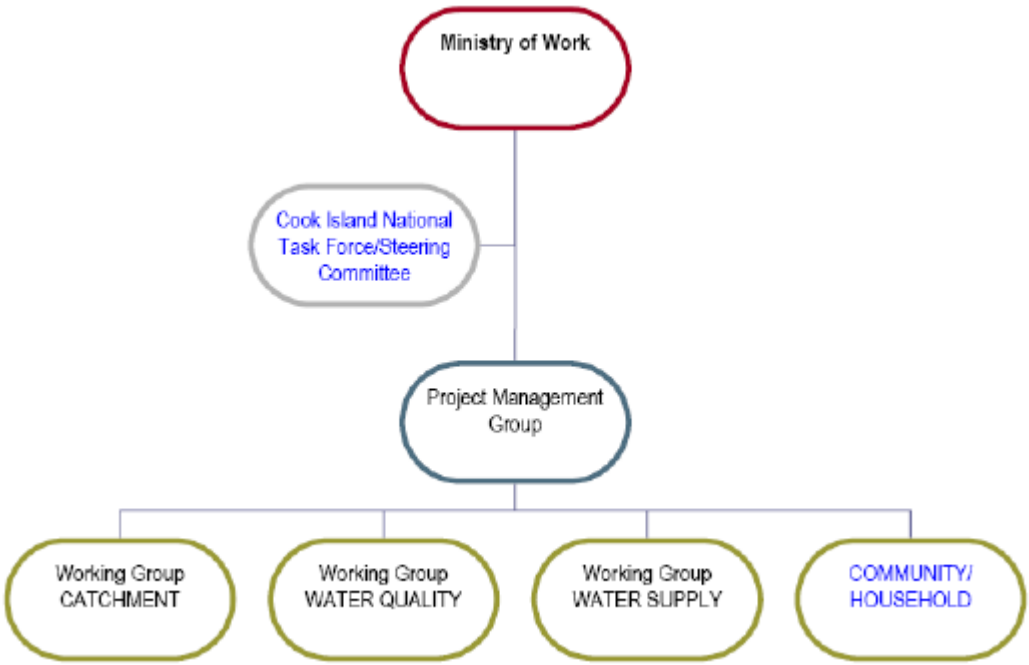

Figure 11: Structure of the Cook Islands Water Safety Plan committee.

3.5.2 Majors Issues and Concerns

The largest institutional issue for water management in the Cook Islands is the lack of an overarching policy and legal framework for water resource management. Current legislation concerns particular aspects of water resource management in a disjointed manner and does not allow for innovative water resource management practises, e.g. water demand management and new pricing structures.

The lack of an overarching planning framework restricts the ability of different agencies to partake in integrated water resource management as they are unsure of their statutory role and frequently appear distrustful of the motivation behind integration. The development of a national policy framework around water resource management would allow an objective review of how water resources are managed throughout the Cook Islands and also provide a template against which the different agencies can support their own 5-10 year planning frameworks.

3.5.3 Measures to manage impacts and concerns (IWRM approaches)

The only current cross institutional arrangement that links closely to IWRM principles is the Water Safety Committee (figure 11). This has been set up for a specific water supply issue but offers a structure for future IWRM institutional arrangements. This is why the WSC has been used as the consultative body for the Cook Islands Hot Spot Analysis for the GEF application. Apart from the WSC there are no current IWRM initiatives on institutional arrangements in the Cook Islands, although government departments do work together on certain projects (e.g. Departments of Marine Resources and Health in CIMRIS). Under the International Water Project (IWP) an initial draft of water management legislation has been started. There is a desire amongst MoW staff for this legislation to enable new financing arrangements for water supply (i.e. separate from central government finances). Similarly this could include different financing for waste disposal and water quality management in general. The legislation work was not part of the overall IWP and has not been formally taken up for consultation and decision making. It would require further work before these could be done.

3.6 Financing

3.6.1 Types of Financing Arrangements

Water supply in the Cook Islands is either funded centrally (where there is a reticulated system) or privately (where there is rainwater collection). There is no charging for water through the reticulated system and all the Ministry of Works budget comes directly from central government. Waste water treatment is a private concern, with septic tank infrastructure and septage removal being paid for privately. The septage treatment plant on Rarotonga is run by the Ministry of Works from central funding.

At present there is no legislative framework present to allow for charging for water supply or waste water treatment (whether by demand or cost recovery). This is a serious barrier to developing the infrastructure as no part of the Ministry of Works budget is separate from normal government budgetary constraints. Figure 12 shows the level of expenditure by the Department of Water Works from 2001-2006. These data are for Rarotonga and operating costs were only available for 3 years. An annual expenditure of $500,000 equates to a per capita expenditure of $53 per resident and $42 if visitors are included. This is low (cf. Wellington City Council in New Zealand expended $123 per capita in 2000 – source Wellington Regional Council documentation) and reflects the simple distribution system and the inability of the government to invest heavily in this area.

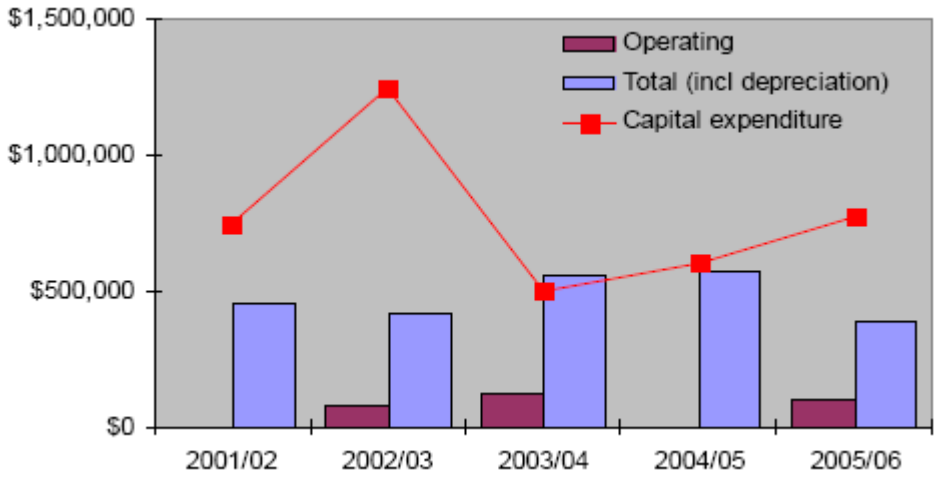

Figure 12: Expenditure of MoW Department of Waterworks 2001-2006. Total expenditure includes personnel, operating and depreciation costs but not capital expenditure (shown separately). Capital expenditure is for pipeline upgrading. Units of expenditure are NZ dollars.

3.6.2 Majors Issues and Concerns

With water supply expenditure being part of normal Government budgetary processes there is risk of important infrastructural requirements being delayed due to budgetary constraints. A water levy system (whether by volume or connection) would allow more certainty in expenditure plans and greater infrastructural planning.

3.6.3 Measures to manage impacts and concerns (IWRM approaches)

As described in section 3.5.3 a start has been made to having water management legislation but this requires considerable further work before being put forward for political and public consultation. This may allow for different financing arrangements than are currently in place. The other IWRM approach is through the demand management project being carried out by SOPAC (see Section 3.1.4). The information from this project should provide information that can be used to propose new financing arrangements.

4. LINKAGES TO OTHER AREAS

4.1 Land use and Agriculture

The IWRM approach recognises the interdependence of land use and water management. This is through the frequent dependence of agriculture on water for irrigation and stock watering and the impact agriculture and other land uses have on water quality.

Cook Islands agriculture has gone through a number of changes in recent years, following primarily market based prices in their export markets, such as Australia and New Zealand. This has seen a major decline in citrus and pineapple production and a shift away from full time agriculture into part-time farming. It is estimated that 85-90% of farmers on Rarotonga are part-time and the majority of full time farmers are over 50 years old (Pers. Comm. W. Wigmore, 2007). Recent market opportunities in SE Asia, including Japan and China, the United States, and Europe, have highlighted additional opportunity to the agricultural sector. Current exports are

based around pawpaw and chillies to New Zealand and Maire (*Alyxia elliptica*) to Hawai'i. Although significant in the gross domestic product data the amount of foreign exchange earned through agriculture is very low; estimated at $0.5-1M per year (Pers. Comm. W. Wigmore, 2007).

While Rarotonga's previously strong agricultural sector continues to decline in the face of increased tourism and residential development, a shift toward focused agricultural development on the southern group of islands outside of Aitutaki and Rarotonga, has taken place. This is a deliberate policy of the Ministry of Agriculture; to shift agricultural to smaller islands to relieve landuse pressure on Rarotonga and Aitutaki (Pers. Comm. W. Wigmore, 2007).

4.1.1 Irrigation and rain-fed agriculture

Water is a major component of agriculture in the Cook Islands, particularly in the growth of vegetables (e.g. tomatoes, corn, and peppers) and taro. As detailed earlier the water demand figure of 1200 litres per person per day is largely through using reticulated water for irrigation. The majority of agriculture is practised at a small scale (0.1 to 1ha); a scale that in other countries might be considered large gardens (Figure 13).

Figure 13: Small plot on Rarotonga growing taro (dryland), cassava and other crops.

The Cook Islands is one of the few places in the Pacific where taro is grown in a wetland environment (Figure 14). Taro is also grown on dry land but there is a taste preference for the wetland taro. The cultivation of wetland taro high in valleys poses a problem for the reticulated

supply source protection, e.g. the taro shown in Figure 14 is above the Takuvaine water supply intake. Sediment generation and human influence on the water from taro cultivation is a serious issue for water supply. The IWP Takuvaine Watershed project has worked with stakeholders, landowners and land users to provide a series of guidelines on what can and can't be done in the Takuvaine valley (Rongo, 2006, see section 3.3).

Figure 14: Taro growing in a wetland created by diverting part of a stream channel through a series of terraces. Takuvaine Valley, Rarotonga.

4.1.2 Agriculture and water quality

Another major agricultural water user is pig farming. On Rarotonga there are numerous pig farms where up to 100 pigs are housed in pens and water is used to wash the pens clean (figures 15 and 16). This is a common practice throughout the Cook Islands. Many of these piggeries have been deliberately placed near streams to allow rapid removal of contaminants. This presents a classic IWRM issue: high water use and the contribution of animal waste to the receiving waters (stream and lagoon).

Figure 15: Intensive piggery on Rarotonga (source: Evans, 2005).

Figure 16: Waste disposal from piggery on Rarotonga (source: Evans, 2005).

4.1.3 Land ownership and land use policy

There is a major issue with agriculture concerning land tenure. Under Cook Island law land is "owned" by families who distribute the right to use the land. Although the land has titled ownership it cannot be sold, only leased to other users. The normal length of lease is 60 years. However, land is normally only leased for occupation or development. Agricultural land use is not considered full occupation; therefore the agricultural land use is often on an informal basis, rather than a formal lease. This creates a problem for an agricultural investor: why spend money developing infrastructure (e.g. a separate irrigation supply and/or smart irrigation systems) when there is no guarantee of land tenure? The lack of security of land tenure discourages agricultural investment that could be beneficial to water resource management and the environment in general.

4.1.4 Deforestation and sedimentation

Deforestation is not a major issue in the Cook Islands, the majority of the uplands are still forested and likely to remain so. Sediment derived from taro plantations is mostly within valleys away from the coastal plain.

4.1.5 Summary of land use and water management issues

There are four IWRM issues linked into land use and agriculture in the Cook Islands:

1) Agriculture is a major water user from the reticulated supply for Rarotonga. Essentially the reticulated supply is a joint potable water and irrigation supply. This becomes a concern if there is a large expenditure on ensuring 100% clean potable water as it makes the irrigation water expensive. Either a separate supply for irrigation or a lower water quality standard need to be considered.
2) The cultivation of wetland taro above water supply intake points creates a problem of sedimentation in the supply.
3) The disposal of waste from livestock farming (and piggeries in particular) creates a major water quality problem.
4) The land tenure system of the Cook Islands works against individual land users spending money on water efficiency as they have no guarantee of long term leases.

These issues can be addressed through IWRM tools such as water demand management (ensuring efficient water use), social change instruments (placing water use responsibility back on the water users), and looking at land use policy and land leases in the light of an IWRM approach.

Although agriculture presents problems for water resources, particularly through high water demand and piggery runoff the major land use and water quality concern is from poorly functioning septic tanks and even for the best tanks the input of nutrients into the groundwater which will be moving into the lagoon. The level of nutrients in groundwater and the rate of movement of groundwater through the coastal plain are currently unknown.

4.2 Habitats and Ecosystems

The Cook Islands, being well to the east across the Pacific has a relatively limited biodiversity (not including ocean species). Rarotonga has 180 indigenous flowering plants, the makatea islands have 90-100, Aitutaki 40 and the northern atolls vary from 25 (Pukapuka) to 18 on Manihiki (PICCAP, 1999). Table 7 outlines the main native habitats and conservation values on each island.

Two prominent features from Table 7 are the loss of coastal forest habitat on the main inhabited islands and the modification and loss of wetlands. These are both due to the main settlements being on the coastal plain (since European times at least) and the use of this land for agriculture. The Cook Islands is not a signatory to the Ramsar Convention on wetlands[•] although it is engaged with the World Conservation Union (IUCN) on wetland conservation and management (P. Gerbeaux, IUCN, pers. comm. 2007).

[•] The Ramsar Convention on Wetlands is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975.

The marine environment of the Cook Islands is divided into the lagoon-reef systems, the outer reef, and the open ocean. There are 24 coral genera and 58 species identified in the Cook Islands (PICCAP, 1999). The lagoon-reef systems are important food sources for Cook Islanders and are use commercially for black pearl production on Manihki and Penrhyn.

Table 7: Habitats and conservation values on islands of the Cook Islands (from PICCAP, 1999).

Island	Area (km^2)	Principal native habitats	Conservation values
SOUTHERN GROUP			
Rarotonga	67	Strand vegetation Coastal forest (mostly lost) Wetlands (mostly lost) Fernlands Inland forest Cloud forest	Inland forest Rarotonga flycatcher breeding Petrel nesting range (4 species) Rare plants Tidal salt marsh (Ngatangiia)
Mangaia	52	Makatea forest	Makatea forest freshwater lake
		Wetlands (mostly lost) Fernlands Inland forest Cloud forest	(Lake Tiriara)
Mauke	18	Makatea Forest Wetlands (modified) Fernlands	Makatea forest
Atiu	27	Makatea forest Wetlands (modified) Freshwater lake Fernlands	Makatea forest freshwater lake (Lake Tiroto)
Mitiaro	22	Makatea forest Wetlands (modified) Freshwater lakes	Makatea forest (dwarf) Freshwater lakes (Lakes Rotonui and Rotoiti)
Aitutaki	18	Strand vegetation Lowland forest (mostly lost) Wetland – saltmarsh	Wetland – saltmarsh
Manu'ae	6	Strand vegetation	Turtle nesting sites
Takutea	1.3	Strand vegetation	Seabird nesting island (protected by landowners)
Palmerston	2	Strand vegetation	Seabird and turtles nesting sites
NORTHERN GROUP			
Penrhyn	10	Strand vegetation	Seabird and turtles nesting sites
Manihiki	5	Strand vegetation	Seabird and turtles nesting sites
Rakahanga	4	Strand vegetation	Seabird and turtles nesting sites
Pukapuka	1.3	Strand vegetation	Seabird and turtles nesting sites
Nassau	1.3	Strand vegetation	Seabird and turtles nesting sites
Suwarrow	0.4	Strand vegetation	Seabird and turtles nesting sites (National Park since 1978)

In the Cook Islands there are several reserves and sanctuaries created for habitat protection and biodiversity reasons. In the South of Rarotonga a 155 ha reserve of upland forest, scrub and fernland was established in 1996 to protect the habitat of the endangered Kakerori (Rarotogan fly catcher). This was set up by land owners and local Ariki (chiefs) with assistance from the National Environment Service. Within the reserve there are restrictions on the type of activities allowed and only limited access is allowed. In 1989 there were only 20 Kakerori left, by 2003 this had

increased to 300, largely through the reserve and the transfer of some birds to Atiu which is free of rats (a major predator).

Suwarrow, in the Northern Cook Island group was declared a National Park in 1978. It is a breeding ground for rare species of turtles, sea birds and crabs. The single resident listed in Tble 2 is a warden, present for most of the year (except the cyclone season). Suwarrow is an important sea-bird breeding site not only for the Cook Islands but for the region and the world. Eleven species of seabirds breed on the island. It supports regionally significant colonies of lesser frigatebirds (9% of world population and the largest population in the South Pacific), red-tailed tropic birds (3% of world population) and the Cook Islands only large colony of sooty terns. Excessive harvesting of sooty terns on Penrhyn (the only other island in the Cooks that have these birds) has reduced the population there. The atoll also supports locally significant colonies of Red-footed Boobies, Great Frigate birds, Masked boobies and Brown Boobies. In addition it is an important wintering site for Alaskan migrant the Vulnerable Bristle-thigh Curlew (Source of info: National Environment Service website).

Manuae, an uninhabited island in the Southern group, is also an important seabird and turtle breeding ground although it does not have official reserve status (it is listed in some publications as a marine reserve but has no formal classification as such).

Takutea, in the Southern Group has been a wildlife sanctuary for sea birds, including frigates and tropicbirds, since 1903. The traditional leaders of Atiu who, are the trustees of Takutea manage the island as a conservation area for wildlife.

Aside from the reserves and sanctuaries described above the largest threat to an ecosystem in the Cook Islands is the coral reef and lagoon system surrounding much of Rarotonga. Development on the island has lead to increased sediment and nutrients entering the lagoon system, causing damage to the corals and the lagoon. Water quality analysis in Titikaveka lagoon (southern Rarotonga) showed that at all sites some water quality parameters were at higher values than recommended for the healthy growth of coral reefs (Hall et al, 2006). The source of these nutrients has not been precisely located but is most probably from septic tank waste seeping into groundwater. A major issue is to establish what level of nutrients there is in groundwater, how quickly that groundwater is moving out into the lagoon, what level of nutrient is sustainable in the lagoon system, and is this level of nutrients attainable with the current septic tank system?

4.3 Health and Hygiene

The World Health Organisation (WHO) reports that the standard of health in the Cook Islands is high. In 2004, life expectancy at birth was estimated at 70 years for men and 75 years for women. The infant mortality rate was 28.60 per 1000 live births in 2005. There has been no case of maternal mortality since 1993. The crude birth rate was 21.2 per 1000 population, and the crude death rate 6.3 per 1000 resident population in 2003. Infectious diseases are rarely seen and usually occur as imported cases. Parasitic intestinal worm disease has been greatly reduced by improved water and sanitation. A water supply and sanitation improvement programme, with the building of flush toilets in all schools and health centres on the outer islands, has enhanced the reduction in these diseases and probably also septic skin disease, rheumatic fever and obstructive airways disease. Leprosy is rarely seen. There was no case of tuberculosis reported in 2003. (Information from WHO database).

The main water related diseases are diarrhoea (835 cases in 2003) and dengue fever. There have been periodic outbreaks of dengue fever: 1992-1993; 1995; 2002 (2491 cases reported) and early 2007. Dengue fever is a mosquito borne disease with no vaccine available. The most effective treatment is elimination of the mosquitoes that carry the disease.

The Ministry of Health periodically carries out water monitoring for microbiological content (coliform) in the water supplies. The water supplies in Rarotonga and Outer islands are neither properly filtered nor disinfected. There are coarse filters at some intakes. During the wet season the water supply is often discoloured and turbid and contains silt, sediment and debris. The water system at present is vulnerable to any form of disaster, such as contamination from agriculture chemicals, sanitation contamination and saltwater intrusion.

The Ministry of Marine Resources carries out water quality monitoring of lagoon sites in Rarotonga and Aitutaki to establish health risks for bathing. They also monitor water quality in Manihiki and Penrhyn to assist black pearl farmers (a major Cook Island export). The report on economic valuation of pollution to the Cook Islands (Hajkowicz & Okotai, 2005) highlights the high risk to tourism from pollution in the lagoon. A major draw card for tourists, especially to Rarotonga and Aitutaki, is the pure waters and a “beach holiday”. It is extremely important for the Cook Islands economy that water pollution does not become a major issue stopping tourists visit.

The Takitumu Irritant Syndrome in 2003-04 caused itchiness or rash on the skin, running or bleeding nose, watery/stinging eyes and respiratory difficulties (Hajkowicz & Okotai, 2005). This is consistent with response to naturally occurring toxins associated with algal blooms (Hall et al., 2006) likely to be associated with elevated nutrient levels in the lagoon. These nutrient levels may rise with increased development on the coastal plain.

Other water related health concerns are gastro-enteritis diseases from the untreated water on most islands (see table 5). Water quality testing by the Ministry of Health and the Water Works Division of MoW has shown E. Coli presence in Rarotonga water supply. The levels fluctuate but there is normally some present.

It is undoubtedly true that tourism development has placed significant extra pressures on water resource management in Rarotonga and Aitutaki. In times of drought the extra tourist population places extra stress on the reticulation system although data from Clement & Bourget (1992) suggests the water consumption by individual tourists is probably less than by Cook Islands residents. The largest stress comes from wastewater disposal, even for large hotels a septic tank is system is still used. This is a major issue for the Cook Islands.

4.4 Watershed and coastal management

The Cook Islands economy is largely dependent on tourism. The biggest draw card for tourists, and the most common promotional image, is the clean and clear tropical lagoon waters. If the Cook Islands were to allow environmental degradation of the coastal lagoon environment through poor waste treatment and lack of integrated water resource management then it truly would be a case of "killing the goose that laid a golden egg". The study of Hajkowicz and Okotai (2005) has clearly set this out in terms of an economic valuation: watershed pollution in Rarotonga has an estimated avoidable cost from improved watershed management of NZ$7.4 Million per year (3% of GDP in 2003). These figures were derived from estimates of the cost of different categories in the absence of pollution; the major categories being healthcare, water treatment and alternative supply augmentation, and loss of tourism income (Hajkowicz and Okotai, 2005). It is vital to the Cook Islands future that watershed and coastal management are integrated fully so that degradation of the coastal lagoons does not impinge upon tourism and general public health.

The Cook Islands Marine Resources Institutional Strengthening (CIMRIS) project is designed to enhance the management and sustainable use of marine resources for the benefit of all Cook Islanders, by building the capacity of the Ministry of Marine Resources (MMR) and related agencies. There are two components of the project that directly interact with an IWRM approach.

- Component 1: *Institutional Strengthening*. To assist MMR to develop the organisation and management systems and skills that will enable it to effectively plan, implement and report major strategies and projects aimed at sustainable marine resource management.

- Component 4: *Sustainable Inshore Ecosystem Management*. To assist facilitate community management of lagoon ecosystem improvement through the application of ecosystem management plans that are based on qualitative and quantitative analysis and continuous monitoring and evaluation, and to assist MMR to coordinate the inputs required from different agencies.

The largest barrier to an integrated management approach is the lack of a national framework and legislation on water resource management. Without this the various departments involved in integrated water resource management struggle to identify their own roles and are reluctant to promote partnerships and integration.

4.5 Stakeholder Engagement

Process and approach used to gather information and institutions and individuals involved and consulted.

Institution	Stakeholders/Interests and Responsibility	Relevance to IWRM and reason for Inclusion	Role in the consultation process
Office for the Minister of Island Administration (OMIA)	Responsible for infrastructure and administration on the outlying islands	Any IWRM initiatives beyond Rarotonga will be administered by OMIA	Represented at Group meeting
Ministry of Finance and Economic Management	Financial centre of government and involvement in disaster recovery (island vulnerability)	Co-funding of IWRM and island vulnerability analysis	Interview with Patrick Arioka, and 2 other staff
Ministry of Agriculture	Land use management	Land use planning initiatives	Interview with William Wigmore
Ministry of Health	Water quality for drinking and bathing	Interested in WQ and septic tank management	Discussion with various staff in rarotonga and represented at Group meeting
Ministry of Works	Water resource management	Intricately involved with water resource management and public water supply	Liaison with Atatoa Herman, Ben Parakoti and other staff
NZAID	Aid development projects in all islands	Links to other water projects in Cooks	Discussed through MFEM
Environment Service	Biodiversity and general environmental protection	Concerned with environmental enhancement & degradation, part of IWP	Discussion with various staff and represented at group meeting
Department of Marine Resources	Water quality in the receiving waters (lagoon)	Interested in water quality of freshwater entering lagoon	Discussion with various staff and represented at group meeting
Cook Islands NGO	Aid projects and general IWRM initiatives	Involvement in future IWRM initiatives	Represented at Group meeting

5. OTHER PROGRAMMES, PROJECTS AND ACTIVITIES RELATED TO IWRM

Process and approach used to gather information and institutions and individuals involved and consulted.

Donor	Project title	Location	Duration	Financial allocation
NZAID	Community water harvesting repairs & drought proofing	Pukapuka Rakahanga Penrhyn Manihiki (Northern Group)	2006 - 2009	$1,875,000 (funding gap of $2,230,000
NZAID & CEAP ADB	Community water harvesting repairs & drought proofing	Wale, Pukapuka	2006 - 2009	$188,000
NZAID	Topographical survey for recovery of public utilities in Pukapuka and satellite imagery for the outer islands	Pukapuka, Rakahanga, Penrhyn, Manihiki, Penrhyn, Nassau, Aitutaki, Palmerston, Mauke, Mitiaro, Atiu, Mangaia		$480,000
NZAID	Cook Islands Ministry of Marine Resources Institutional Strengthening Project (CIMRIS)	Throughout Cook Islands	2005-2009???	????
NZAID	Water demand management partnership (SOPAC & PWA)	Rarotonga	2006-09	$90,000
Cook Islands Govt	Water supply infrastructure upgrade	Rarotonga	??	>>
EU	HYCOS	Rarotonga and other islands	2007-2009	
NZAID	Water quality monitoring	Rarotonga	?	$100,000
AUSAID	Water safety planning	All Cook Islands		$90,000

6. CAPACITY DEVELOPMENT NEEDS FOR REMOVING THE BARRIERS

The Cook Islands, as with most Pacific Islands states, suffers from a lack of capacity to implement large-scale IWRM plans. It is important to note that there is not a lack of capability among people currently concerned with water management, the majority are tertiary level trained with an excellent understanding of the key water management issues. The issue is that these people are inundated with projects in many different areas related to water and there are not enough staff members to take on new initiatives. The following recommendations for capacity building are based on the observations of Dr Davie from his short time on Rarotonga (January 2007).

1) The first step in capacity development for IWRM should be to develop a national framework and legislation on water resource management. If done well, this will enable long-term planning of staff requirements to implement a clear set of goals and objectives over a 10-20 year period. This will also provide a clear framework for the different agencies (and possibly new agencies) to work together on key cross-cutting themes like IWRM.

2) Run a series of workshops in the Cook Islands on the theme of integration ("what can be achieved through working together that can't be achieved through separation"). This should be run at two levels with a different workshop for each. First for the high level managers and politicians in organisations, in order to ensure engagement by their organisations. The second should be for the "on-the-ground practitioners" to give practical ideas on how integration can be achieved. These workshops need to include regular follow up sessions to challenge practitioners to move beyond current institutional barriers.

3) Develop a capacity needs assessment for IWRM to be presented to the Government for development over a 10 year time frame. The National Sustainable Development Plan (Te Kavenga Nui) provides an excellent platform for this. Included in Te Kavenga Nui documentation is an infrastructure development plan; a similar framework could be used to develop a national capacity plan. The plan should include targeting recruitment and training in particular areas of benefit for integrated water resource management.

7. INTRODUCING AN INTERGRATED APPROACH TOWARDS BARRIER REMOVAL

Current IWRM approaches in the Cook Islands are well developed in some areas but very weak in others. Grouping these into strong medium and weak, the areas of strength are hydrometric monitoring (a relatively recent initiative), Geographical Information Systems (GIS) and digital imagery for information storage and display; and planning for disasters and climate change (although implementation of the plans is still to come).

The medium strength areas include: initiatives around community awareness of land use, freshwater and marine interactions; improving water supply infrastructure; water demand management and water quality monitoring. In these cases there have been initiatives to develop these areas of IWRM but there is still a considerable amount of work to be done to make them mainstream water resource management concerns.

The weakest areas are around institutional arrangements, financing, and waste water treatment. These are the areas that require the largest amount of work to have an integrated approach to water resource management. The following list is in priority order for the type of work required to produce integrated water resource management in the Cook Islands.

National legislative and policy framework for water management

The lack of a national legislative and policy framework for water policy is a major barrier to IWRM. Under the present system government departments and other organisations are unsure of each others roles and there is possible duplication and/or omission of roles. It also leads to mistrust on the motives behind integration in the management of water resources. There is a need for the current draft water management legislation (drafted under the IWP) to be reviewed and enlarged to look at institutional structures and roles for future IWRM. The establishment of a Water Safety Council (2006) has given a good impetus for establishing an overarching organisational framework for IWRM in the Cook Islands. This can be carried forward by setting in place a policy and legislative framework that promotes integration between agencies involved in water resource management.

Understanding waste water treatment impacts on receiving waters

There is a need to understand the contribution current wastewater treatment systems (septic tanks) make to nutrients entering receiving waters, i.e. groundwater, streams and the lagoon. This requires an assessment of how much nitrogen and phosphorus is in groundwater and how quickly the groundwater system is moving towards the lagoon. This information needs to be tied into an assessment of what levels on nutrient are sustainable in the lagoon. With both these sets of information a decision can be made as to whether the desired water quality standards are attainable under the current waste water treatment practices or a new systems needs to be designed. This could be a centralised waste water treatment plant or an upgrade of current septic tanks; the decision on which would be dependent on the required water quality standards.

Capacity building around integrated management

As set out in section 7 there is a major need to address the issue of capacity in the area of integrated water resource management. This requires long-term succession and training planning.

Water demand management

As island states like the Cook Islands face increased risks through climatic vulnerability the reduction in water leakage and wastage is desirable. This will allow for cutting costs in service provision but also ensure that the current allocation goes further. This can be achieved by bringing in simple water demand management techniques such as smart irrigation systems, water metering and pricing, and education on water usage.

Water supply surety and island vulnerability

Surety of water supply is an issue that needs addressing as tourism expands in the Cook Islands and possible climate change alters the patterns of rainfall. This needs to be addressed in conjunction with water demand management so that water supplies are not overdeveloped at the expense of the environment. Possible future strategies include greater use of groundwater on Rarotonga (during periods of drought), aquifer storage and recovery (ASR) during the wet season on outlying islands and desalination.

Land tenure and water usage (integrated planning)

The current land use tenure system within the Cook Islands is detrimental to agricultural investment in water smart irrigation systems and other technology that might lessen agriculture's water resources impact. A review of land tenure system needs to be carried out with a view to considering impacts beyond revenue returns to the land owner. This does not necessarily mean a change in the overall system (which is excellent for retaining ownership with the indigenous people) but a review of how agriculture is treated as a land use compared to other land uses. French Polynesia, which has a similar land tenure system, is currently undergoing a similar review.

Although there are many areas that require addressing for full IWRM to be achieved in the Cook Islands there is considerable potential for it to be achieved. It has the advantage of being a relatively small country without greatly increasing population pressures and a moderate to high rainfall. The largest requirement is a political and community will for integration between agencies

so that IWRM can lead to achieving sustainable growth in harmony with the Cook Islands' culture and environment.

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