WASTEWATER MANAGEMENT IN RAROTONGA: IT IS NOT JUST A MATTER OF A TECHNOLOGICAL FIX?

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ABSTRACT

Apart from one small community sewage treatment system in Rarotonga, all domestic and commercial wastewater in the Cook Islands is managed by on-site systems. The Cook Islands comprise 15 islands with a total residential population of almost 15,000. About 10,000 live on the main island of Rarotonga. Nearly all development is on the coast where free draining coral sands overlay a shallow groundwater table that drains into an encircling coral lagoon. The tourist industry earns the greatest revenue in the Cook Islands and tourists expect a high standard of sanitation service when they come to enjoy healthy, safe and ecologically stable coral lagoon ecosystems for swimming, snorkeling and other activities. For an economy with high costs of living and low salaries, the challenge is to find the right formula to provide the required high standard sanitation service.

The first sanitary systems used on the islands were pit toilets. These smelt and created health problems so there was a move to pour-flush toilets. These proved unsatisfactory so the Government agencies recommended flush toilets with single, then dual and now three-chamber septic tanks, with most discharges to soak holes. With rapid development on the coastline and deteriorating coral reef health, comes increasing recognition of the impact of on-site sanitation systems on human health and ecological sustainability. The Cook Islands Government Agencies, with assistance from NZAID and AusAID, are addressing these concerns. While some are hopeful that a simple low cost technological fix is all that is required, it is increasingly clear that a multi-level integrated approach is required; involving institutional strengthening, training, inter-agency co-operation and effort, and community awareness programmes as well as improved wastewater technologies and systems. This paper presents and discusses the experiences of the authors in preparing and delivering a programme to strengthen sanitation practices in the Cook Islands.

Keywords: On-site wastewater, Cook Islands, training, regulations, ecosystem impact.

1 INTRODUCTION

The Cook Islands are a Polynesian island group comprising 15 islands located in the Pacific Ocean between latitudes 14° S and 22° S, and longitudes 159° W and 164° W. The main island Rarotonga, is a volcanic island of 67 km^2 and a population of 14153 (includes visitors) and 2964 private dwellings (2006 census). The other 14 islands accommodate a total population of 5416.

Geologically, the Cook islands are very different and include the high volcanic island of Rarotonga, four raised coral islands with volcanic cores (Mangaia, Mauke, Mitiaro and Atiu), a near atoll with a volcanic core (Aitutaki, which is the next most populated island), one sand cay (island of sand on coral foundation) and eight atolls.

The coastal fringe of Rarotonga consists of sediments derived from inland and sea deposition processes. Foothill terraces have formed from fans of strongly weathered volcanic alluvium while a narrow strip of

beach deposits and coral debris surrounds the island. A depressed belt of swamp, underlain partly by coral sand and partly by fan gravels, occurs between the terraces and the coastal strip (Leslie 1980).

The number of visitors to the Cook Islands in 2004 was just over 94,000. The Cook Islands (CI) Statistical Bulletin (September Quarter 2006) projects a visitor population of 16,500 by 2016 with 87% of visitors to Rarotonga and 10% to Aitukaki. The visitor population for the Cook Islands in 2006 was about 9500. Rarotonga is a popular destination for many New Zealand and Australian travellers seeking friendly and jovial hosts, fun island nights, relaxing white sand beaches and warm and beautiful lagoons for swimming, diving and snorkeling.

The Cook Islands (CI) economy is dependent on tourism, which in 2004/2005 generated 40% of the GDP. The Cook Island Government realises that a sustainable tourist industry will only be achieved with sanitation services that protect the health of the public and the ecological sustainability of the coral lagoons. A recent study by CSIRO (Hajkowicz, 2005) highlighted the extent to which the CI economy depended on healthy and stable ecosystems. The study estimated that Rarotonga…. *could potentially avoid costs of NZ$7.4 million per year, or $2,900 per household per year, if watershed pollution across the entire island was prevented*.

The same report notes that - *effective management of watersheds to recover at least some part of these costs will require a combined government, industry and community response on:*

- Soil erosion and stream sedimentation;
- Herbicide and pesticide run-off;
- Fertiliser run-off;
- Livestock and animal waste;
- Septic tank leakage;
- Mosquito outbreaks from stream blockage and poor waste disposal; and
- Liquid and solid waste disposal.

In addition to the economic drivers, the CSIRO report noted that there are numerous other non-financial impacts which also have significant, possibly greater, value to people: namely *potential loss or harm to biodiversity and loss of recreational or cultural sites, damage to scenic beauty and non-financial human health impacts.*

2 WATER AND SANITATION SERVICES: RAROTONGA

This paper focuses on Rarotonga, the main island in the CI group. On Rarotonga, nearly all development is on the coast where free draining coral sands overlay a shallow groundwater table that drains into an encircling coral lagoon. The tourists expect a high standard from water supply and wastewater infrastructural service. In addition to the demand that the tourism industry places on such services, the Cook Islands are subject to severe cyclones. Between 4 February and 8 March 2005, the Cook Islands experienced five damaging cyclones, four of which were assigned a severity rating of Category 5 and caused damage to homes and essential public infrastructure. The recent Asian Development Bank (ADB) Infrastructure Master Plan (ADB, 2006) highlighted the need for a *long-term national climate change adaptation strategy and an integrated infrastructure development plan, which incorporates climate change adaptation concepts.*

2.1 Water and Wastewater Infrastructure

A ring main around the island of Rarotonga supplies most of the population with a reticulated water supply. The island's water is sourced from 12 intakes, drawing water from spring and surface water

sources in the inland valleys. Apart from coarse gravel filters, there is no treatment of the raw water. The reticulated town water system is also used for agricultural purposes.

Binnie (1984) reports Rarotonga water consumption figures of approximately 1200 litres per capita per day, which is high when considering a reticulated water supply system. Leakage and wastage of reticulated water are major issues for Rarotonga. Binnie (1984) estimated leakage losses at 16% of total demand.

Apart from one small package sewage treatment plant (currently non-operational) servicing a school and about 50 households in Tereora and Tepuka, there are no reticulated sewerage or wastewater systems in the Cook Islands. All properties (domestic, commercial, industrial and agricultural) have some type of on-site wastewater servicing system. On Rarotonga and Aitutaki, mostly septic tanks to soakage pits with some commercial operators having secondary treatment systems. Other islands rely on pit toilets.

A very high proportion of on-site wastewater systems on Rarotonga are single or multi-stage septic tanks, with no filter and direct overflow into soak holes. For coastal properties (the majority), soak holes are in the highly permeable coral sands with the groundwater table from 1 to 4m below ground level. This groundwater emerges in the island's shallow lagoon. In Rarotonga, the different soils range from a narrow coastal band of very free draining coastal sands to heavy volcanic clays inland. Many of the inland clays are Category 5-6 as in AS/NZS 1547, certainly unsuitable for soak holes, some are unsuitable for seepage trenches for primary effluent.

The results of a recent sample audit of 12 on-site wastewater systems by the authors revealed:

- Of the 12 properties visited, none appear to have a septic tank that would conform to septic tank standard AS/NZS 1546 Part 1;
- Only three had accessible inlet and outlet tees;
- None was fitted with septic tank outlet filters;
- It was not possible to check the capacity of the tanks in relation to the loading. For one accommodation provider the single septic tank will have been overloaded;
- Two septic tanks had serious leaks and therefore were failing to operate; and
- All systems inspected were discharging to a soak pit or a small soakage bed.

Recently installed (ADB funded) septage management ponds located in Arorangi at the Waste Management Centre, receive and processes septage from the septic tanks on the island and it is claimed that this plant has sufficient capacity for 15 years (Asia Development Bank 2006, Vol 2, #332). A similar facility has been installed in Aitutaki.

3 HEALTH AND ECOSYSTEM ISSUES

The need for a high standard of sanitation services in Rarotonga and the outer islands is driven by both the public health needs of the island's permanent residents and requirement to protect the lagoon ecosystems, which are a major attraction for the essential tourism industry

Evans (2006), noted that the reef has been plagued with ciguatera, and that the toxin that causes ciguatera fish poisoning comes from a microscopic marine organism called a dinoflagellate. She also noted that a contributing factor to the deterioration of Rarotonga's reef and lagoon was sedimentation, for reefs located near reef passages. *Clearance of vegetation and construction on sloping lands results in increased soil runoff from the land. Most coral can tolerate short-term sedimentation but prolonged exposure leads to loss of their symbiotic zooxanthellae, polyp swelling and excessive mucous secretion* (Evans, 2006). Evans quoted Kirk who measured sediment buildup in the lagoon from Avana River *after being dislodged from*

the land during agricultural activity and house construction. The filling of Ngatangiia passage has caused a 'dam-effect' which has slowed flushing of Muri lagoon and hindered the transportation of coral sand out of the system (Kirk, 1980).

What has been described as the irritant syndrome, occurred between November 2003 and May 2004. During this event people *on the southern side of the island complained of symptoms such as skin rashes, itchiness, sore throats, running noses, asthma attacks, shortness of breath and conjunctivitis-like symptoms such as redness and burning in the eyes.* (Evans, 2006). There have been various explanations for this event. A visiting World Health Organization consultant suggested that these symptoms were the result of a toxic dinoflagellate bloom in the lagoon. Quoting Lehane, Evans notes that *high numbers of this dinoflagellate have been correlated with high nutrient levels in the water* (Lehane, 1999).

As a consequence of ecological stress on lagoons, the CI Ministry of Marine Resources, with technical assistance from the National Institute of Water & Atmospheric Research Ltd (Hamilton, NZ) implemented a water quality monitoring programme of streams and the lagoon to provide baseline data and to evaluate whether potentially toxic algae species were present in the Titikaveka lagoon area. The results of this study for the period December 2004 to April 2005 (Hall *et al.* 2006) found that *water quality of the streams was highly variable, with potentially toxic levels of ammoniacal nitrogen …* and the *… water quality measurements in the lagoon showed that at all sites some water quality parameters were at higher values than recommended for the healthy growth of coral reefs.*

While no work has been carried out tracing lagoon and surface stream contamination to septic tank soak pits, it is generally accepted that current sanitation practices are substandard and require upgrading.

The ADB report (Barrett Consulting Group 1995) identified three wastewater management issues:

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

The ADB study included a mass balance of key nutrients entering the Rarotonga lagoon (Barrett Consulting Group 1995). The study found that the nitrogen contribution along the coastline varied from 0.36 to 1.9 kg/yr for every metre of coastline for the 1991 census. The report projected that these values would increase to 0.9 to 2.7 kg/yr.m by 2005 and advised that these levels of N loading would create grave ecological stress for near-shore coastal lagoons.

4 SEWAGE REGULATIONS

Current sanitation standards are set by the Public Health section of the Ministry of Health who issues a set of guidelines for on-site sanitation as part of the development approval process. Two other government agencies may be involved in the permitting process; the National Environment Service may require an Assessment of Environmental effect and the Ministry of Works who require a building permit. The Public Health guidelines are a three page document that sets out the requirements for a three chamber septic tank and soak hole/absorption trench. This same document specifies setback distances, from boundaries, public roads, buildings and water courses. These guidelines are now considered insufficient for the larger development projects and the environmental conditions typically found in the Cook Islands.

The new Public Health (Sewage) Regulations 2007 have recently been drafted by the Ministry of Health and the adoption of these is imminent. The purpose of these regulations is to regulate for best practice in sanitation. This legislation will require a considerably higher standard of sanitation practice than in the

past, demanding a substantially increased capacity in government agencies, industry and engineering design. For example the Regulations draw on many of the standards set in AS/NZS1547:2000 for on-site systems.

The Regulations (Section 7) require the registration of Sanitary Professionals and Technicians. The registration of septic tanks and more advanced treatment units is required under Section 8&9 of the Regulations.

Capacity building involving Government agencies, industry and the community is essential to effectively implement these new regulations. Few sewerage system installers are familiar with the standards set in AS/NZS1547:2000. Most installers and regulators don't appreciate the importance of properly designed land application systems. Septic tank designs also fall below standards set out in AS/NZS 1546:1. The three development approval agencies had overlapping and yet conflicting policies on sewage treatment. Inter-agency co-operation and co-ordination is necessary for the successful implementation of the Regulations.

5 THE CIMRIS PROJECT

In anticipation of the need for increased capacity in sanitation engineering and management, training has been undertaken since early 2006 as part of the Cook Islands Marine Resources Institutional Strengthening (CIMRIS) project. This project, jointly funded by NZAID and AusAID aims *to enhance the management and sustainable use of marine resources for the benefit of all Cook Islanders.* The project involves a multidisciplinary team of specialists, including those with expertise in the areas of fisheries management, marine resources, ecosystem science, engineering, and community development. A key component of the project is the use of ecosystem-based management plans based on qualitative and quantitative analysis with continuous monitoring and evaluation. The project recognises that the marine ecosystems in lagoons in the east and south of Rarotonga are under extreme stress and the ability to sustain a subsistence fishery drastically diminished, as is the appeal of the area for overseas visitors expecting to see coral and fish. The CIMRIS project further recognizes that recovery will take a long time and will require a sustained effort by local and central government as well as local communities. Effluent from septic and sewerage systems in the catchment areas and effluent from agricultural activities contributes to this degradation. The project brief is to introduce appropriate septic, sewerage and agricultural effluent management systems for tourist resorts, residences and agricultural activities to reduce the presence of nitrates and phosphates in lagoon and reef waters.

Two key initiatives progressed as part of this project are a three stage training programme in sanitation and development of a code of practice for domestic sewage, as part of a pilot integrated lagoon management plan for the Takitumu Vaka (a district which includes the Muri and Titikaveka villages of Rarotonga).

6 SANITATION TRAINING

The CIMRIS project coincided with the new Public Health (Sewage) Regulations 2007 legislation. Two stages of a three stage training programme by the Centre for Environmental Training (CET) have been completed. (CET, based in Newcastle New South Wales, is a provider of professional training in on-site and decentralised wastewater management.)

The training objectives were to provide a programme for stakeholders that promote best practice in the design and management of sewage services in the Cook Islands and meet the requirements of the Public

Health (Sewage) Regulations 2007. The training programme provides training for three Course Categories described in Table 1

TABLE 1. Training categories

Category		Participants
Inspectors/auditors	C1	For regulators; inspectors, auditors, environmental managers and assessors
Sanitary Engineers	C2	For system and component designers, system certifiers and problem solvers.
Wastewater industry	C3	For installers, technology and septic tank manufacturers, suppliers and servicing agents.

There are three training stages:

Stage 1: (6 days) June 2006 – Basic principles in wastewater treatment and land application
Stage 2: (5 days) May 2007 – Treatment systems, site assessment and compliance
Stage 3: August to Dec 2007 – Supervised projects. Training trainers.

The course structure for each category consists of:

- A series of block courses with lectures, tutorials, discussion groups and field visits;
- Assessable exercise;
- Supervised projects and assignments between block courses; and
- Mentoring.

Stages 1 and 2 involved about 30 participants from government agencies (including Public Health, Ministry of Works, National Environment Service), industry (installers, servicing agents, drainlaying and plumbing companies, septic tanks manufacturers and cleaners, engineering consultants) and operators and maintenance staff from resorts and members of the community with an interest in sanitation services.

The existing standard of trade practices (septic tank construction, installation and servicing) is low. Practical training for septic tank manufacturers, installers and servicing agents is considered essential, and because the CET courses described above do not provide the practical trade skill training needs, there is a proposal being currently being developed the National Human Resources Development Department, to upgrade, to NZ certification standards, a number of trade training programmes in the Cook Islands, including plumbing and drainlaying.

7 TAKITUMU LAGOON MANAGEMENT PLAN: PILOT STUDY

One of the challenges the CIMRIS project faced was to achieve an inter-agency integrated approach to improving the state of the lagoons. As a pilot study, a lagoon management plan was therefore instigated for the Muri-Titikaveka catchments (Takitumu Vaka) of Rarotonga. This Plan has been developed by CIMRIS in conjunction with the Takitumu Vaka Council, members of the Takitumu community, and officers from government agencies, particularly the Ministry of Marine Resources, the National Environment Service, and the Ministry of Health.

The Management Plan for the Takitumu lagoon seeks to guide actions so that the lagoon will remain healthy and productive. The Plan sets out a cooperative pathway to be adopted by all those who live, work or visit the Takitumu area. The Plan is based on the principles established in the National Sustainable Development Plan 2007-2010 (NSDP) and the National Environment Strategic Action Framework 2005-2009 (NESAF). The Plan empowers the community in partnership with traditional leaders, government, business and the voluntary groups to work together to (i) identify the key issues (ii) take action to reduce

the threats to the health of the lagoon and (iii) respond to the growing environmental pressures. The action components of the plan include:

- Best practice guidelines for pig management;
- Code of Practice for domestic and commercial sewage management;
- Water quality monitoring of streams and the lagoon (nutrients, bacteria, suspended solids);
- Snapshot of groundwater nutrient levels;
- Develop and deliver the awareness and communications strategy;
- Monitor lagoon fauna and flora, and ciguatera abundance;
- Assess coral reef health;
- Estimate fish species consumption;
- GIS-based environmental information system to better manage land use practices;
- Best Practice Guidelines for erosion control in the catchment; and
- Best Practice Guidelines for lagoon and stream foreshore protection

8 COMMUNITY AWARENESS PROGRAMME

The Public Health Department within the Ministry of Health and other stakeholders in sanitation are preparing a number of community awareness brochures on sanitation, including:

- *How a septic tank works;*
- *How to apply for a sewage construction permit; and*
- *The problem with soak pits*

The awareness brochures provide a transition from the old Ministry of Health sanitation guidelines to the new Public Health (Sewage) Regulations. The new sanitation standard is very different to the existing one: without widespread awareness of the reasons for this change, their enforcement will be difficult, if not impossible. Communication via the media is expected to be significant, and a list of frequently asked questions has been prepared for this purpose. Community sanitation training workshops will also be used to stimulate widespread community participation and support.

9 CONCLUSIONS

There is a culture of expectation of a quick and preferably cheap technological fix that can be installed, forgotten and that will solve the sanitation problems in the Cook Islands. There is a widespread lack of understanding of wastewater treatment and dispersal processes and the fate of the various wastewater constituents within the context of the ecological and social systems in which they are embedded.
Even though risks to public and ecosystems health came from wastewater pathogens and nutrients, there was an expectation that primary treatment using multi-chamber septic tanks would significantly mitigate such risks and that adding a filter to septic tanks would further reduce such risks. These measures alone will have little effect on these types of risks. Such a culture increases vulnerability to the commercial spin of plausible agents selling wastewater technologies. Often such agents, whether from within the country or from outside, have an inadequate understanding of the local CI circumstances and conditions. There are many examples of failed technologies.

The approach being taken by the MOH/CIMRIS project includes the following levels:

- Development of appropriate sanitation regulations and codes that not only set design and management standards but also require registration of sanitation professionals, technicians and technologies;
- Training of professionals and technicians in agencies and the sanitation industry;

- Raising community awareness;
- Facilitating interagency co-ordination and co-operation;
- Monitoring approved installed systems;
- Monitoring ecosystems

The expectation is that an integrated multi-level approach to providing sanitation services in the Cook Islands will result in sustainable infrastructure providing protection and enhancement of public and ecosystem health.

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